CONTENTS

President’s welcome ................................................................................................................................. 3
Acknowledgements................................................................................................................................. 4
Organization ............................................................................................................................................... 5
Faculty ....................................................................................................................................................... 6
Accreditation ............................................................................................................................................... 7
General information .................................................................................................................................. 8
Social programme ....................................................................................................................................... 9
Scientific programme ............................................................................................................................... 12
Members’ day sessions (abstracts) ........................................................................................................... 20
Presentations (abstracts) .......................................................................................................................... 30
Scientific sessions (abstracts) .................................................................................................................... 169
Posters exhibition (abstracts) .................................................................................................................... 187
Radiological technologists’ sessions (abstracts).................................................................................. 207
Dear colleagues

It is a pleasure to announce the 17th Symposium of the European Society of Urogenital Radiology (ESUR). Supported by the European Society of Radiology (ESR), the Society of Urogenital Radiology (SUR), the Royal Belgian Society of Radiology (KBVR-SRBR) and the Belgian Association of Urologists (BAU), ESUR 2010 will meet in Bruges, Belgium. From September 9th until September 12th, 2010 you are welcome at the Symposium in the conference centre ‘Oud Sint-Jan’ in Bruges.

Urogenital radiology is rapidly evolving, with new imaging technologies on the one hand and increasing modalities for focal treatment and targeted intervention, requiring tailored imaging and follow-up, on the other hand. The main topic of the ESUR 2010 Symposium is ‘Imaging and Focal Therapy’ and will be covered by specialists in interdisciplinary lecture sessions and workshops.

The scientific programme should be largely attractive and includes lectures, workshops, scientific sessions and a Bracco satellite lunch symposium. The scientific events are hosted in former patient wards of the ‘Oud Sint-Jan Hospital’. During the congress hours there will be a technical exhibition in the congress venue. The coffee breaks will be organized at the exhibition area to improve contacts with the representatives of the industry. The social event on Saturday evening and the accompanying persons’ programme take the participants to historical Bruges, a UNESCO World Heritage Centre.

We hope that physicians with a particular interest in uroradiology share and compare knowledge, visions and expectations in future technologies, and strengthen friendships with colleagues across Europe and countries from all over the world.

The Organizing Committee and the City of Bruges are delighted to welcome you and your partner to the ESUR meeting, from September 9th until September 12th!

Raymond Oyen, MD, PhD
Chairman of the Local Organizing Committee

ESUR 2010
ACKNOWLEDGEMENTS

Diamond sponsors:

Gold sponsors:

Silver sponsors:

Generous financial support granted by:

Professional advice, assistance and documentation:

Kind support by:

Catering:

Website: DATAVISION
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ORGANIZING SECRETARIAT

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Herestraat 49
3000 Leuven, Belgium
info@esur2010.be
Tel.: +32 16 34 37 71 / Fax: +32 16 34 37 69
www.esur2010.be or www.esur.org

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V. Sahni (US)  
M. Scherr (DE)  
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F. Stacul (IT)  
G. Tardáguila (ES)  
H. Thoeny (CH)  
H. Thomsen (DK)  
C. Trianthropoulou (GR)  
A. Tuncay Turgut (TR)  
A.J. van der Molen (NL)  
Ph. Van Hover (BE)  
S. Verma (US)  
G. Villeirs (BE)  
M. Weston (UK)  
R. Zagoria (US)
ACCREDITATION

The ESUR 2010 – 17th Symposium of the European Society of Urogenital Radiology (event code: 4381) was granted 18 European CME credits (ECMEC) by the European Accreditation Council for Continuing Medical Education (EACCME). Each participant should only claim those hours of credit that she/he actually spent in the educational activity. EACCME credits are recognized by the American Medical Association towards the Physician’s Recognition Award (PRA). The CME credit certificate will be handed out on site at the end of the Symposium.
GENERAL INFORMATION

Bruges
Find more information on the city where ESUR 2010 takes place: www.brugge.be
National Geographic rates Bruges 19th on the list of Best-Rated Places.

Venue
ESUR 2010 takes place in the Site “Oud Sint-Jan”.

Site Oud Sint Jan
Mariastraat 38
8000 Bruges (Belgium)
Tel: +32 (0)50 476 100
Fax: +32 (0)50 476 101
SOCIAL PROGRAMME

THURSDAY SEPTEMBER 9TH, 2010

The Members’ Dinner will take place in the BALLROOM at the Kempinski Hotel Dukes’ Palace in Bruges. The entrance tickets will be handed out on-site at the secretariat of the Symposium, if registered.

FRIDAY SEPTEMBER 10TH, 2010

All participants, accompanying persons and sponsors are kindly invited to join the Welcome Reception and walking dinner with typical Belgian specialties at the conference venue on Friday, September 10th, 2010 at 18h00. The entrance is free of charge for all registered participants (accompanying persons included).
The participants are invited by the Mayor to a Welcome Reception at the TOWN HALL at 19h00.

The Gala Dinner is organized at the most beautiful “Provinciaal Hof”, situated at 2 minutes’ walking distance from the Town Hall.

The entrance tickets, for both the welcome reception and the course dinner, will be handed out on-site at the secretariat of the Symposium, if registered.
ACCOMPANYING PERSONS’ PROGRAMME

The fee for accompanying persons is €100,00 (registration until June 15th, 2010) / €125,00 (late registration as from June 16th, 2010).

This fee includes:
- the welcome reception and walking dinner with typical Belgian specialities on Friday, September 10th, 2010 at the congress venue
- a guided walking tour in Bruges with an English-speaking professional guide, including a coffee break
- a museum pass
- a ticket for a boat trip

Guided walking tour: Bruges city centre

You will explore the UNESCO World Heritage centre to get an overview and information about buildings and life in medieval Bruges. A cup of coffee with chocolate will be offered in a typical location.

The guided walking tour will take place on September 10th, 2010 from 14:00h until 16h00. The language of the tour is English.

Early booking is recommended as on-site availability cannot be guaranteed. The organizers reserve the right to cancel the tour if the minimum required number of participants is not reached. There will be no refund for cancellations of accompanying persons unless the activity is cancelled by the organizers, whereupon a total refund is guaranteed.

Registration for accompanying persons does include admission to the congress exhibition, but does not include congress materials.

Further tours to Bruges and/or its surroundings can be booked on an individual basis on-site at the conference office.
SCIENTIFIC PROGRAMME

**SCIENTIFIC PROGRAMME**

<table>
<thead>
<tr>
<th>Date</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thursday, September 9(^{th}), 2010</td>
<td>Members’ day</td>
</tr>
<tr>
<td>Friday, September 10(^{th}), 2010</td>
<td>Presentations Workshops</td>
</tr>
<tr>
<td>Saturday, September 11(^{th}), 2010</td>
<td>Presentations Workshops</td>
</tr>
<tr>
<td>Sunday, September 12(^{th}), 2010</td>
<td>Scientific sessions Guidelines Subcommittees Quiz</td>
</tr>
</tbody>
</table>

Programme subject to change.

**CONFERENCE HOURS**

<table>
<thead>
<tr>
<th>Date</th>
<th>Start – End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thursday</td>
<td>09.09.2010 – 14:00h – 18:00h (Members’ Day)</td>
</tr>
<tr>
<td>Friday</td>
<td>10.09.2010 – 09:00h – 18:00h</td>
</tr>
<tr>
<td>Saturday</td>
<td>11.09.2010 – 09:00h – 17:30h</td>
</tr>
<tr>
<td>Sunday</td>
<td>12.09.2010 – 09:00h – 13:30h</td>
</tr>
</tbody>
</table>

**SECRETARIAT**

The symposium secretariat will be operating at the entrance hall of the congress centre for registration, information and certificates, throughout the Symposium.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thursday, September 9(^{th}), 2010</td>
<td>12:00h – 19:00h</td>
</tr>
<tr>
<td>Friday, September 10(^{th}), 2010</td>
<td>08:00h – 19:00h</td>
</tr>
<tr>
<td>Saturday, September 11(^{th}), 2010</td>
<td>08:00h – 19:00h</td>
</tr>
<tr>
<td>Sunday, September 12(^{th}), 2010</td>
<td>08:00h – 13:30h</td>
</tr>
</tbody>
</table>
| Thursday  
| September 9, 2010 | Friday  
| September 10, 2010 | Saturday  
| September 11, 2010 | Sunday  
| September 12, 2010 |
|-------------------|-------------------|-------------------|-------------------|
| Registration      | Registration      | AMBASSADEUR       | BACH Poster Exhibition |
| BACH              | BACH              | BEETHOVEN         | 08:00 - 12:00    |
| Poster Exhibition | Poster Exhibition | MOZART            |                  |
| 08:00 - 18:00     | 08:00 - 18:00     | STRAUSS           |                  |
| AMBASSADEUR       | AMBASSADEUR       | Scientific Session I-IV |
| Lecture Session I | Lecture Session IV| 09:00 - 10:30     |                  |
| 08:55 - 10:30     |                   |                  |                  |
| Coffee break      | Coffee break      | Coffee break      |                  |
| 10:30 - 11:00     | 10:30 - 11:00     | 10:30 - 11:00     |                  |
| WITTE ROOS        | BEETHOVEN         | AMBASSADEUR       |                  |
| Opening Technical Exhibition | Programme Technologists | Lecture Session VIII | 11:00 - 12:15 |
| 10:30             | 11:00 - 12:30     |                   |                  |
| Registration      | AMBASSADEUR       | AMBASSADEUR       |                  |
| BACH              | Lecture Session II| MOZART            |                  |
| Poster Exhibition | Lecture Session V en VI | 11:00 - 12:30 |                  |
| 12:00 - 18:00     | 11:00 - 12:30     |                   |                  |
| AMBASSADEUR       | AMBASSADEUR       | AMBASSADEUR       |                  |
| Bracco Satellite Lunch Symposium | Lunch | Film Interpretation Session | 12:15 - 13:00 |
| 12:30 - 14:00     | 12:30 - 13:30     | Closing Ceremony and Awards | 13:00 - 13:30 |
| BEETHOVEN         | AMBASSADEUR       | AMBASSADEUR       |                  |
| Members’ Day Session I | Lecture Session VII | MOZART |                  |
| 14:00 - 15:45     | 13:30 - 15:00     | STRAUSS           |                  |
|                   |                   | 15:00 - 15:30     |                  |
| Coffee break      | Coffee break      | AMBASSADEUR       |                  |
| 15:45 - 16:15     | 16:00 - 16:30     | BEETHOVEN         |                  |
|                   |                   | MOZART            |                  |
|                   |                   | STRAUSS           |                  |
|                   |                   | Workshops I-III   |                  |
|                   |                   | 16:30 - 18:00     |                  |
|                   |                   | Workshops IV      |                  |
|                   |                   | 16:00 - 17:30     |                  |
| BEETHOVEN         | VVALDI GARDEN     | TOWN HALL         |                  |
| Members’ Day Session II | Opening ceremony | Reception         |                  |
| 16:15 - 18:05     | Welcome reception & cocktail | 19.00 |                  |
|                   | 18:00             | PROVINCIAL HOF    |                  |
|                   |                   | Gala Dinner       |                  |
|                   |                   | 20.00             |                  |
| BEETHOVEN         |                   |                   |                  |
| General Assembly  |                   |                   |                  |
| 18:05 - 19:05     |                   |                   |                  |
| KEMPINSKI HOTEL   |                   |                   |                  |
| Members’ Dinner   |                   |                   |                  |
| 20.00             |                   |                   |                  |
HONORARY LECTURE: PARVI RAMCHANDANI

“MINIMALLY INVASIVE MANAGEMENT OF UPPER TRACT UROTHELIAL CANCER”

Moderator: B.K. Ham (DE)

‘Dr. Parvati (Parvi) Ramchandani is a professor of radiology and surgery in the School of Medicine, and currently serves as chief of the genitourinary radiology section. She is in Pennsylvania since 1990, and is involved in the education of radiology residents, abdominal imaging and interventional radiology fellows, urology residents, urology nurse practitioners, and nephrology fellows. She is consistently rated one of the best teachers by residents in both the radiology and the urology departments. Dr. Ramchandani’s trainees speak of the transformative role she has played in their lives as well as the enduring effect of her teaching; her students especially appreciate her energy, enthusiasm, encouragement, and genuine interest in and concern for their education and well-being’.

Source: Almanac, University of Pennsylvania

Volume 55 Number 32

www.upenn.edu/almanac
“CONTRAST MEDIA AND THE KIDNEY: NEW INSIGHTS, NEW PERSPECTIVES”

Moderator: R. Oyen (BE)

Follow-up of patients who develop CIN: a new insight on long-term risks

F. Stacul (IT)

New perspectives for contrast enhanced ultrasound: follow up of patients after renal tumor radiofrequency ablation

J.M. Corréas (FR)

Contrast enhanced MRI and safety: insights into patient management

H. Thomsen (DK)
**PREVIEW CENTRE**

A preview centre will operate throughout the duration of the Symposium. Presenters are kindly requested to hand in all material of their presentation at least 60 minutes before their scheduled session time. If a presentation is early in the morning, presenters are encouraged to check their presentation at the preview room the afternoon before.

Please note that all versions of MS Power Point and Mac will be accepted. If you intend to use embedded video clips in your presentation, please remember to submit video files separately.

**CONFERENCE ROOMS**

<table>
<thead>
<tr>
<th>Lecture Sessions</th>
<th>Ambassadeur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Members’ Day Sessions</td>
<td>Beethoven</td>
</tr>
<tr>
<td>Workshops</td>
<td>Beethoven Mozart Strauss</td>
</tr>
<tr>
<td>Poster Exhibition</td>
<td>Bach</td>
</tr>
<tr>
<td>Technical Exhibition</td>
<td>Witte Roos</td>
</tr>
<tr>
<td>Technologists Sessions</td>
<td>Beethoven</td>
</tr>
<tr>
<td>Coffee – Lunch</td>
<td>Witte Roos</td>
</tr>
<tr>
<td>Welcome Reception</td>
<td>Vivaldi Garden</td>
</tr>
<tr>
<td>Meeting Room</td>
<td>Simon Stevin Salon</td>
</tr>
</tbody>
</table>

**CONFERENCE LANGUAGE**

The official language is English. Translation will not be provided.
**REGISTRATION FEES**

<table>
<thead>
<tr>
<th></th>
<th>before 15.06.2010</th>
<th>from 16.06.2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESUR / SUR Member</td>
<td>€ 275,00</td>
<td>€ 325,00</td>
</tr>
<tr>
<td>Non-Member</td>
<td>€ 325,00</td>
<td>€ 375,00</td>
</tr>
<tr>
<td>Member RBRS (KBVR/SRBR)</td>
<td>€ 305,00</td>
<td>€ 355,00</td>
</tr>
<tr>
<td>Single day ticket (Saturday – Urologists only!)</td>
<td>€ 150,00</td>
<td>€ 175,00</td>
</tr>
<tr>
<td>Residents*</td>
<td>€ 125,00</td>
<td>€ 175,00</td>
</tr>
<tr>
<td>Technologists/Radiographers* (Saturday only)</td>
<td>€ 75,00</td>
<td>€ 85,00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accompanying Persons</td>
<td>€ 100,00</td>
<td>€ 125,00</td>
</tr>
<tr>
<td>Members’ Dinner (Thursday)</td>
<td>€ 80,00</td>
<td>€ 80,00</td>
</tr>
<tr>
<td>Course Dinner/Social event (Saturday)</td>
<td>€ 100,00</td>
<td>€ 100,00</td>
</tr>
</tbody>
</table>

The conference fee for ESUR/SUR members, non-members, RBRS members and residents includes participation in the scientific sessions, admission to the technical exhibition, coffee breaks, lunches, the welcome reception, and the congress bag with the abstract book and a sweet surprise, certificate of attendance and certificate of accreditation.

The registration fee does not include participation in the accompanying persons’ programme.

The single day ticket for Urologists (Saturday only!) includes participation in the scientific sessions, admission to the technical exhibition, coffee breaks, lunch and the congress bag with the abstract book and a sweet surprise, certificate of attendance and certificate of accreditation. However, Urologists are encouraged to participate the full programme!

The registration fee does not include participation in the accompanying persons’ programme.

The fee for technologists/radiographers on Saturday includes the admission to the dedicated lectures, the technical exhibition, coffee breaks, lunch, a congress bag with text book and a certificate of attendance.

The fee for accompanying persons includes a guided walking tour in the Bruges city centre, the welcome reception, a museum pass and a ticket for a boat trip. It however does not include participation in the scientific sessions.

The early registration fee is applicable for registration and payment until June 15th, 2010. As from June 16th, 2010 a late registration fee will be charged without further notice.

*Please note that for the registration as resident or technologist a certificate of your employer is required.*
**Changes, Cancellations and Refund Policy**

Changes or cancellations must be requested in writing to info@esur2010.be.

A refund of the registration fee less an administrative fee of € 50,00 will be given if a written cancellation is received by **September 1st, 2010**. Cancellations after this date and no-shows will be nonrefundable. All eligible refunds will be issued after the congress and no refund will be processed on-site.

There will be no refund for cancellations of accompanying persons unless the activity is cancelled by the organizers, whereupon a total refund is guaranteed.

Participants are responsible for cancelling their accommodation and travel arrangements. Please note that in case of cancellation or no-show the hotels reserve the right to charge the full stay if the hotel room cannot be resold.

**Taxes**

21% VAT and all applicable taxes are included in all fees.

**Badges**

Delegates’ badges will be available at the symposium secretariat at the congress venue. It is advised to all participants to wear their badge in the symposium area as well as in the exhibition area.

The badges will distinguish following groups:

<table>
<thead>
<tr>
<th>Role</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presenters – Chairpersons</td>
<td>red color</td>
</tr>
<tr>
<td>Participants</td>
<td>blue color</td>
</tr>
<tr>
<td>Accompanying persons</td>
<td>green color</td>
</tr>
<tr>
<td>Exhibitors</td>
<td>yellow color</td>
</tr>
<tr>
<td>Secretarial staff</td>
<td>grey color</td>
</tr>
<tr>
<td>Technical staff</td>
<td>white color</td>
</tr>
</tbody>
</table>

**Technologists**

A scientific programme focusing on CT and MR imaging of the urogenital tract will be offered to technologists.

The fee for technologists/radiographers on Saturday includes the admission to the dedicated lectures, the technical exhibition, coffee breaks, lunch, a congress bag with text book and a certificate of attendance.
**TECHNICAL EXHIBITION**

There will be technical exhibition in the congress venue during the congress hours.

**PICTURES**

A photographer will be present at all major events. Pictures will be available on the website.

**INTERNET**

Free wireless internet access is available at the congress site.

**MOBILE PHONES**

It is kindly asked to switch off mobile phones during the presentations.

**INSURANCE – LIABILITY**

All participants are strongly advised to carry the appropriate travel and health insurance, as the ESUR 2010 organizers cannot accept liability for any accidents or injuries, damage to private property or additional expenses incurred as a result of changes of dates, venue, programme or anything else that may occur at the Symposium.
DETECTION OF PROSTATE CANCER FOCI IN PATIENTS WITH BIOCHEMICAL ALTERATIONS: 1H-MRS AND DCEMR AT 3T IN COMPARISON WITH PCA3 TEST RESULTS

V Panebianco1, G Busetto2, A Sciarra2, F Galati1, V Bonocore1, R Passariello1
1Department of Radiological Sciences and 2Department of Urological Sciences, Sapienza University of Rome, Italy

PURPOSE: In this study we compared PCA3 test with MRSI-DCEMR combined examination in the detection of prostate tumor foci in patients with persistently elevated PSA levels and prior negative random TRUS-guided biopsy.

MATERIALS AND METHODS: A total of 43 consecutive patients with a first negative random TRUS-guided prostate biopsy for prostate adenocarcinoma with persistent elevated PSA levels (total PSA between ≥4 ng/ml and < 10 ng/ml) and negative DRE underwent MR examination on 3 T magnet (Verio, Siemens, Germany) equipped with surface phased array and endorectal coil. Scan protocol included morphologic imaging with TSE T2-weighted sequences on the axial, sagittal and coronal planes, spectroscopic imaging with 3D CSI sequences and dynamic contrast enhanced imaging using 3D FLASH T1-weighted sequence. The second prostate biopsy was performed no later than 30 days from the first prostate biopsy and no later than 2 weeks from PCA3 test and MR examination.

RESULTS: For PCA3 test, the total number of urinary sediments that could be analyzed successfully was 95.3% (41 on 43 specimens) as for MR, the examination and the following comparison with biopsy results was possible in all patients (43/43, 100%). The overall sensitivity and specificity of PCA3 in this cohort were 76.9% and 66.6% respectively with a Positive Predictive Value (PPV) of 80% and a Negative Predictive Value (NPV) of 62.5%. Sensitivity and specificity, for combining MRI, MRS and DCEMR, were respectively 92.8% and 86.6% with a Positive Predictive Value (PPV) of 92.8% and a Negative Predictive Value (NPV) of 86.6%.

CONCLUSION: The association MRSI/DCEMR in comparison with PCA3 results shows a better characterization of prostate cancer foci and can improve cancer detection rate especially in patients with prior negative TRUS-guided biopsy and altered PSA serum levels.

THE ROLE OF CT UROGRAPHY IN GYNAECOLOGICAL MALIGNANCIES

O Nikolic1, S Stojanovic1, S Djurdjevic2, M Basta Nikolic1
1Center for Radiology, 2Clinic of Gynaecology and Obstetrics, Clinical Center of Vojvodina, Novi Sad, Serbia

PURPOSE: 1. To optimally assess the upper and lower urinary tract, 2. define the grade of hydronephrosis and level of obstruction, 3. visualise urinary tract anomalies and anatomical variations in patients with gynaecological malignancies.

MATERIAL AND METHODS: During a period of one year (1.03.09-1.03.10.) 116 patients with different gynaecological malignancies were operated. 42 patients underwent irradiation therapy (vulvar, cervical, endometrial carcinoma and uterine sarcoma). All the patients were examined using single-bolus three-phase CTU protocol (non contrast, venous and excretory phase) with intravenous administration of Furosemide. CTU examinations were performed by a Siemens Somatom Sensation Cardiac 64 scanner. Postprocessing included MPR, MIP, VRT and curved MPR reconstructions.

RESULTS: There were 24 cases of cervical cancer, 31 ovarian cancers, 36 uterine cancers (sarcoma, endometrial carcinoma), 25 others (retroperitoneal tumors of different origin, rectosigmoid carcinoma). Among all the examined patients (158) in 43 patients we found uni/bilateral hydronephrosis/hydrouretre due to compression, malignant infiltration or fibrous changes of the ureter. We also found 1 false negative bladder infiltration in case of uterine tumor, 6 true positive bladder infiltrations and 3 rectosigmoid infiltrations. In 7 patients there was a different amount of ascites in the abdomen and pelvis. There were 3 cases of ureteral duplication and 1 ectopic kidney. In advanced stages of the disease the same patient usually had more than one pathological finding. Additional findings during CT urography were: liver metastases, bone metastases, lymphadenopathy, omental cake, pleural effusion.

CONCLUSION: CT urography has been of great importance to gynaecological surgeon not only for disease staging, but also for optimal visualisation of the ureteral routes and surgery planning.
Visualisation of the urinary tract with demonstration of the level of ureteral obstruction was possible even in the absence of renal excretory function.

QUANTITATIVE GADOBENATE DIMEGLUMINE MR-PERFUSION PARAMETERS IN PROSTATE CANCER
MK Scherr¹, M Seitz², UG Mueller-Lisse¹, M Ingrisch¹, UL Mueller-Lisse², MF Reiser¹
¹Department for Clinical Radiology and ²Department for Urology, University of Munich, Germany

PURPOSE: To determine if quantitative, model-based MR-Perfusion (MRP) with gadobenate dimeglumine (Gd-BOPTA) discriminates between prostate cancer (PCA), benign tissue, and transitional zone tissue (TZ).

MATERIALS AND METHODS: 27 Patients (age, 65+/−4 years; PSA 11.0+/−6.1 ng/ml) with clinical suspicion ofPCA underwent standard MRI, 3D MR-Spectroscopy (MRS), and MRP with Gd-BOPTA. After definition of an arterial region of interest (ROI), maps of the mean transit time (MTT) were calculated using Tikhonov-regularized deconvolution. On these maps, regions of interest were defined and classified as benign regions (bROIs, n=29), cancer regions (cROIs, n=14), and regions of transitional zone (tzROIs, n=18), based on results of combined MRI/MRS and subsequent guided prostate biopsy alone (17/27), biopsy and radical prostatectomy (9/27), or sufficient negative follow up (7/27). Subsequently, quantitative perfusion analysis was performed using a two-compartment exchange model, yielding the parameters plasma flow (PF), plasma volume (PV), plasma mean transit time (PMTT), extraction flow (EFL), extraction fraction (EFR), interstitial volume (IV) and interstitial mean transit time (IMTT). Two-sided T-tests (significance level p<0.05) were used to investigate possible discrimination of bROIs vs. cROIs and cROIs vs. tzROIs, respectively.

RESULTS: PMTT discriminated best between bROIs (11.8+/−3.0s) and cROIs (24.3+/−9.6s) (p<0.0001), while PF, PV, PS, EFR, IV, IMTT also differed significantly (p0.00002 to 0.0136). Discrimination between cROIS and tzROIs was insignificant for all parameters except PV (14.3+/−2.5ml vs 17.6+/−2.6ml, p<0.05).

CONCLUSION: Quantitative, 2-compartment MRP with Gd-BOPTA discriminates between prostate cancer (PCA) and benign tissue with several parameters e.g. for further biopsy planning in peripheral zone. However, distinction of PCA and TZ does not appear to be reliable.

MRI FOR PATIENT SELECTION IN ACTIVE SURVEILLANCE OF PROSTATE CANCER
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PURPOSE: To determine predictive accuracy of T2w (T2-weighted) MRI and DWI (Diffusion weighted MRI) in patient selection for active surveillance (AS) by stage and Gleason score (GS). To determine influence of cancer volume on the above.

MATERIALS AND METHODS: 12 prostatectomy patients, who met the following criteria, were retrospectively included:
1 inclusion criteria AS (Dall’Era, Cancer, 2008, 112: 1650-1659) 2 3T MRI with endorectal coil and DWI (single-shot EPI TR 2600 ms, TE 91 ms, b-values 0, 50, 500, 800 s/mm², 1.5 x 1.5 x 3mm). 4 radiologists with 1 year (novice) and ≥3 years of experience in prostate MRI (experienced) independently examined images. T2w-MRI and T2w-MRI+ ADC were scored in 2 sessions with a two week-interval. Five point scales were used for presence of a stage ≥T3 and of a GS 4 or 5 component. Receiver operating curve (ROC) analysis was performed on a patient basis using prostatectomy as a ground truth. Scores of 4/5 were considered positive for prediction of a GS 4/5 or stage T3, which predicted AS exclusion.

RESULTS: 8 true AS patients and 4 AS exclusion cases were included. AS exclusion based on stage and GS was predicted more correctly by experienced radiologists (100% of cases (4/4)) in comparison to the inexperienced radiologist (75% (3/4)). 75-100% (6-8/8) of AS patients was predicted correctly. For all readers T2w MRI GS was most accurate in predicting AS exclusion (AUC 0.84) followed by T2w stage (AUC 0.78) and DWI GS (AUC 0.66). Prediction of AS exclusion by T2w MRI+ADC GS was
significantly less accurate (z = 3.32, 2-tailed p=0.0009) for cancers <0.5 cc (AUC 0.45) in comparison to cancers >0.5 cc (AUC 0.89).

Conclusion: T2w-MRI may contribute in patient selection for active surveillance.

T2w-MRI+DWI GS based prediction of AS exclusion performed significantly worse for small cancers (<0.5 cc).

LOCAL PROSTATE CANCER RECURRENCE DETECTION IN BIOCHEMICAL PROGRESSION AFTER PROSTATECTOMY: 1HMRS-DCEMR AT 3 T IN COMPARISON WITH [(18)F]CHOLINE PET/CT RESULTS

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PURPOSE: The aim of this study was to compare the performance of proton MR spectroscopic imaging (1H-MRSI) and dynamic contrast-enhanced MRI (DCE-MRI) combined techniques versus [(18)F]choline PET/CT in the diagnosis of local prostate cancer recurrence after RRP.

MATERIALS AND METHODS: Eighty-four patients with high risk for local cancer recurrence after RRP on the basis of the pathological stage and postoperative PSA increase and who were candidates for external beam radiotherapy underwent MR examination on 3T scanner (Verio Avanto, Siemens Medical Solutions, Erlangen, Germany) equipped by surface phased array and endorectal coil. Scan protocol included morphologic imaging with TSE T2-weighted sequences on the axial, sagittal and coronal planes, spectroscopic imaging with 3D CSI sequences and dynamic contrast enhanced using 3D FLASH T1-weighted sequence. The same patients underwent PET/CT. As gold standard, TRUS biopsy results and PSA value reduction after Radiation therapy. ROC curve analysis was performed in order to compare each technique diagnostic accuracy level.

RESULTS: 1HMRSI-DCEMR showed sensitivity of 92% and specificity of 75%, while PET/CT showed 62% and 50% respectively in small lesions (mean volume local recurrence < 10 mm). 1HMRSI-DCEMR showed a 94% sensitivity with 100% specificity in lesions with local recurrence mean volume > 10 mm; in this group PET/CT showed a 92% sensitivity and 75% specificity.

CONCLUSION: The diagnostic accuracy of combined 1HMRSI-DCEMR was higher than PET/CT (mean volume local recurrence < 10 mm). We obtained similar accuracy level between techniques for lesions major than 10 mm. MR exam was the only one exam with high diagnostic accuracy in evaluation of prostatic fossa in patient with low PSA increased (ranged between 0.2 ng/ml to 2 ng/ml).

THE INITIAL EXPERIENCE WITH PERCUTANEOUS CRYOABLATION OF RENAL CELL CARCINOMA IN LEEDS

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PURPOSE: This aims to evaluate our initial clinical experience with percutaneous image-guided cryoablation of renal cell carcinoma (RCC).

MATERIALS AND METHODS: Percutaneous cryoablation was performed on 22 RCCs in 20 patients from May 2008 to April 2010 in a single institution. All treatments were performed using CT-guidance and under general anaesthesia. Warm pyeloperfusion or hydrodissection technique was used accordingly. The treatment response was examined with contrast enhanced CT or MRI. Technical success was defined by absence of contrast enhancement within the tumour on CT or MRI. All complications, the management and outcomes of the complications were prospectively documented.

RESULTS: A total of 22 renal tumours were cryoablated with a mean tumour size of 2.5cm (range 0.7-5.5 cm). The mean patient age was 68 years (age range 38-82 years). The primary and overall technical success rate was 85% vs. 95% respectively. Twenty one renal tumours were completely ablated (18 during a single session, 2 after a second session and 1 after a third session) with a mean follow-up period of 7.95 months (range from 0.1-12 months). One patient declined re-treatment. There were 2 minor complications including subcapsular haematoma and transient lumbar plexus injury. One predicted ureteric injury occurred while treating a centrally RCC adjacent to the renal pelvis.

CONCLUSIONS: Percutaneous image-guided cryoablation is safe, effective and minimally invasive treatment for RCC. There is a definite learning curve for cryo-needle placement and residual disease should improve with operator’s experience. Warm pyeloperfusion should be considered for treating tumour close to the collecting system/ureter.
MEDIUM TERM OUTCOME AND PATTERNS OF RELAPSE OF RENAL TUMOURS TREATED WITH RADIOFREQUENCY ABLATION
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INTRODUCTION: Percutaneous radiofrequency ablation (RFA) has become an increasingly accepted curative treatment option for renal cell carcinoma (RCC) especially in patients with co-morbidity, single kidneys or multiple tumours. Previous reports have raised concerns about durability of oncologic control and skip areas of viable tumour within ablation zones being a source for tumour relapse. We determined medium term outcome for a large series of RFA treated RCCs and radiological patterns of relapse.

MATERIALS AND METHODS: Retrospective review was made of medical records, clinic letters and MR/CT images of a cohort of patients with biopsy proven RCC who were treated with RFA in a single North American centre, up to October 2007. In patients who relapsed MR/CT imaging was reviewed and compared with pretreatment imaging.

RESULTS: 125 biopsy proven RCCs were treated with RFA in 104 consecutive patients. Mean age 70.4 years, 66% were men and tumours ranged in size from 0.6 - 8.8 cm. Clinical and Imaging follow up was for a mean of 23.9 and 22.9 months respectively. 17 patients had primary treatment failure and 2 patients had secondary failure or relapse (at least one disease-free interval scan). Of the 17 patients with primary failure, 6 had repeat treatment with no further recurrence, the remainder had either further treatment with residual disease, surgery or conservative management. 87.5% of patients were tumour free with a mean follow-up time of 29.9 months. 13 patients have been lost to follow up. The secondary failures relapsed at 30.7 and 31.7 months. Relapsed-residual tumour always involved the periphery of the ablation zone, there were no areas of viable tumour within the margins of the ablation zone.

CONCLUSION: Medium term follow up of RFA for RCC shows good oncological control. Our relapse patterns do not support the theory of skip lesions within ablation zones, even when overlapping ablations were used for larger tumors.

SECONDARY CTKUB SIGNS OF URETERIC COLIC – THE ESSENTIAL PICTORIAL GUIDE
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PURPOSE: The gold standard diagnostic investigation for ureteric colic is Unenhanced Computed Tomography of the Kidneys, Ureters and Bladder (CTKUB). Direct intraluminal stone visualization is not always possible, and this pictorial review illustrates the key signs every radiologist should be familiar with, which support or refute the diagnosis of ureteric colic.

MATERIALS AND METHODS: Documented primary and secondary CTKUB signs supportive of ureteric colic or radiological mimics such as phleboliths are identified. Each radiological sign is illustrated with the best examples from a retrospective review of CTKUB cases. The diagnostic weightings of signs are discussed and placed into a guide to facilitate interpretation based on the findings of an extensive literature review.

RESULTS: Radio dense foci along the expected pathway of the ureter but not definitely within the lumen are said to be indeterminate. However, the presence of hydronephrosis and hydroureter predict that a distal indeterminate calcific focus represents a ureteric stone with an accuracy of up to 99%. Secondary signs in decreasing order of sensitivity and specificity are hydronephrosis, hydroureter, perinephric oedema, and nephromegaly. The soft tissue rim sign has a sensitivity and specificity of up to 77% and 92% for stones proximal to the vesico-ureteric junction. The pale kidney sign has been identified in up to 95% of patients with colic. A comet-tail sign is said to have a positive predictive value of up to 100% for identifying a phlebolith.

CONCLUSIONS: Diagnostic difficulty arises with an indeterminate calcific focus. In these cases a number of supporting secondary signs of ureteric obstruction should be sought. A positive soft tissue rim sign helps to positively identify a ureteric stone. In the absence of these signs a positive comet-tail sign suggests a phlebolith. Secondary signs in the absence of a calcific focus suggest the recent passage of a stone.
TYPICAL MR-FINDINGS IN VULVAR AND VAGINAL PATHOLOGIES
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Congenital anomalies of the vulva and the vagina are usually detected already in the physical examination. Diagnostic imaging, especially ultrasound, cystourethrography and MRI can add special information about the anomaly and are the leading diagnostic tools to verify them. Pathologies of the vulva and the vagina are rare. In fact that more and more younger women undergo an infection of the human papilloma virus (HPV), the incidence of vulvar and vaginal malignancies caused by the HPV will increase.

Diagnstic imaging, especially with MRI, can add important information about the local extension of these tumors. This course will give an overview about the most frequent congenital anomalies which can be visualised with diagnostic imaging. Imaging findings of the most frequent benign and malignant lesions of vulva and vagina will be demonstrated. The course will also go into detail about the changes of revised FIGO and TNM staging of vulvar and vaginal carcinoma.

PERCUTANEOUS RADIOFREQUENCY ABLATION OF RENAL CELL CARCINOMA: THE LEEDS EXPERIENCE
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PURPOSE: To evaluate our clinical experience with percutaneous image-guided radiofrequency ablation (RFA) of renal cell carcinoma (RCC) and to assess factors that may influence the complication rate.

MATERIALS AND METHODS: RFA was performed on 167 RCCs in 128 patients from June 2004 to April 2010 in a single institution. All treatments were performed using image-guidance (US or CT) and under general anaesthesia or conscious sedation. Cold pyeloperfusion or hydrodissection technique was used accordingly. The treatment response was examined with contrast enhanced CT or MRI. Technical success was defined by absence of contrast enhancement within the tumor on CT or MRI. All complications, the management and outcomes of the complications were prospectively documented. Multivariate analysis was performed to determine variables associated with major complications.

RESULTS: The treated RCCs with size ranged from 0.9-5.6cm (mean=3 cm). Amongst them, 164 (98.2%) were completely ablated with a mean follow-up period of 25.9 months. Three patients declined re-treatment. There were 9 major complications including ureteric injury (n=6), calyceal-cutaneous fistula (n=1), acute tubular necrosis (n=1) and abscess (n=1). Multivariate analysis revealed that cold pyeloperfusion protects the collecting system from thermal injury (p<0.001) and lower pole tumors were associated with higher incidence of pelvi-ureteric injury (p<0.001).

CONCLUSIONS: Image-guided RFA is safe, effective and minimally invasive treatment for small RCC. Cold pyeloperfusion technique should be considered whenever performed RFA close to the collecting system/ureter. It is important to be aware of the higher incidence of PUJ injury for lower pole tumors so that patient could be consented accordingly.

NEW PROTOCOL OF CT CYSTOGRAPHY (CTC) WITH DUAL SOURCE TECHNIQUE IN DETECTION OF BLADDER LESION
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PURPOSE: To assess a new CT protocol of CTC and Virtual Cystoscopy with Dual Source technique in detection of bladder lesions using Cystoscopy with Photodynamic Diagnosis (PDDs) as reference standard.

MATERIALS AND METHODS: Thirty hematuric patients suspicious for bladder cancer and fourteen patients who had undergone transurethral resection of the bladder underwent CTC and Virtual Cystoscopy with multi detector CT and Dual Energy technique after administration of i.v. contrast agent.
Patient population was divided into three groups based on lesion size at PDDs cystoscopy. Results of the CT study were compared with those of conventional cystoscopy and PDDs cystoscopy.

**RESULTS:** PDD cystoscopy depicted 92 bladder lesions in the 44 patients examined. Sensitivity and specificity values of CTC and VC alone were constantly lower than those of the combined-approach (group 1: 93.25% and 92.54%; group 2: 100% and 100%; group 3: 100% and 100%, respectively). Regarding lesion size, it has been also demonstrate that multidetector-row CT performed with thin-slice reconstructions (1mm) allow a good sensitivity in the detection of lesion over 1 mm. ROC analysis showed that the combined approach decreases the lower dimensional threshold for lesion detection (1.4 mm). The study of bladder wall after administration of c.a. and Dual Energy technique permit to distinguish superficial or infiltrative lesion in 89% of cases.

**CONCLUSION:** CTC and VC are promising diagnostic approach for bladder cancers measuring in the range of 1–5mm and to distinguish from superficial to infiltrative lesion. The main disadvantage of CTC and VC is the low sensitivity to depict flat lesions, as demonstrate on cystoscopy with PDD method. CTC can be used for the evaluation of hematuric patients confining standard cystoscopy at therapeutical role.

**US COMPARED WITH CTU FOR INVESTIGATING MACROSCOPIC HAEMATURIA**

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**PURPOSE:** To evaluate and compare the diagnostic accuracy of US and multidetector computed tomography urography (CTU) for upper urinary tract disease.

**MATERIALS AND METHODS:** The study population consisted of 100 consecutive patients aged ≥40-years, with infection excluded attending a hospital haematuria clinic, from 29/6/09 to 1/2/10. All presented with macroscopic haematuria, and were referred by a primary care physician. Initial assessment was by a clinical nurse specialist followed by same-day CTU, US and flexible cystoscopy. US and CTU examinations were performed and reported independently by a different radiologist blinded to the findings of the other examination. For US and CTU the presence or absence of a renal or ureteric mass, renal cyst, stones, hydronephrosis, hydroureter and abnormalities of renal size, outline or cortical thickness were recorded. The reference standard included histopathology for upper tract (UT) tumours, unenhanced CT for stone disease, and imaging and histopathology follow-up for normals.

**RESULTS:** Renal cell cancer was present in 3 of 100 patients. All were detected on CTU, and 2 cases were detected on US, giving sensitivity of 100% for CTU and 67% for US. Upper tract urothelial cancer (UTUC) was present in 2 of 100 patients. One patient had UTUC at two sites. Both cases were detected on CTU but not identified on US. Hydronephrosis was absent in both cases. Sensitivity for UTUC = 100% for CTU and 0% for US. Specificity for diagnosing upper tract cancer = 99% for CTU and 100% for US. For diagnosing upper tract stones, sensitivity of US = 43% and specificity = 96%.

**CONCLUSION:** US has low sensitivity for diagnosing both UT tumour and stones especially when the tumour is small and hydronephrosis absent. CTU has high sensitivity and specificity for UT cancers and should be the preferred examination for investigating patients with macroscopic haematuria at high risk for urological cancer.

**IMAGING AND PATHOLOGICAL FEATURES OF SPERMATIC CORD LESIONS**

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**PURPOSE:** To present the imaging and pathological features of various spermatic cord lesions and to demonstrate the specific diagnostic imaging findings with pathological correlations.

**MATERIALS AND METHODS:** The gray-scale, panoramic and Doppler sonography; computed tomography and magnetic resonance imaging (MRI) examinations of patients with spermatic cord lesions who was admitted between 2002-2010 were retrospectively evaluated. The most demonstrative images of the common lesions and the diagnostic clues of the uncommon lesions were determined in correlation to the pathological specimens and/or follow-up imaging of the patients.

**RESULTS:** The demonstrative examples include benign and malignant primary tumors and the metastases to the spermatic cord which are very rare. The non-tumoral lesions as spermatic cord cysts, lipomatosis, inflammatory lesion (funniculitis spermaticus) examples are also presented.
CONCLUSION: Spermatic cord lesions are relatively rare. Some may present with characteristic features on sonography or MRI, and specific diagnosis may be achieved at the initial admittance. Further investigations and unnecessary surgical procedures may be avoided if radiologists become more familiar to the imaging features of these rare lesions.

CT UROGRAPHY IN PRONE POSITION – EFFECTS ON CONTRAST LAYERING IN THE EXCRETORY PHASE
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INTRODUCTION: CTU must accurately assess the mucosal surfaces of the collecting system. One limitation of excretory phase imaging is fluid-fluid levels between the non-opacified urine and the excreted contrast material. Small TCC’s might be missed if they are not surrounded by opacified urine. This study is a follow up to an earlier experimental study where the mixing of urine and iodinated contrast medium where investigated using a bladder phantom.

PURPOSE: The aim of the study was to investigate the mixture of iodinated contrast medium (Iomeron 400mg/ml) with urine would be better when CTU was performed in prone position compared to the standard supine position.

MATERIALS AND METHODS: 20 patients, age 64±9 (54, 77) years, referred for CTU were included in the study and underwent CTU in prone position. The 20 included patients were compared to 20 matched controls undergoing CTU in the standard supine position. Examinations were performed on a 64 slice GE LightSpeed VCT with a four phase CTU protocol. Patients ingested 1000 ml of water in the hour before the examination and were told not to void 45 minutes prior to the exam. The excretory scan was performed 8 minutes after injection of 400 mg I/kg body weight.

RESULTS: The layering effect in the kidney pelvis were almost non-existent in the prone patients whereas layering were seen in 35% of the supine controls. In the bladder the mixing of urine and contrast were significantly better in the prone group were only 10% of the bladder contained non-opacified urine compared to 40% in the supine group.

CONCLUSION: Adapting the findings from the initial bladder phantom study to clinical practice by performing CTU in prone position provides better visualization of the mucosal surfaces of the collecting system in the excretory phase, increasing the accuracy of CTU.

COMPARING THE EFFECTS OF GADODIAMIDE AND GADOTERATE ON RATS WITH RENAL IMPAIRMENT
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PURPOSE: To compare the effects of the gadolinium based contrast agents (Gd-CAs), gadoterase (ionic macrocyclic) and gadodiamide (non-ionic linear), on tissue gadolinium retention, dermal collagen and skin cellularity in rats with marked renal impairment.

MATERIALS AND METHODS: Wistar rats were subjected to 5/6 subtotal nephrectomy (SNx) under isoflurane anaesthesia. Gadoterase (Dotarem™) or gadodiamide (Omniscan™) were injected intravenously, 2.5 mmol/kg/day for 5 consecutive days. Control group received normal saline (5ml/kg). Animals were sacrificed 4 weeks later. Tissue gadolinium was determined by inductively couple mass spectrometry. Total skin cellularity and dermal collagen was assessed by a blinded observer.

RESULTS: Reduced renal mass was associated with a 4-fold increase in serum creatinine (30±0.8 vs. 117±11 μmol/L) and about 80% fall in creatinine clearance from base line (2.46±0.39 vs. 0.61±0.1 ml/min, p<0.01). No histological changes were observed in the skin in the control group. Gadoterase had no effect on total skin cellularity (796±214 vs. 869±152 cells/mm², NS) or dermal collagen. In marked contrast, gadodiamide produced apparent increase in dermal collagen and a 4-fold increase in total skin cellularity (735±214 vs. 3092±976 cells/mm², p<0.02) together with increased immunostain for CD34, FSP-1, prolyl-4-hydroxylase and α-smooth muscle actin. Gadoterase was associated with lower tissue gadolinium retention than gadodiamide particularly in the skin (43±6 vs. 842±236 nmol/g, p<0.01), but also in bone (60±9 vs. 380±66 nmol/g, p<0.002) and liver (442±112 vs. 969±128 nmol/g, p<0.02). No significant difference was observed in the Gd content of the kidney (2501±41 vs. 3561±724 nmol/g, NS).
CONCLUSION: Gadoterate, in marked contrast to gadodiamide, had no effect on skin cellularity or dermal collagen in rats with renal impairment and was associated with a lower retention of gadolinium in tissues, especially in the skin. These observations support the low risk of gadoterate in inducing nephrogenic systemic fibrosis (NSF) in patient with advanced renal impairment in contrast to the high risk associated with gadodiamide and the importance of high kinetic stability of the macrocyclic Gd-CAs in avoiding NSF.

HYPERGLYCEMIA IN INPATIENTS RECEIVING CORTICOSTEROID PREMEDICATION
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PURPOSE: To assess the effect of short-term corticosteroid premedication on serum glucose in hospitalized patients.

MATERIALS AND METHODS: Serum glucose in adult inpatients before and after corticosteroid premedication was compared to serum glucose in non-premedicated controls. Patients were placed into nine cohorts, defined by use or non-use of intravascular nonionic contrast medium (IV or IA) and corticosteroid premedication (oral or IV). Patients were further subdivided by presence or absence of diabetes mellitus (type I or type II). Results were analyzed with ANOVA and a stepwise linear regression analysis.

RESULTS: There were 426 corticosteroid premedication episodes in 426 patients; 877 examinations in 848 patients served as controls. Overall, cohorts receiving corticosteroid premedication experienced a brief (24-48 hour) increase in mean maximum post-baseline serum glucose (IV, +80 mg/dl; oral, +69 mg/dl), greater than the increase in non-premedicated controls (+46 mg/dl). Type I (+144 mg/dl) and type II (+109 mg/dl) diabetics had a greater elevation than non-diabetics (+34 mg/dl). Both corticosteroid premedication (IV, p=0.02; oral, p=0.01) and diabetes mellitus (type I, p=0.0002; type II, p=0.0001) were independent risk factors of hyperglycemia; however, diabetics had similar periprocedural glucose elevations when they were and were not premedicated. There was no significant difference in the effects of IV and oral premedication (p=0.6), or between type I and type II diabetics (p=0.8).

CONCLUSIONS: Diabetes mellitus (type I and type II) and corticosteroid premedication (oral and IV) are significant independent risk factors for the development of hyperglycemia near the time of inpatient radiology studies, with the hyperglycemic effect of diabetes mellitus dwarfing that of premedication. In fact, periprocedural hyperglycemia in premedicated and non-premedicated diabetic patients is of a similar magnitude, possibly because endogenous corticosteroid production obscures the effects of exogenous premedication.

PERITONEAL IMAGE GUIDED CORE BIOPSY RELIABLY PREDICTS SURGICAL HISTOLOGY
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PURPOSE: To correlate histology from image guided peritoneal core biopsy (IGPCB) at initial presentation of peritoneal carcinomatosis with subsequent histology from interval debulking surgery (IDS). Our purpose was to determine if IGPCB was prone to diagnostic sampling error.

MATERIALS AND METHODS: Some women with presumed stage IIIC/IV primary peritoneal / ovarian cancer receive neoadjuvant chemotherapy (NCTx) rather than radical cytoreductive surgery for reasons of either comorbidity or disease extent. Increasingly these women undergo diagnostic IGPCB at initial presentation. A total of 126 consecutive women who had IDS after NCTx over a 6-year period were identified. 80 women had had prior diagnostic IGPCB and the remainder had surgical or other diagnostic biopsies. All had multidisciplinary team meeting (MDTM) discussion prior to IGPCB in a single institution.

RESULTS: The initial IGPCB provided diagnostic material in 76 of 80 patients (95%). Three women with non-diagnostic biopsies had repeat IGPCB which was diagnostic; one required laparoscopic biopsy. There was complete correlation of the cancer diagnoses between IGPCB and IDS histology. In 65 of these 79 patients the final IDS histology had the same morphological subtype as the IGPCB; 14 showed a different morphological subtype but this difference would not have affected initial management. There were thus no significant errors in diagnosis and there were no complications.
Over the study period IGPCB replaced all other primary diagnostic methods prior to NCTx / IDS. A small and interesting group of women who had IGPCB did not proceed to IDS and these women will be discussed further.

CONCLUSIONS: This study shows an excellent correlation between IGPCB and IDS histology and that IGPCB was successfully adopted across a large referral population over a period of 5 years. IGPCB is safe, provides a reliable histological diagnosis and should be the standard of care in women considered for IDS for ovarian cancer.

LOCALLY ADVANCED CERVICAL CANCER: MR IMAGING IN PREDICTION OF RESPONSE AFTER PREOPERATIVE CHEMORADIATION THERAPY

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INTRODUCTION: The prognosis of locally advanced cervical cancer (LACC) is still disappointing, with a 65-70% of survival rate. The use of concurrent chemotherapy and radiation therapy followed by surgery has been advocated by some european clinical groups in order to improve patients’ prognosis. The need for surgery and its radicality depends on tumor response to neoadjuvant treatments. The evaluation of residual disease after chemoradiation therapy is therefore crucial in subsequent treatment planning and is conventionally based on clinical examination and magnetic resonance imaging (MRI). Very few studies have correlated MRI findings and histology in cervix cancer. Purpose: to assess the accuracy of MRI in evaluating the LACC response to concurrent preoperative chemoradiation therapy, using qualitative and quantitative criteria.

MATERIALS AND METHODS: 1.5 T pelvic MRI pre- and post chemoradiation therapy (45-50 Gy) in 55 patients with LACC (53 y/o; 30-79), with < 35 days between second MRI and surgery, were retrospectively qualitatively evaluated with a consensus by two radiologists with 10 and 7 years of practice in gynecologic MRI for presence or absence of residual disease. Quantitative analysis was performed only on cases judged as positive by qualitative evaluation in order to ascertain whether any quantitative criterion may help in distinguishing true from false positive cases. The quantitative parameters included: tumor diameters, tumor volumes calculated with ellipsoid method and with 3-D volumetry according Simpson’s modified formula before and after treatment, and fractional regression rate. The MRI findings were correlated to histopathologic findings with Wilcoxon Signed-Rank test and with Mann-Whitney test.

RESULTS: qualitative evaluation showed sensitivity, specificity, accuracy, positive predictive value, negative predictive value, LR+, and LR-: 93%, 53%, 63.6%, 42%, 96%, 1.965, and 0.127. Quantitative analysis showed that the diameter of residual disease measured by MRI was on average twice the true diameter measured at histology (18 mm versus 9 mm). No quantitative dimensional criterion showed significant differences between true positive and false positive cases.

CONCLUSION: qualitative MRI has very high sensitivity and negative predictive value, but low specificity and positive predictive value for predicting presence of residual disease after chemoradiation treatment in cervical cancer. Evaluation of quantitative dimensional parameters didn’t improve the accuracy of the technique and was of no help in differential diagnosis between true and false positives qualitative evaluations.

CT DIFFERENTIAL DIAGNOSIS OF ADRENAL INCIDENTALOMAS

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INTRODUCTION: Due to the rapid advance in medical imaging (such as CT, MR imaging, PET-CT, etc.) many (especially asymptomatic) masses are detected on the adrenal gland. Among these adrenal incidentalomas, adenoma and adrenal metastasis are the most common tumors. Because the management of these three lesions is different, it is very important to differentiate them adequately on imaging study. The objective of our scientific exhibition is in the CT differential diagnosis of these three adrenal incidentalomas.
MATERIALS AND METHODS: Among the 300 adrenal incidentalomas found at abdominal or abdominopelvic CT and proven clinically and/or pathologically in our hospital for recent 10 years, we tried to differentiate adrenal adenoma (including lipid-poor ones), adrenal metastasis, and adrenal cancer by using CT attenuation, and washout calculation on dynamic adrenal CT. In some cases, chemical shift MR imaging and FDG PET were performed complementally.

Percentage of enhancement washout = (E – D) / (E – U) x 100
Percentage of relative enhancement washout = (E – D) / E) x 100
E: Early enhanced CT (1 minutes)  D: Delayed enhanced CT (15 minutes)  U: Unenhanced CT

RESULTS: Most of the adrenal adenomas were over than 60% of enhancement washout, and over than 40% of relative enhancement washout. However, the differential diagnosis of adrenal cancer and metastasis is not easy on CT only, so CT guided adrenal biopsy or FDG PET were performed additionally. FDG PET can characterize adrenal metastasis with 100% sensitivity and questionable specificity.

CONCLUSIONS: Most adrenal incidentalomas were adenomas, and could be accurately characterized by dedicated CT. The percentage change in contrast material washout on CT is a useful adjunct to absolute CT attenuation values in differentiating adrenal adenomas from adrenocortical carcinomas. CT guided adrenal biopsy or FDG PET can help to differentiate adrenal metastasis from adrenal cancer.

EXPERIMENTAL STUDY – BLADDER PHANTOM AND MIXTURE OF IOHEXOL
P Dahlman
Department of Radiology, Uppsala University Hospital, Uppsala, Sweden

INTRODUCTION: CT Urography (CTU) must accurately assess the mucosal surfaces of the urinary collecting system. One potential limitation of excretory phase imaging that is important to address is fluid-fluid levels between the non-opacified urine and the excreted contrast material. This layering effect is caused by the different specific gravity of non-opacified urine and iodinated contrast material. Small transitional cell carcinomas might be missed if they are not surrounded by opacified urine.

PURPOSE: The aim of the study was to investigate the mixture of iodinated contrast medium (Iohexol) with urine.

MATERIAL AND METHODS: In the first part of the study a bladder phantom was created and a suitable concentrations of Iohexol to urine tested. In the second part of the study the formation of fluid fluid levels was studied and then different techniques to break up the layers and mix contrast material with urine.

RESULTS: 1-3% Iohexol was suitable to create conditions similar to excretory phase imaging. The layering effect was most distinct when Iohexol was administered at slow rate from the bottom of the bladder phantom. In order to break up the fluid-fluid levels large repetitive movements where needed. The most efficient method was to put a spoon into the bladder phantom and stir the contents. No new fluid-fluid levels appeared, if no more contrast was added.

CONCLUSION: The findings of the current study bring clarity to the formation of, and strategies to break up, fluid-fluid levels. Adapting the findings in clinical practice might help better visualize the mucosal surfaces of the bladder and collecting system, increasing the accuracy of CTU.
Generally speaking, there are many indications to do fetal MR scans but they can be grouped in these headings:

- Add diagnostic certainty
- Find additional anomalies
- Research
- To aid parental understanding
- Pre-delivery operative planning

Short image acquisition times are now possible with new sequences, so that the fetus no longer needs to be kept still. Most problems are solved with T2 weighted images but T1 and diffusion weighted images are available. It is important to remember appearances with alter with stage of gestation.

MR is not a screening test. All the fetuses will have had some problem suspected on screening ultrasound. The majority of indications are from the central nervous system (including ventriculomegaly, posterior fossa and spina bifida anomalies) but there are also well recognised uses in lung volume estimation, urogenital and gut anomalies.

MR images are visually very powerful. They can greatly help the parents understand what is wrong. However, care needs to be taken with counselling as the prognosis for many anomalies is not known. Even seemingly devastating anomalies may have a good outcome. These aspects will be explored during the talk with illustrations from numerous cases.

1. Normal urogenital tract in the fetus

Visualization of the urinary tract is among the most important landmarks of the normal early embryo-fetal development.

The bladder can be demonstrated as early as the 9th week of gestation (WG) and the kidneys appear as hyperechoic masses within the lumbar areas around the 10-11th weeks. The kidneys will grow progressively with the evolution of the pregnancy measuring 20 mm around 20 WG and 40 mm around 40 WG. Along with their growth, their sonographic appearance will evolve. Globally, the renal echogenicity will diminish. Therefore, the renal cortex should not be hyperechoic compared to the liver or spleen after 30 WG. Also, the so-called cortico-medullary differentiation will appear (starting around 18 WG) with a relatively hypoechoic medulla compared to the relatively hyperechoic cortex. Other evidences for a normal development of the urinary tract include a normal volume of the amniotic fluid and normal chest development.

The fetal genital tract can also be demonstrated. Differentiating between male vs female fetuses can be obtained in the late 1st trimester and the sex will be confirmed during the second trimester. The testes are easily seen in the second trimester, the uterus mainly in the 3d trimester.

2. Abnormal fetal urinary tract

Fetal uropathies at various degrees of severity occur in about 5 % of pregnancies. Their detection has increased and modified the workload of pediatric radiology departments. Renal dilatation is the most frequent finding. Various diagnostic criteria are used. Most authors agree on the method of measurement and thresholds of abnormal renal pelvis diameter (measured on a transverse scan of the fetal kidney).
Values of 4 mm and 7 mm as upper limits are widely accepted respectively during the second and third trimester. Based on the renal pelvic diameter, the uropathy can be classified as mild, moderate or marked. The ESUR/ESPR working group in pediatric uroradiology has defined 5 grades of hydronephrosis leading to specific post natal managements. Visualization of the fetal ureter or an enlarged bladder should also be considered as abnormal.

Nowadays, once a fetal uropathy is demonstrated, the US approach is standardized evaluating:
- the degree of obstruction
- uni- or bilaterality of the uropathy
- the level of obstruction
- the appearance of the parenchyma
- associated malformations
- caryotype
- amniotic fluid volume

The differential diagnosis of fetal uropathies includes UPJ or UVJ obstruction, vesico-ureteric reflux, multicystic dysplastic kidney, complicated duplex system, bladder outlet obstruction.

The prognosis of uropathies can be assessed based essentially on the amniotic fluid volume. Other features of relatively poor prognosis include hyperechoic parenchyma, marked bilateral dilatation, parenchymal cysts and urinoma.

3. **Normal urinary tract in the neonate**

After birth, ultrasound would be the first imaging examination performed whenever there is a suspicion of an uropathy. On US, the neonatal kidney resembles closely the pre-natal appearance: relatively echogenic cortex and hypoechoic medulla leading to the so-called cortico-medullary differentiation. Still, the renal cortex is most often hypoechoic compared to the liver and spleen.

For the work-up of uropathies, the US examination should include the bladder and the genital tract. Noteworthy, the neonatal uterus is physiologically “hypertrophied” due to foeto-maternal hormonal influence.

4. **Abnormal neonatal urinary tract**

As mentioned, neonatal US is frequently performed in order to confirm an antenatal diagnosis.

US criteria considered as indicating a potential uropathy include:
- renal pelvis dilatation > 7 mm
- calyceal dilatation
- ureteral dilatation
- renal pelvic wall thickening
- ureteral wall thickening
- loss of cortico-medullary differentiation
- evidences for dysplasia
- enlarged bladder

Based on these criteria, the post-natal work-up can be decided; whenever necessary it will include voiding cystogram, MR Imaging and scintigraphic evaluation.

This work-up has also been greatly standardized thanks to the ESUR-ESPR working group and will hopefully lead to an optimized treatment and prognosis for patients affected.

**Suggested readings**


MR IMAGING OF THE FETAL AND MATERNAL UROGENITAL TRACT

G Masselli

Italy

Introduction

The urogenital tract is the most common site of all anomalies detected prenatally, accounting for approximately 30% of all antenatally detected anomalies.

Although ultrasonography (US) remains the most widely used diagnostic imaging modality for routine evaluation of the fetus, magnetic resonance (MR) imaging has become an invaluable complement to US in all cases in which additional information is desirable.

While the ability of US to detect fetal abnormalities is limited in cases such as maternal obesity, oligohydramnios, and in certain fetal positions, MR using fast and ultrafast pulse sequences enables high-quality morphologic fetal images to be acquired regardless of the mother's physical condition or fetal position.

Moreover, MR imaging provides functional information which are useful studying the fetal genitourinary system.

This lecture reviews and discusses the MRI techniques as well as to illustrate the characteristic MRI findings of the most frequent anomalies of the fetal and maternal urogenital tract.

MR technique

Most fetal MR studies are performed during mid and third trimesters of gestation. No deleterious effects of MR on the fetus have been reported to date; nevertheless, it is not recommended during the first trimester.

Patients are asked to urinate before the procedure to avoid the urge to urinate. They are normally placed in the supine position and introduced feet-first to minimize claustrophobia.

No special preparations are necessary for the woman or the fetus. Some groups sedate the mother to prevent fetal movements, but in our experience fetal movements do not affect the study when ultrafast MR pulse sequences are used.

We perform fetal MR on a 1.5-T superconducting magnet with a multi-element phased-array body coil.

Our study protocol includes a scouting acquisition, followed by a series of steady-state sequences in the axial, coronal, and sagittal planes of the maternal abdomen to evaluate maternal abdominal organs, uterine anatomy, the placenta, the amount of amniotic fluid, and fetal position. After these sequences, a series of coronal, axial, and sagittal half-Fourier single-shot turbo spin-echo of the different regions of the fetus are obtained. The thorax and abdomen of the fetus are in the same plane and can be studied together. The brain is usually in a different plane from the thorax and abdomen and therefore usually needs to be studied independently. It is convenient to position each sequence over the immediately prior one to avoid oblique planes due to fetal motion.

Occasionally, thick-slab highly T2-weighted can be useful. For the volumetric, highly T2-weighted sequences, we use the single-shot rapid acquisition with relaxation enhancement sequence with the following parameters: echo time of 1100 ms, echo train of 240, an 180° flip angle, matrix of 240 _ 256, and a 156-Hz/pixel bandwidth. One slab of 50 to 100 mm thick is obtained in 7 s. The MR Imaging protocol is shown in Table 1.

MR imaging of the fetal urogenital tract

Normal Anatomy

On T2-weighted images fetal kidneys are identified as oval structures of intermediate signal intensity on both sides of the, with high signal intensity in the collecting system.

Fetal ureters are not normally seen on T2-weighted images unless dilated, when they are seen as high-signal tubular structures. It is sometimes necessary to perform T1-weighted sequences to differentiate dilated ureters from bowel loops. On T1-weighted images, dilated ureters are seen as low-signal tubular structures, whereas distal bowel loops are hyperintense because of the meconium.
adrenal gland is of relatively low signal intensity on T2-weighted images and can be observed in the suprarenal position.
The urinary bladder is visualized as high signal intensity structure on T2-weighted images of the pelvis. The urethra cannot be seen, but external genitalia are easily recognized. The genitalia are typically well visualized on axial or sagittal views. The testicles descend into the scrotum between 28 and 35 weeks and are intermediate signal intensity structures within the scrotum.

Fetal urogenital anomalies
Fetal urinary tract anomalies associated with poor prognosis and fetal urinary tract anomalies associated with good prognosis.

Urinary tract anomalies associated with poor prognosis are those with oligohydramnios and/or pulmonary hypoplasia and those that course without oligohydramnios but are associated with other severe malformations. Genitourinary tract anomalies with oligohydramnios can be caused by a lack of urine production due to severe bilateral renal disease or by severe outflow bladder obstruction. The fetus swallows amniotic fluid, and urine is continuously being produced. A fluid-filled bladder is a very valid, indirect sign of a functioning renal excretory system.
The kidneys themselves should also be scrutinized for possible malformations. Absence of the kidney in the renal fossa is well evaluated using MRI, that can also identify the ectopic location. Renal cystic diseases and urinary tract obstruction are the most common intrauterine malformations detected.
A very commonly encountered pathologic entity of the urogenital system is a dilatation of the renal collecting system with subsequent hydronephrosis. The most common prenatally detected cause of a hydronephrosis is a ureteropelvic junction obstruction. The extent of dilatation of the renal pelvis and the degree of parenchymal affection should always be noted. The dilated renal pelvis may hang down and is sometimes confused with a hydroureter. A duplicated renal collecting system is the other most common urinary tract anomaly. The dilated upper collecting system may be associated with ectopic ureterocele. It is easier to detect this condition with MR imaging than with US.

In congenital multicystic dysplastic kidneys, multiple small cysts are found. Sometimes there is severe oligohydramnios due to an obstruction to the flow of urine out of the bladder. In these cases, there is no or little amniotic fluid, as in cases of severe bilateral renal disease, but normal kidneys and an enlarged bladder can be identified. Frequently a result of urethra malformation, bladder outflow obstruction commonly occurs in male fetuses, and it is a common cause of renal failure in children. In these cases, MR imaging shows the bladder as a very large fluid-filled round structure filling the entire abdomen. The kidneys are identified as normal or dysplastic.

MR imaging of the Maternal urogenital tract
Acquired or congenital abnormalities of the uterus may affect fetal well-being or complicate delivery. MR imaging is useful for delineating uterine anatomy and for detecting uterine and ovarian abnormalities. Pregnancy may be complicated by abnormalities of placental formation, position, or implantation. Magnetic resonance (MR) imaging offers different potential advantages for evaluating uterine and placental abnormalities during pregnancies; these include multiplanar imaging capabilities, a higher soft tissue contrast and the ability to detect and distinguish blood from other fluid collections in different organs.

Table 1. Magnetic Resonance Imaging Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>FIESTA*</th>
<th>T2 ssFSE †</th>
<th>T1 3D sequence (LAVA) §</th>
<th>DWI**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetition time/echo time (msec)</td>
<td>Axial</td>
<td>Axial</td>
<td>Axial</td>
<td>Axial</td>
</tr>
<tr>
<td></td>
<td>4.3/2.2</td>
<td>4.3/2.2</td>
<td>1000/90</td>
<td>4.1/1.1</td>
</tr>
<tr>
<td>Flip angle (degrees)</td>
<td>50</td>
<td>50</td>
<td>150</td>
<td>10</td>
</tr>
<tr>
<td>Field of view (mm)</td>
<td>320-400</td>
<td>320-400</td>
<td>320-400</td>
<td>320-400</td>
</tr>
<tr>
<td>Matrix</td>
<td>256x224</td>
<td>256x224</td>
<td>256x224</td>
<td>256x224</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>256x192</td>
</tr>
</tbody>
</table>
Parallel imaging factor | 2  | 2  | 2  | 2  | 3  | 2  \\---|---|---|---|---|---|---\
Section thickness (mm) | 4  | 4  | 3  | 3  | 2.5 | 4  \\---|---|---|---|---|---|---\
Intersection gap (mm)  | 0  | 0  | 0  | 0  | 0  | 0  \\---|---|---|---|---|---|---\
NEX  | 1  | 1  | 1  | 1  | 1  | 6  \\---|---|---|---|---|---|---\
Receiver Bandwith | 125 | 125 | 62.50 | 62.50 | 62.50 | 1930 \\---|---|---|---|---|---|---\
Acquisition Time (sec)  | 19 | 21 | 15-20 | 15-20 | 15-18 | 180 \\

* The FIESTA sequence is a steady-state free precession sequence (other vendors: True Fisp, balanced FFE).
† The T2 ssFSE is the T2-weighted half-Fourier acquisition single-shot turbo spin-echo (other vendors: Haste)
§ The T1 three-dimensional (3D) fat-saturated sequence is the T1-weighted dynamic breath-hold examination (LAVA) with fat saturation sequence (other vendors: Vibe). Fat saturation was achieved with the chemical shift-selective fat suppression technique.
** DWI was acquired with b values of 50, 400 and 800 sec/mm.

References

LECTURES SESSION II

**TOPIC: FEMALE PELVIS**
Moderators: J Spencer (UK), B Brkljačić (HR)

ENDOMETRIOSIS AND THE GU TRACT
S Goldman

*BR*

The definition is the presence and growth of functioning endometrial tissue in places other than the uterus that often results in severe pain and infertility.

Endometriosis is a highly prevalent disease, it is estimated that there is a 10% prevalence in the general population. Age is the only socio-demographic characteristic for which a consistent positive relationship has been observed. In general, the risk of endometriosis appears to increase for reproductive health factors that may relate to increased exposure to menstruation (i.e., shorter cycle length, longer duration of flow, or reduced parity). The risk appears to decrease for personal habits that may relate to decreased estrogen levels (i.e., smoking, exercise).

Endometriosis is most commonly found in the pelvis notably on the ovaries and behind the uterus. It can involve the bowel and urinary tract. The diagnosis is confirmed by direct visualization usually by laparoscopy. There is a very large spectrum in the severity of endometriosis: It may consist of no more than a few tiny spots or at the other extreme, there may be extensive disease with cysts filled with a chocolate-like material and scar tissue around the pelvis. The chocolate cysts are derived from blood released by the endometriosis at the time of menstruation. Endometriosis is essentially a condition occurring in the pelvis. There are rare occasions when it may occur elsewhere such as in the lung.

The objectives of this presentation are to discuss the effectiveness of MR in the diagnosis of endometriosis, also perform a correlation between laparoscopy and MR, and learn how to map out the
extent of disease. To be considered a gold standard, a study should be effective, widely available, with a reasonable cost and provide additional information.

In terms of diagnostic efficacy MR and TVUS with bowel preparation are similar, however when it comes to abdominal staging, availability, total examination time, need of bowl preparation, MR seems to be superior. The downsides of TVUS with bowel preparation are: the need of an expert; at least 50 minutes of total exam time and an usually not very well tolerated bowel preparation. On the other hand good MR performance is mainly dependent on well-set technical parameters and on a reader with MR experience. The learning curve for MR reading of endometriosis is probably shorter than that of a dedicated TVUS.

Several articles show similar efficacy for MR and TVUS with bowel preparation in the diagnosis of endometriosis.

In terms of MR costs we must think of 3 different settings:

1. It is available and offered free of charge in over 80% of state-funded health services.
2. Medical organizations (HMO) cover the costs for the associates.
3. The cost for an exam paid for privately is about €330.00

In terms of availability almost every State funded hospitals, publicly owned hospitals, and many private clinics have an MR unit available.

In order to reach optimal MR performance one should have proper technique and a well-defined extensive evaluation algorithm of the cavity.

In terms of preparation we use Buscopan® (butibrometo escopolamina) to decrease bowel motion, intravaginal and rectal gel.

The vaginal and rectal gel turn virtual cavities into real and facilitate the identification of lesions in the para cervical, para vaginal and para rectal spaces and permit a better characterization of changes in the uterosacral ligaments, rectum vaginal septum besides the vagina and rectum/sigmoid. It also facilitates the identification of multiple lesions and infiltration degree of the intestinal wall.

And in terms of technical parameters we use a T2TSE in axial, sagittal and coronal orientations, a T1 Dixon that includes in phase, out of phase, fat saturation and water saturation. Sequences pre and post contrast.

In order to facilitate the evaluation and perform a proper road map, the cavity is divided into an anterior, a medial/posterior and lateral compartments. Each of these with a pre determined set of structures that will be evaluated.

**ANTERIOR COMPARTMENT**
- ABDOMINAL WALL
- BLADDER
- VESIÇOUTERINE POUCH
- UTERINE ANTERIOR WALL SEROSA

**MEDIUM AND POSTERIOR COMPARTMENTS**
- UTERUS
- POSTERIOR SEROSA WALL
- RETROCERVICAL / TORUS UTERINUS NODULE
- VAGINA
- RV SEPTUM
- RECTUM AND SIGMOID

**LATERAL COMPARTMENT**
- OVARIES
- SALPINX
- PARA CERVICAL SPACES
- PARA UTERINE SPACES
- RETROCERVICAL SPACE
- PARA RECTAL SPACES
- UTEROSACRAL LIGAMENTS
- ROUND LIGAMENTS
- URETER
- ILEUM/CECUM/ APENDIX

MR shows 3 distinct aspects for endometriosis:
- Hyperintense collections in T1 with signal decay in T2, identified preferably in the ovaries (endometrioma) or more seldom collected in the cavity.
- Hypointense images in T2, linear and spiculated, which attain the pelvic cavity globally.
- Hypointense mass in T2 with hyperintense foci in T2 and sometimes T1, which correspond to what is known as “adenomyosis” of medium line and is found in the rectum vaginal septum.

Deep endometriosis is described as nodular or retractile fibrotic-like tissues that are hypointense on T2-weighted images and isointense to muscle on T1-weighted images. Adhesions and indirect signs are diagnosed as hypointense peritoneal strands that converged to loculated fluid collections or organ displacements. If colon involvement is suspected, the distance from the anorectal junction is described and the length and depth of the lesion are measured. Infiltration of the colon wall is described in different layers (none, serosa, muscularis, submucosa, mucosa).

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IMAGING STRATEGIES FOR STAGING CERVICAL AND ENDOMETRIAL CARCINOMA
Corinne Balleyguier, Elise Zareski, Catherine Uzan, Pierre Duvillard, Catherine Lhommé, Karen Kinkel
France

In 2010, imaging is mandatory for staging cervical and endometrial carcinoma. For cervical carcinoma, even if staging is still dependant on clinical FIGO classification, FIGO committee recommends to add MRI for staging. MRI helps to determine local extension such as parametrial or bladder invasion. Slices must cover abdomen and pelvis from the symphysis to the left renal vein, to detect local invasion and suspicious lymph nodes in a single examination.

T2-weighted sequences are the most interesting sequences for local staging, but axial T1-weighted sequences can be done to detect suspicious lymph nodes. Diffusion-weighted imaging (DWI) sequences are optional but might be helpful in detection of residual tumor or suspicious lymph nodes after chemoradiotherapy and might be competitive with PET-imaging. PET-imaging is needed in case of tumor > FIGO IB1 with no suspicious lymph node visible on MRI. MRI is required for staging endometrial carcinoma to detect a myometrial invasion (< 50 %, FIGO IA; or > 50 %, FIGO IB in 2009 update of FIGO). Indeed, treatment differs according to risk for lymph node invasion, and thus myometrial invasion. Dynamic imaging after contrast enhancement is required and optimal signal intensity differences between endometrial carcinoma and normal myometrium are seen at 2min30 of a dynamic 3D GE sequence. T2 weighted imaging in sagittal and at least one oblique axial/coronal orientation is also required for local staging. As in cervical carcinoma staging, DWI can help to detect suspicious lymph node or peritoneal carcinomatosis. ESUR Guidelines for endometrial carcinoma staging in MRI have been published in 2009 in European Radiology, as guidelines on MRI and cervical carcinoma will be published in 2010. These guidelines will be presented during the session.

UTERINE ARTERY EMBOLIZATION FOR FIBROIDS
N Cowan
United Kingdom

INTRODUCTION: Uterine fibroids occur in 20% - 70% of women of reproductive age (1) and are the most frequent indication for hysterectomy in pre-menopausal women. Fibroids represent a major public health issue. Most are asymptomatic and require no treatment but others may cause menorrhagia, dysmenorrhoea, dyspareunia, abdominal distension, pressure effects on adjacent structures, infertility and pregnancy loss. Conventionally fibroids are treated by hysterectomy but new forms of minimally invasive treatments are now available.
Uterine artery embolization [UAE] is a recently described treatment for uterine fibroids (2). Ravina in 1995 published results from a pre-operative embolization programme originally aimed at reducing haemorrhage during hysterectomy and myomectomy. UAE alone was found to be sufficient to treat fibroid-related symptoms in many women (2). Other series using like methods have reported similar results (3) (4) (5) (6).
MATERIALS AND METHODS: Accurate pre-treatment diagnosis is essential. Usually it is the responsibility of the gynaecologist to make the diagnosis and to exclude if possible contra-indicating pathology e.g. active salpingitis, urinary tract infection, tubo-ovarian abscess, ovarian tumour, atypical endometrial hyperplasia, endometrial carcinoma and uterine leiomyosarcoma. An assessment of follicle-stimulating hormone (FSH) on the third day of the cycle before the procedure, is helpful for patients under the age of 45, to allow some evaluation of post-treatment amenorrhoea, should this occur. The incidence of post-procedure ovarian failure and loss of regular menses varies from <1% - 14% and is significantly more likely to occur in women above the age of 45 (7). The menstrual history should be checked and a pregnancy test done to exclude the possibility of pregnancy. Fibroid embolization procedures should be avoided in an early pregnancy. If the patient has taken adequate contraceptive precautions, embolization may be performed at any stage of the menstrual cycle. If adequate contraception has not been used treatment should only be given in the early to mid-follicular phase of the cycle (equivalent to the ‘ten-day rule’).

Pre-procedure magnetic resonance imaging (MR) or ultrasound (US) are needed to determine the size, number and location of the fibroids. The MR appearances of fibroids are well described (8). MR is currently considered to be the most accurate imaging technique for detection and localization of fibroids (9) (10). MR is more sensitive than US in the detection of fibroids because of its ability to detect individual tumors (11). MR may also accurately assess an enlarged fibroid uterus (>140 ml ), which is not possible with US because of the limited field of view. The capability of MR to demonstrate the uterine zonal anatomy allows accurate classification of individual masses as submucosal, intramural, or subserosal (10).

The use of prophylactic antibiotics to reduce post-treatment infection is debatable. Evidence from the use of prophylactic antibiotic therapy in association with vaginal hysterectomy, caesarean section and colorectal surgery suggests that single-dose prophylactic antibiotic therapy is reasonable, using a combination of metronidazole with a cephalosporin or a quinolone drug e.g. ciprofloxacin (12).

UAE is most commonly carried out under intravenous sedoanalgesia. It takes approximately 60-90 minutes to perform, requires a hospital stay of one night and a convalescence period usually of around month. Successful catheterisation of both uterine arteries may be achieved with a unilateral femoral artery approach using a monoaxial 4 Fr Right Internal Mammary (RIM) catheter in nearly all cases. Use of a RIM catheter obviates the need to form a Waltman loop, which helps to reduce fluoroscopy time and radiation dose. Co-axial catheter systems may be used for exceedingly tortuous proximal uterine arteries.

An awareness of the uterine artery normal variants is important for the angiographer. These include demonstrable ovarian artery collaterals (26%)(13), multiple uterine arteries (2%) and partial uterine artery replacement (2%). Collateral flow via an ovarian artery may be a cause of uterine artery embolization treatment failure and non-target effects (14). In addition the rectal and vesicle branches of the internal iliac artery may simulate the uterine artery. Nonselective abdominal aortography for demonstration of ovarian artery collaterals, significantly increases the radiation dose to the patient (15) and should be avoided.

Most operators use polyvinyl alcohol particles (PVA) 355-500μ as embolic material. In early series, platinum coils were sometimes used to terminally plug each uterine artery but should the procedure need to be repeated they will prevent re-entry. Alternative varieties of embolic particles (tris-acryl calibrated gelatin microspheres) are now available and are currently undergoing evaluation (16).

With operator experience and attention to technique, UAE may be performed at radiation exposures comparable to those used in routine diagnostic studies. By limiting fluoroscopy time, the use of magnified and oblique views, non-pulsed fluoroscopy and road-mapping, the absorbed ovarian dose (AOD) may be minimized (17) (18) (19)

Pain control, particularly in the first twelve hours, is important as some patients develop pelvic pain of severe intensity. Drug regimens should be able to provide rapid relief of pelvic pain both on an inpatient and on an outpatient basis. Post-procedural pain cannot be predicted from baseline uterine or fibroid volume and the severity of pain experienced cannot be used to predict outcome (20).

A written patient information leaflet dealing with post-embolization complications and contact details should be given to the patient upon discharge from hospital.

Results: UAE is technically successful in 98-99% of cases (3) (21) (22) (23). Smaller baseline fibroid size and submucosal location are more likely to result in a positive imaging outcome (24). Clinical results show that in approximately 90% there is improvement in abnormal bleeding and bulk-related symptoms. Of those presenting with menorrhagia 90% return to a normal cycle within one-month following the procedure (25). Temporary amenorrhoea was reported in 2.6% [2/76] of cases (25). At 3 months after UAE, most women experience uterine volume reduction of 30-60%. The proportion of volume of individual fibroids is often more than the proportion of volume reduction of the whole uterus.
Many fibroids under 5 cm in diameter may become undetectable after UAE. There is evidence that volume reduction continues for up to one year in many women. Patient satisfaction with UAE is high, with 85-90% of patients indicating that they would again choose UAE as therapy. Overall success is 89.4% (68/76) as determined by those patients requiring no further treatment (25). Most of the published data about UAE for fibroids is in the form of case series and prospective observational studies. There have been a number of comparative studies between UAE and other procedures and recently level 1 evidence has become available. Results of the REST trial (Randomised controlled trial of Embolization vs Surgical Treatment for fibroids), EMMY trial (EMbolization vs hysterectomy for symptomatic uterine fibroid disease) and the HOPEFUL trial (Hysterectomy Or Percutaneous Embolisation For Uterine Leiomyomata) will be discussed. Complications: Complications of UAE are rare but may be serious if not dealt with promptly. Patients should be instructed to contact their interventional radiologist in the first instance if they feel unwell. The radiologist is best placed to see patients initially following UAE. Fever, pelvic pain and elevated white blood cell count, constituting the post-embolization syndrome, occur in approximately 4% [2/53] patients necessitating readmission for treatment with intravenous antibiotics and analgesics (3). Spontaneous expulsion of a necrotic fibroid may occur following the procedure and hysteroscopic patients necessitating readmission for treatment with intravenous antibiotics and analgesics (3).

Serious infections are reported in about 1% of cases. Most respond to oral antibiotic therapy. Patient presenting with abdominal cramps, pressure symptoms and a foul smelling discharge not responding to antibiotics within 48 hours should be referred for hysteroscopy and dilatation & curettage.

Death within 30 days of UAE has been reported (26) (27). Appropriate patient selection, pre-procedure assessment, post-embolization management and follow-up are therefore vital. UAE has a lower risk of morbidity and mortality than hysterectomy or myomectomy (28).

**DISCUSSION:** Pre-procedure MR helps to exclude patients referred with an incorrect diagnosis as well as those with a normal uterus or small insignificant fibroids. The differential diagnosis of uterine fibroids includes adenomyosis, a solid adnexal mass, focal myometrial contraction and uterine leiomyosarcoma. MR may differentiate fibroid from adenomyosis, solid adnexal mass or focal myometrial contraction but differentiation of fibroid from leiomyosarcoma on the basis of MR signal characteristics is not reliable (29). The incidence of uterine sarcoma in patients undergoing surgery for presumed leiomyoma ranges from 0.23% - 0.4% (30), (31). Malignant degeneration may be suspected if a fibroid enlarges suddenly, especially following menopause (29). The presence of an indistinct border or irregular contour at MR is suggestive of sarcomatous transformation (32), but the specificity of this finding has not been established. The malignant potential of fibroids is sufficiently low to make consideration of resection warranted only if symptoms develop. Biopsy of a fibroid is not routinely performed prior to embolization or hysterectomy. UAE of a malignant tumor masquerading as a fibroid may be unavoidable, because the imaging characteristics of leiomyosarcoma do not allow confident differentiation from uterine fibroids. The rare possibility of malignant change should not be regarded as a contra-indication to UAE but recurrent hemorrhage and uterine enlargement after UAE should raise suspicion of uterine malignancy and prompt referral to a gynecological oncologist for appropriate treatment (33) (34).

Fertility may be preserved following UAE as demonstrated by a number of successful post UAE pregnancies (35) (36). Currently there is still insufficient data to make any firm prediction about fertility rates after UAE or to recommend unreservedly the procedure to patients desiring future pregnancies. It is highly likely that this position will change in future. Which patients will benefit most from UAE? Fibroids do not constitute a homogeneous pathological group. Sub-groups may be defined according to size, site, number, age of the patient and fertility wishes. Further analysis may in the future define subsets of patients for which UAE is the preferred procedure.

A very interesting pilot study indicates the facility cost of UAE ($3,080) compares favourably with hysterectomy, the cost of which ranges from $3,100 to $4,900 depending on the type of procedure performed (37). Hysterectomies have higher facility costs than UAE because of longer hospital stays and procedure times. On average UAE requires a 1-day hospital stay, whereas the mean hospital stay is 2.6 days for laparoscopic hysterecstomy, 3.9 days for open hysterectomy, and 2.9 days for vaginal hysterectomy. The average procedure time is 92 minutes longer for laparoscopic hysterectomy than for UAE (158 min vs. 66 min), 57 minutes higher for open hysterectomy (123min vs. 66 min), and 22 minutes higher for vaginal hysterectomy (88 min vs. 66 min) (37). UAE may be performed widely wherever interventional radiology personnel and facilities are available. Training standards for physicians performing UAE for fibroids have recently been published (38).

**CONCLUSION:** UAE should be considered in all women with menorrhagia and associated fibroids if they wish to retain their uterus and / or avoid surgery. UAE is well tolerated and usually has a shorter
recovery time compared with surgical alternatives. If patient demand for UAE increases and the procedure becomes more commonly performed, changes in work flow and reallocation of resources will be required.

References
IMPLICATIONS OF EORTC 55971 AND MRC UK CHORUS STUDIES

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For many years the primary management of newly diagnosed advanced ovarian cancer has been cytoreductive surgery followed by chemotherapy. The findings of two recent international research protocols impact significantly on this aspect of management and have already stimulated a lively debate in gynaecology circles [1].

A significant minority of women with newly diagnosed ovarian cancer are unfit for radical surgery or the outcome of multidisciplinary review is that surgery is unlikely to adequately debulk their extensive tumour. For this group increasingly neoadjuvant chemotherapy is being used as the primary treatment with the aim of proceeding to subsequent surgery should either (or both) the patient or disease bulk improve sufficiently to allow this. This protocol of neoadjuvant chemotherapy followed by interval debulking surgery (IDS) began to be adopted following an EORTC study reported in 1995 [2]. In that study women whose tumour could not be debulked at primary surgery were treated with chemotherapy and underwent subsequent IDS.

That approach is being further investigated in the EORTC 55971 study and the MRC UK CHORUS (Chemotherapy OR Upfront Surgery) study. These address the timing of surgery relative to chemotherapy for newly diagnosed ovarian cancer. Women felt to be ‘operable’ at diagnosis were randomised to receive either surgery followed by chemotherapy or neoadjuvant therapy followed by IDS. Early results from the EORTC 55971 study indicate similar outcomes for the two randomised
arms but lower surgical morbidity in the IDS arm. The CHORUS study is continuing to recruit and an a priori plan is for meta-analysis of the two studies. The management implications of these studies are significant: at first sight the pivotal role of surgery in initial management is challenged. There has been much debate and some criticism of the study findings and recommendations [1] but it seems clear that ‘use of neoadjuvant chemotherapy is a safe alternative in this group of patients and does not compromise the standard of care’. There are also significant implications for imaging and investigation of these women with suspected ovarian cancer. Embarking upon neoadjuvant chemotherapy demands a confident histological diagnosis and this can be provided by image guided core biopsy (IGCB) [3-6]. This becomes more important as investigation of chemotherapy regimens specific to the different subtypes of ovarian cancer are being established. Put simply a diagnosis of adenocarcinoma based on cytological evaluation of ascitic fluid is increasingly insufficient. Other cytological techniques such as preparation of a cell block specimen are untested in this regard.

One tantalising question for future investigation is whether women could be treated by chemotherapy alone. In the IDS protocol women are treated with 3 cycles of chemotherapy, re-evaluated with CT, undergo surgery and then complete their chemotherapy with 3 or more further cycles of treatment. For some women there is such an impressive response to the initial 3 cycles of therapy that no residual disease is evident on the re-evaluation CT. The question has been often asked in our own multidisciplinary team meeting (MDTM) as to the purpose of removal of the apparently normal gynaecological apparatus and omentum at that stage. The surgery potentially interrupts the intensity of chemotherapy and / or causes morbidity in a woman who is starting to again feel well.

In summary, the results of these collaborative studies from EORTC and MRC UK [7, 8] are likely to impact significantly on the management of ovarian cancer. The radiologist will play a leading role in the multidisciplinary planning of initial care of women with suspected ovarian cancer. More image guided biopsies are likely if IDS increases in popularity.

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SATELLITE LUNCH SYMPOSIUM

**CONTRAST MEDIA AND THE KIDNEY: NEW INSIGHTS, NEW PERSPECTIVES**
Moderator: R Oyen (BE)

**FOLLOW-UP OF PATIENTS WHO DEVELOP CIN: A NEW INSIGHT ON LONG-TERM RISKS**
F Stacul
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(not available)

**NEW PERSPECTIVES FOR CONTRAST ENHANCED ULTRASOUND: FOLLOW UP OF PATIENTS AFTER RENAL TUMOR RADIOFREQUENCY ABLATION**
JM Corréas
*France*

(not available)

**CONTRAST ENHANCED MRI AND SAFETY: INSIGHTS INTO PATIENT MANAGEMENT**
H Thomsen
*Denmark*

(not available)
A large number of publications on contrast induced nephropathy (CIN) was published in the last decade and provided considerable new information.

**CIN definition**
In 1999 the Contrast Media Safety Committee (CMSC) of the ESUR suggested the following definition of CIN: “Contrast-medium nephrotoxicity is a condition in which an impairment in renal function (an increase in serum creatinine by more than 25% or 44 μmol/L) occurs within 3 days following the intravascular administration of a contrast medium in the absence of an alternative etiology” (1). This definition is still widely used. However recent studies underscored that an absolute increase in serum creatinine (SCr) should be the primary endpoint because the relative increase is not suited for patients with a normal SCr (2) and relative changes are highly dependent on baseline renal function and may not be adequate in patients with chronic kidney disease (CKD) (3). Acute Kidney Injury Network (AKIN) suggested a new threshold, an absolute increase in SCr ≥ 0.3 mg/dL (26.4 μmol/L) (4), which requires further validation. Timing of SCr post procedural measurements was debated too: a single 48 h measurement appeared more sensitive than a single 24 h measurement (2) and probably trials should consider both 24 h and 48 h post procedural SCr measurements.

**Identification of patients at risk**
The CMSC of the ESUR listed in 1999 a number of risk factors, namely “raised S-creatinine, particularly secondary to diabetic nephropathy; dehydration; congestive heart failure; age over 70 years; concurrent administration of nephrotoxic drugs” (1). Their significance has been later confirmed and new risk factors were added, namely a recent myocardial infarction (< 24 hrs), a low LVEF and conditions reducing the blood supply to the kidney during vascular procedures (hypotension) or reducing its oxygen supply (anemia) (5-9).

**Procedure related risk factors**
This topic should consider choice of contrast media, dose of contrast, route of contrast administration and timing of multiple studies.
The CMSC suggested the use of low- or isoosmolar contrast media (CM) in patients with risk factors (1). Aspelin et al. (10) showed a significantly higher incidence of CIN following iohexol administration when compared to ioxixanol in patients with CKD and diabetes who underwent angiography. A number of studies followed and considered the relative renal safety of ioxixanol and of different non ionic monomers. Recent meta-analyses indicated that ioxixanol is not associated with a reduced risk of CIN after intravenous application while after intraarterial injection iohexol is associated with a greater risk of CIN than is ioxixanol in patients with renal insufficiency, whereas no significant difference between ioxixanol and other non ionic monomers could be found (11,12).
Recent studies tried to identify the maximum amount of CM that can be injected minimizing the risk of CIN (13,14), but a safe dose does not exist and therefore only the minimum amount of CM necessary answering clinical question should be injected.
The risk of CIN appears to be significantly lower following intravenous contrast administration (15) and it appears that only CT patients with eGFR < 45 ml/min are truly at risk for CIN. The interval between two procedures requiring injection of CM in patients at risk is obviously dependent on the clinical situation, but when possible waiting for two weeks should be suggested.

**Preventive strategies**
They include hydration (volume expansion), pharmacological support, extracorporeal therapy (hemodialysis and hemofiltration) and withdrawal of nephrotoxic drugs. There is general consensus that volume expansion (i.v. hydration) is effective in preventing CIN. It appears that volume expansion is more effective than oral hydration (16) although the latter may provide some benefit. There is unfortunately no clear evidence providing the optimal rate and duration...
of infusion, but it appears the most effective regime for intraarterial procedures is to administer 1.0-1.5 ml/kg/h of normal saline 12 hrs before and 12 hrs following the procedure. A number of meta-analyses recently supported the use of sodium bicarbonate that appears to provide better protection than normal saline (17-19). The efficacy of different drugs for preventing CIN remains unproven. N-acetylcysteine received considerable attention and is widely used but results of clinical trials were conflicting. Hemodialysis is not effective for preventing CIN, while hemofiltration provided interesting results (20) but is costly and requires management in the intensive care unit. Clinical data on withdrawal of nephrotoxic drugs are lacking, however it appears withdrawal 24 hrs before CM administration in patients at risk is advisable, if allowed by the clinical condition.

In conclusion, the large amount of new literature reinforced the knowledge we had without suggesting dramatic changes in the management of patients at risk for CIN. However minor refinements to current guidelines are probably advisable.

References

CONTRAST-ENHANCED ULTRASOUND IN GU AND OBG: AN UPDATE
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Contrast-enhanced ultrasound (CEUS), based on the IV administration of Ultrasound Contrast Agents (UCAs), is now a well-established technique for the evaluation of focal liver lesions. Additional indications have now been recommended for kidney, trauma and VU reflux by the EFSUMB Guidelines [1]. Other fields under investigation include prostate, testis, uterus and ovary and placenta. In 2005, ESUR published guidelines on safety of CEUS [2], but no clinical guidelines on the use of CEUS in the genitourinary (GU) and in the obstetrics and gynecology (OBG) fields have been yet endorsed by ESUR.

From a review of the international literature published from 2005, an update of various aspects of CEUS in both fields can be presented.

Agents
The review of literature indicates that most published studies have been using Sonovue® from Bracco, which is the main agent approved for radiological use in EU, Switzerland, Norway, China, Hong Kong, India and Singapore. Only a few of them from North American and Asia with respectively Definity® or Sonazoid® reported experience [3, 4]. However, it has to be reminded that Sonovue® has been approved in Europe for macro and microvasculature, in liver and breast and only in adults. Consequently, clinical use for GU purpose is off-label. It may be the initiative of ESUR to advocate for an extension of the clinical applications of CEUS to GU, OBG and paediatric fields.

Safety
The guidelines published by ESUR in 2005 [2] indicated that UCAs are generally safe. In 2006, a review of 23 188 abdominal CEUS with Sonovue® from Italy, reported an adverse effects (AE) rate of 0.125% and of severe anaphylactoid reactions of 0.008%, as low as or lower than observed with Gd chelates [5]. A similar survey conducted in the USA on 78 883 echocardiograms performed with Definity® and Optison® founded a similar rate of anaphylactoid AE of 0.006% [6, 7]. No death was observed. As a result, the FDA turned a black box warning for the use CEUS in cardiac patients, initially published in 2007, from contraindication to warning in 2008. An experimental study on pigs kidneys showed that contrast agent-ultrasound interaction in anesthetized pig kidneys under the output level for the imaging visualization and microbubble destruction used did not cause tissue damage. Results suggested that CEUS could be used in humans for regular analysis of the kidney microcirculation with minimal risk of tissue damage. [8]. Some recent clinical studies confirmed good tolerance of UCAs [9].

RENAL indications
Examination protocol
Only low MI contrast specific techniques are now recommended. They allow dynamic imaging with evaluation of the different vascular phases. A detailed procedure can be found in the update of the European Guidelines published in 2008 [1]. Important points are that:
Real time scanning should be performed for up to 180 seconds to continuously assess the wash in and wash out phases.
In some contrast specific US modes, simultaneous display of tissue and contrast signals has been implemented. This modality is particularly useful for small lesions to ensure that the target lesion is kept within the scanning field during CEUS.
Because of the dynamic nature of real time CEUS, the investigation should be documented on video or digital media.

In patients with suspected vascular diseases (mainly small vessel diseases) or trauma, long and short axis views should be obtained during both the cortical and medullary phases. CEUS is subject to the same limitations as standard ultrasound, and sensitivity may be markedly reduced in the deep field. In case of high bubble concentration, attenuation may cause shadowing.

Blood flow quantification with CEUS
Taking the advantage of the high temporal resolution of CEUS, an increasing number of papers have been dedicated to renal functional studies, including studies on various animal models and humans. Replenishment of tissues after bubbles destruction seems to be more often used than bolus administration for the evaluation of functional perfusion parameters: regional or cortical blood flow (BF), regional blood volume using various mathematical models [10-12]. Most approaches use time-intensity curves in a region of interest, less often the time delay for microbubbles to cross a vascular bed [12]. The importance of working with raw linear data [13] has been emphasized, as well as the importance of breath motion correction [7].

Tested models included changes in cortical BF after high-protein meal [9] or vasoactive drugs [7], evaluation of disturbance of perfusion in peritubular capillaries in patients with chronic kidney disease [4], evaluation of response after antiangiogenic therapy [12, 14, 15].

**Renal tumors**

CEUS may be helpful in the demonstration of renal pseudotumors, considered dubious at conventional and power Doppler US, with complete concordance with CT and MRI [16, 17].

Concerning renal tumors, there is currently no place for CEUS in the detection of focal renal lesions, as its sensitivity remains limited for small lesions when being compared to contrast enhanced CT or MR [1].

Since 2005, improvement in the knowledge on characteristics of enhancement of renal tumors after UCAS injection has been achieved:
- low MI greyscale harmonic imaging [18] should now be preferred to Color Doppler techniques [19]
- main patterns are: the demonstration of presence of vessels and shape of vasculature in solid component of the tumor [20]; a better display of cystic or necrotic component within lesions [21]; an analysis of enhancement profiles on ROIs within the lesion after bolus administration [22]; a study of the presence and characteristics of pseudocapsule [23]

Characterization of lesions and differential diagnosis between benign and malignant tumors is improved with CEUS, but needs to be confirmed on large series, and the place of the technique compared to CT and MRI remains debatable. Contrast-enhanced sonography was first found to be better than unenhanced sonography and CT in the diagnosis of malignancy in complex cystic renal masses, and would be appropriate for renal cyst classification with the Bosniak system [18, 21].

**Vascular disorders**

A decade ago, CEUS has been shown to decrease the number of inadequate Doppler studies in renal artery stenosis detection [28]. It also allows a better detection of segmental or subcapsular renal infarction and cortical necrosis in the native and transplanted kidney [29].

**Renal trauma**

Contrast-enhanced sonography proved to be a reliable technique for the evaluation and follow-up of low-grade renal injuries, but also for detection of active bleeding. An advantage is reduced radiation exposure, as fewer MDCT examinations are needed [30, 31].

**Renal infections**

The place of CEUS in renal parenchyma infection is still subject to discussion with different results published in the case of pyelonephritis and abscesses [1, 32, 33].

**Transplantation**

CEUS should be incorporated as a method to evaluate graft status because of its capability to evaluate cortical capillary blood flow [34]. Recent studies suggest it would be helpful in the diagnosis of acute pyelonephritis [33], and that some CEUS-derived parameters may distinguish acute tubular necrosis from acute rejection, adding prognostic information [35].

**Other GU indications**

Contrast-enhanced Color Doppler imaging has been recommended as first-line imaging modality for the detection of crossing vessels in patients with UPJO [36].

More than 20 papers evaluating the potential role of CEUS in prostate cancer (CaP) have been published in the international literature in the five last years. To summarize the current trend, CEUS improves detection of CaP, with a limited sensitivity of 71%, but a high positive predictive value of
Hemodynamics indices (Acceleration Time and Time-to-peak) of high-grade tumors are significantly shorter than those of low-grade tumors [38]. Targeted biopsies lead to fewer biopsies per session without loss of detection rate and CEUS could be used to visualize effects of HIFU and hormonal therapy [39].

Animal studies have been studying the assessment of the testis perfusion, in particular in setting of acute ischemia [40]. There is one recent study on voiding ultrasonography confirming the interest of Sonovue®, compared to retrograde radiological cystography, in the detection and grading of vesico-ureteral reflux. [41]

CEUS in gynecology and obstetrics
In a few preliminary studies, CEUS has been slowly introduced to gynecology and obstetrics, with benefits reported in the evaluation of endometrial carcinoma [42, 43], and in ovarian masses[44]. Another field is the evaluation of CEUS on the permeability of placenta barrier [45].

References
The development of new molecular imaging probes and other contrast media has been much anticipated by the imaging community. While current agents have revolutionized the practice of imaging (imagine scanning without Gadolinium chelates or iodinated contrast media) such agents are also limited because they are small molecules that enhance non-specifically and wash out quickly. The current generation of molecular imaging agents is also somewhat limited. The best example from the current generation, Fluorodeoxyglucose (FDG) scanning, has revolutionized the practice of medicine since its reimbursement several years ago.

**The impact of FDG**

FDG has created many opportunities for the next generation of molecular imaging agents. Keeping in mind that it took almost 20 years from development to adoption of FDG in the clinic, the subsequent development of FDG has been remarkably swift. The recognition that FDG scans could be better displayed as PET/CT fusions led to the development of PET/CT scanners and more significantly has resulted in more interest in reading PET scans by Diagnostic Radiologists as opposed to Nuclear Medicine specialists. It is now commonplace for Diagnostic Radiologists to read PET/CT as part of their work day, whereas 5 years ago this was a rare event. Also, the demand for FDG has created a business opportunity for the synthesis and distribution of PET agents in major metropolitan areas. In the United States three major vendors compete in large markets for FDG PET production. These facilities are often compliant with Good Manufacturing Practices (GMP) producing safe and highly regulated products of the highest quality, ready to inject into the patient. This differs markedly from the situation 5-10 years ago when local radiochemistry facilities produced their own FDG under a variety of conditions. Moreover, the businesses that supply FDG to hospitals have worked out an elaborate and efficient delivery system, usually consisting of an armada of small trucks or courier services. All of these developments have created opportunities for the next generation of molecular imaging agents. Rather than requiring elaborate and expensive cyclotrons and radiochemistry facilities, there is the potential that future agents will be made commercially and shipped to the point of care. This puts these agents in the hands of even small hospitals remote from large city centers and bodes well for the future. An excellent example is Sodium Fluoride imaging, an excellent alternative to the conventional bone scan. Because the infrastructure for FDG is so well established, the deployment of NaF will be much quicker and it is already being used in many centers (pushed by the world wide Technetium shortage).

**Economics of Molecular Imaging**

The development of FDG leads to some enthusiasm about the future. However, this must be tempered by the reality of the costs of bringing drugs to market. Note that no one actually owns FDG or brought it specifically forward as a drug. The process of doing so is quite expensive and the return on investment (the "other ROI") may be low. Realistically hundreds of millions of dollars must be spent to get approval for such agents, which, by their nature, will be used in specialized populations of patients, and so profits may be low. Fortunately, we are seeing major vendors (GE Healthcare, Siemens, IBA) enter this arena in the hopes of vertically integrating their products. Smaller startup biotechs are also developing new molecular imaging probes. Meanwhile, increasing regulations and scrutiny are being placed on "home kitchen" radiochemistry departments in the United States, making it more expensive to develop new agents within medical centers and limiting the number of sites that can legitimately claim to be developing new radiopharmaceuticals.

**Clinical Challenges**

There is a lot of interest amongst clinicians to develop imaging biomarkers because they recognize the limitation of current biomarkers. However, the process of validating these markers is not easy. By their nature, the patients participating in such trials do not benefit from participation and therefore, are reluctant to sign up for such studies. We have found that there is no substitute for genuinely interested clinicians who can convince their patients to participate; imagers in general are not as persuasive and accrual is difficult. Many clinicians have unrealistic expectations of the imaging agent: they want the agent to give them usable information even before its been validated. For instance, if a clinician has an agent that is pro-apoptotic then they are eager to participate in a trial of an imaging agent that purportedly measures apoptosis, however their enthusiasm wanes when they find that the ability of this agent to actually measure apoptosis must still be validated. A major issue is that patients and clinicians are reluctant to include tissue biopsies for research purposes. Such biopsies are viewed negatively by Institutional Review Boards as well. Thus, it can be difficult to validate the results of an intervention in patients except by clinical outcome or by comparison to conventional imaging.
Clinicians are especially interested in markers that indicate they can stop further therapy but this endpoint also is difficult to validate. Finally, a major challenge is that often the centers and clinicians willing to entertain molecular imaging in their protocols, conduct their own trials with investigational drugs. The combined use of an investigational therapy and an investigational imaging agent in a single trial, can be problematic from a regulatory perspective. Notwithstanding all these challenges, it is not only possible to conduct such trials but highly rewarding. Observing how these new agents work and collaborating with clinicians to put them to the best use is stimulating research.

New Molecular Imaging Probes and Contrast Media

The advances in molecular biology, the understanding of cancer biology and the ability to extract genomic and proteomic information from tissues have led to the platform development of many new molecular imaging probes. These agents largely follow from the “hallmarks” of cancer described by Hanahan approximately ten years ago. Cancers are classified by their ability to respond to growth factors, have alternative energy metabolisms, avoid mortality, develop blood and lymph vessels and proliferate. They are prone to hypoxia as well. These hallmarks are reflected in a wide range of new agents. For instance, to measure the response to growth factors various epithelial growth factor receptors can be labeled with small molecules (e.g. affibodies) or larger molecules (e.g. antibodies). Regarding energy metabolism, FDG reflects glycolysis, however fatty acid metabolism can be reflected by radiolabeled acetate and amino acid metabolism can be reflected by radiolabeled amino acids (real and synthetic) such as glycine, leucine and methionine. Cancers avoid mortality by shutting off apoptosis, programmed cell death, which is dependent on a cluster of enzymes, caspases, that are released from the mitochondria. New therapeutic drugs are designed to reactivate apoptosis and this can be reflected in agents that depend on caspase to yield signal. A variety of such imaging agents, such as those radiopharmaceuticals that bind to caspase or are enzymatically activated by caspase have been developed. A variety of angiogenesis/lymphangiogenesis imaging agents have been developed that target specific cell surface receptors (e.g. integrins) that are upregulated during angiogenesis. Additionally, new macromolecular MR contrast agents that do not leak as readily from the vascular endothelium have been developed to investigate angiogenesis and lymphangiogenesis as well. Proliferation can be measured by radiolabeling thymidine (Fluoro-L-thymidine or FLT), a nucleoside that is taken up in cells that are synthesizing DNA. This is especially important in distinguishing inflammation (FDG+ but FLT-) from cancer (FDG +, FLT+). Finally, a series of hypoxia agents have been developed that reflect tissue pO2 such as CuATSM and F-MISO. These are useful in predicting outcomes related to therapy.1-5

Conclusion

Thus, while significant challenges remain, the future for molecular imaging is very bright. The ability to label a vast array of important molecules means that in the future, clinicians will be able to probe different aspects of tumor physiology in vivo, thus selecting the best set of therapies for a particular patient. Moreover, the results of the therapy can be monitored carefully and without biopsy, using imaging. The global infrastructure to manufacture and deliver such agents into the hands of imagers is already in place and novel technologies to fuse PET and CT or MRI have been developed or are in process. Granted, the road ahead will be difficult and will require intrepid explorers, but there is undoubtedly a bright future ahead.

References


ESUR GUIDELINES ON PROSTATE CANCER IMAGING
J Barentsz
The Netherlands

(not available)
The presentation will report on the progress made by the ESUR urography working group with respect to formulating recommendations and guidelines for CT urography. The structure of the proposed document will consist of the following sections:
1. Introduction
2. Evaluation
3. Optimisation
4. Solutions for problems with using CTU
5. Discussion
6. Recommendations & Conclusions

The session will be conducted in an interactive format, with opportunity for comments and contributions from the audience.
If there are people who would like to contribute to these guidelines, then please make yourself known to Dr Nigel Cowan during the meeting.

Presentation of 2 new proposals for imaging algorithms

Imaging in suspected reno-vascular hypertension in children
Imaging in paediatric urinary tract trauma

Trauma
We have proposed and discussed a flowchart on the work-up of children sustaining renal trauma. The definition of severe trauma / high pre-test probability will be added in a footnote or box. Also we should clearly state that this does not include suspected NAI – this will be added.
In the unstable patient, FAST can help the surgeon on deciding where to start their procedure, and in the stable patient this 1 minute exam does not really delay anything significantly and often is established routine in many centres in their emergency room handling – .
The suggestion came up to divide the flow chart in two – one for severe trauma and patients with high pre-test probability, and one with mild / moderate trauma and low pre-test probability. The respective use of CT and US is presented.
As for the hypertension
Clearly there is a the lack of any evidence in this field, particularly in children, and we present a flow chart and propose a multi-institutional study to gain more evidence on many unclear aspects such as Doppler criteria, the real value (sensitivity / specificity, lesion size, intra-renal vessels …) of CTA and the various MRA techniques in the various age groups, etc…!
As far as achievable, there will be a more clear definition of the value of the different Doppler findings and indices. Ewe should also consider making the common trunk (US - renal artery stenosis – DSA and interventions) more prominent, and the other less common or important or clear imaging steps a little less prominent.
WORKSHOPS

WORKSHOP I

**TOPIC: CLINICAL APPLICATIONS OF CT UROGRAPHY**
Moderator: D Babnik-Peskar (SLO)

**CT UROGRAPHY AND SURVEILLANCE OF THE UPPER URINARY TRACT FOR UCC**
AJ van der Molen
*The Netherlands*

In recent times, CT Urography has supplanted intravenous urography in upper tract tumor detection and surveillance of the upper tract when pathology has been found in the lower urinary tract. Urothelial carcinoma (UCC) of the upper tract is a relatively rare malignancy occurring only in 5% of all urologic tumors. Patients usually present with hematuria, dull flank pain or renal colic. In a selected population with symptoms of macrohematuria, the risk of finding UCC is between 10-24%. Of these tumors, only 10% will be located in the upper urinary tract, mostly papillary tumors in the renal pelvis and lower ureter. Between 2 and 5% of upper tract UCC are multiple. In patients having upper tract UCC, synchronous lower tract UCC can be found in 25-40%, while in 11-13% of patients metachronous tumors of the upper tract can develop.

As multiphase CTV is a relatively high radiation dose examination, the CTV should be properly justified. Good patient selection, based on risk stratification, is important. The classic risk factors include age, male sex, smoking, presence of macroscopic hematuria, previous UCC, radiotherapy of the pelvis, and exposure to aromatic amines. Furthermore, as detection strongly relies on adequate CTV technique as well as adequate distention and opacification of the upper urinary tract, attention to the details of the CTV protocol remains essential.

**CT UROGRAPHY AND RENAL CALCULI**
MF Bellin
*Hôpital Bicêtre-Paul Brousse, AP-HP, University Paris Sud, France*

The management of urinary calculi is mainly determined by presenting symptoms, calculus location, stone burden, calculus composition, and spatial relationships with the collecting system. Urinary tract stone disease generally presents with a classic scenario of acute flank pain, for which the appropriate initial imaging evaluation required is unenhanced CT; CT urography is useful in the evaluation of chronic stone disease.

**Evaluation of patients with acute flank pain. Detection of stones**

Since the initial reports by Smith et al. in 1995 (14) and subsequent reports, nonenhanced CT has become the reference standard for the detection of stones in patients with acute flank pain. The clear advantage of unenhanced CT is its unsurpassed accuracy, with reported sensitivity of 92%-100% and specificity of 94-100%. Coronal reformatted images have been recommended as a useful adjunct to axial images because they speed up the evaluation of suspected urolithiasis and increase radiologists’ confidence. Virtually all stones can be seen on unenhanced CT images with an attenuation value >200 HU, including uric acid and cystine stones. The only stones that may be nonopaque on CT images are pure matrix stones and concretions of crystals of indinavir. Several secondary signs at CT have proved valuable to confirm the diagnosis of ureterourolithiasis including hydrourouter, hydronephrosis, periureteral edema, perinephric fat stranding, and unilateral renal enlargement. Phleboliths may be difficult to differentiate from stones. In some 50% to 77% of ureteral calculi a confirmatory finding is seen with soft tissue thickening 1 to 2 mm around the stone (soft tissue rim sign), resulting from edema at the site of stone impaction. The specificity of this sign has been reported at 90-100%. Phleboliths may show a central lucency, in contrast to the dense centers seen in calculi. The comet tail sign (eg, an eccentric, tapering soft tissue area adjacent to the calcification) is a reliable sign in the diagnosis of phleboliths.

Another advantage of CT over other imaging modalities in the evaluation of patients with acute flank pain is its ability to detect nongenitourinary and nonstone disease, which may be the cause of symptoms. In the literature CT scanning provided an alternative diagnosis in the absence of stones in 10%-16% of patients. The medical conditions that may mimic the pain of ureteral colic include
appendicitis, diverticulitis, biliary disease, aortic aneurysm, pyelonephritis, acute renal infarction, ectopic pregnancy, pelvic inflammatory disease and unsuspected tumors.

Techniques of CTU
CT urography is defined as a CT examination of the urinary tract obtained before and after administration of iodinated contrast medium (that contains 30-42 g of iodine) and includes excretory-phase images. Unenhanced scans are mainly obtained to detect calculi, but also to provide a baseline attenuation value of any abnormality. Excretory-phase scans are obtained to evaluate the lumen and the wall of the urinary tract and to determine the presence or absence of urothelial abnormalities. In patients with chronic stone disease, unenhanced scans and excretory-phase are essential, whereas vascular-phase scans and nephrographic-phase scans (to optimize evaluation of the renal parenchyma) are optional. Evaluation of the CT excretory-phase images depends on opacification and distension of the urinary tract. Until now, there is no universally accepted technique for performing CT urography. Oral hydration is often inadequate and administration of intravenous furosemide (10 mg 2-3 minutes prior the administration of contrast material) has proved useful to improve middle and distal ureteral opacification and distension compared with intravenous saline alone. Two main techniques of CT urography are available. The three-scan CT protocol includes unenhanced images, nephrographic phase images obtained 100 seconds after administration of contrast material and excretory phase images obtained 10-15 minutes after contrast medium injection. The split-bolus protocol reduces the total number of scans from 3 to 2 and decreases radiation exposure. After the unenhanced images, a 30-50 mL dose of contrast material is administered followed by a delay of 8-10 minutes before 80-100 mL of contrast material is given. A CT scan is obtained 100 seconds after the second dose of contrast material, containing excretory information from the first dose and nephrographic information from the second dose. Slice thickness, reconstruction parameters are not standardized. Various 3D reconstruction techniques can be used for CT urography, including MIP, curved multiplanar reformation, volume rendering, and virtual endoscopy. On CT urographic images, the opacified urine is less dense than stones, and stones are visible within the opacified collecting system.

Imaging information essential in choosing appropriate treatment
In patients with stones, the main therapeutic options include medical treatment, extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), ureteroscopic removal, and open surgery, which was the method of choice for treating these patients in the past. The information most useful for planning treatment is the location of the stone and the stone burden, the composition of the stone, and its spatial relationships with the collecting system.

Stone location. The major predictors for spontaneous stone passage of a ureteric stone are size and position. Unenhanced CT and CT urography both reliably determine the precise location of stones: in the kidney, in the renal pelvis or at the pyeloureteral junction, in the lumbar or pelvic ureter, at the vesicoureteral junction or in the bladder.

Stone burden. Measurement of stone burden at CT is used to predict the rate of spontaneous passage of ureteral stones, to plan treatment and to predict treatment success, particularly for ESWL. The most common method of assessing stone burden is measurement of stone size (greatest dimension, or more precisely stone surface and volume). It is more precise with CT than with conventional radiography, as shown by Narepalam et al. (10). The most accurate way to measure urinary stones is to use bone windows settings with magnification. The volume of stones can be given on 3D images with a precision exceeding 4.8%, according to Olcott et al. (11).

Stone fragility. The fragility of stones at ESWL seems to be correlated with their internal morphologic features. Heterogeneity in stone composition renders a stone susceptible to fragmentation with treatment while homogeneous stones tend to be more rigid and therefore harder to break with ESWL, often requiring more treatment sessions. The internal structure of stones is best appreciated when viewed with bone window settings and when imaged at high resolution with thin sections.

Stone composition. The choice of effective clinical management of urinary tract calculi can be facilitated by knowing the precise chemical composition of the stones and their corresponding fragility. Typically, pure stones composed of calcium oxalate monohydrate and brushite or cystine are relatively refractory to shock wave lithotripsy and percutaneous ultrasonic lithotripsy, and are more likely to be treated endoscopically whereas uric acid stones are usually treated with oral alkalinization. Calcium oxalate dihydrate and struvite stones usually fragment easily with both shock wave lithotripsy and ultrasonic lithotripsy.

Bellin et al. (1) have shown in vitro that single-energy multidetector CT can be used to characterize and stratify calculi of various chemical composition with 64%-81% accuracy. Differentiation among stones is less reliable in vivo, because it is dependent on the size, accurate placement of the region of
interest, slice thickness, and whether stones are of pure or mixed composition. In vivo, CT attenuation measurements have been shown to be most valuable in allowing differentiation of 100% uric acid stones from other stones. Dual-energy CT shows great promise in the determination of stone composition.

**Predisposing conditions and anatomic variants.** Congenital anomalies of renal position, number, and form of the urinary tract can predispose to stone formation and are easily appreciated with CT urography. CT urography may be useful to delineate a calyceal diverticulum and show its communication with the collecting system; it may also demonstrate renal tubular ectasia. Duplications of the collecting system are more obvious on a single coronal image that depicts the collecting system in its entirety than on conventional axial CT images. Horseshoe kidneys are also nicely depicted with CT urography. Furthermore, CT urography can identify other entities frequently associated with stones, including UPJ syndrome, congenital megaureter, ureterocele, stenosis or extrinsic compression of the urinary collecting system, and some diversions.

**Complications of stones.** They include urinary tract obstruction proximal to stones, chronic calculous pyelonephritis, and xanthogranulomatous pyelonephritis. CT urography can reliably detect signs of obstruction: early fornical blunting, dilatation of the renal collecting system, renal parenchymal atrophy. It may also show infectious complications of stones, including pyelonephritis, renal abscess and pyonephrosis. Information about urinary obstruction and infection has a major influence over whether and how to treat stones.

**Treatment planning.** CT can be useful in the presurgical planning of interventional procedures such as PCNL. It may assist in the selection of an appropriate calyx for percutaneous access and of a safe path for puncture by depicting the relationships of the kidney to various surrounding organs such as the spleen, liver, and colon. Knowledge of pelvicalyceal anatomy is critical for renal stones of >1 cm in diameter, as the infundibulopelvic angle, infundibular length and width are all important determinants of outcome. When PCNL is planned, these variables are essential in deciding the most appropriate angle and calyx for percutaneous puncture. Several authors have highlighted the value of the SSD (as measured from the center of a stone to the skin surface on axial CT) as a reliable predictor of stone-free status following ESWL for lower pole renal stones, but this remains controversial.

**Follow up**
The main objectives of imaging are threefold: to confirm stone-free status, to identify the presence of residual stones, and to rule out urinary obstruction. Most series on ureteroscopy or percutaneous nephrolithotomy use postoperative plain radiography of the kidneys, ureters and bladder (KUB) or ultrasound (for renal stones) to determine outcomes. However, in a recent series of 92 patients who underwent 113 ureteroscopic procedures for either renal or ureteral stones, Macejko et al. (8) reported that the overall stone-free rates by CT were lower than stone-free rates reported by KUB or IVU criteria. These authors concluded that the significance and natural history of residual stones fragments on CT scan after ureteroscopy needed to be addressed in further studies.

**Conclusions**
CT currently plays a major role in the management of patients with urolithiasis, from the initial diagnosis to treatment planning and posttreatment evaluation.

**References**

Pagina | 54
CT AND UPPER URINARY TRACT INFECTION: ALGORITHM FOR DIAGNOSIS AND INTERVENTION

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The scope of this presentation is the role of CT urography in the evaluation and treatment guidance of urinary inflammatory diseases in adults.

It is a cliche by now that imaging of any sort is not necessary in most patients who present with urinary tract infection, since most have no complicating features or comorbidities and can be treated by antibiotic therapy with clinical followup only. Complications of infection, such as abscesses, emphysematous inflammation, xanthogranulomatous pyelonephritis, papillary necrosis and strictures, and conditions predisposing to severe infections must be diagnosed to permit successful treatment, and these always require imaging.

Selection of patients for imaging is not perfect; the most effective of guidelines lead to normal examinations in some patients and fail to image some patients with complications; nevertheless, principles have emerged to guide imaging and are published in a number of guidelines. Patients with diabetes, symptoms of obstruction, failure to respond rapidly to standard antibiotic treatment or worsening despite therapy, a history of repeated infections, urosepsis (especially with particularly virulent organisms like Pseudomonas), immunocompromised states such as AIDS and immunosuppressive therapy for organ transplants. Males and patients sufficiently ill to require hospitalization for urinary infection have higher rates of imaging-demonstrated abnormalities and probably require imaging.

CT urography competes with a number of other modalities which might be used in these clinical situations. CT with standard urinary tract techniques probably does as well as CD urography for most diseases; there are, of course, inflammatory conditions which produce abnormalities only in the urothelium, which CT urography will reveal and standard CT may miss. In most comparative studies, ultrasound has been found not to be as sensitive as CT techniques for a variety of perirenal, renal parenchymal and hollow visceral abnormalities, but considerations of cost, radiation dose, patient body habitus and disease severity sometimes make it an appropriate first imaging test. In children, DMSA scintigraphy is being recognized not only as useful to demonstrate parenchymal inflammation and scars, but as a valuable first imaging test which may obviate the need for other imaging; in adults, however, it has not become standard. MR urography has the potential to demonstrate a very similar range of abnormalities as CT urography; its future use will probably be determined by comparisons of
the issues of cost, radiation, availability and fraction of high-quality exams. Standard excretory urography, of course, has been supplanted by CT techniques nearly everywhere. Patients with acute pyelonephritis may demonstrate a variety of findings. CTU may be normal, or reveal regions of parenchymal swelling with diminished inhomogeneous or striated nephrogram. Abnormal regions may be of any number, size and laterality, but except in the case of obstructive pyonephrosis, are always patchy in distribution. Occasionally pyelitis may appear simply as urothelial swelling. Abscesses appear as they do in standard CT, with central fluid-filled regions and enhancing rims; the rim thickness and enhancement patterns may vary greatly as a function of age of the lesion. A spectrum ranging from simple focal pyelonephritis to focal phlegmon to evident abscesses may be encountered. Perirenal abscesses appear similar, and may be accompanied by manifestations of ureteral obstruction. Emphysematous infection may present with a variety of gas patterns, which may appear in the collecting system, renal parenchyma, perirenal spaces or any possible combinations. Obstructive pyonephrosis may be difficult to distinguish from sterile hydronephrosis; occasionally gas or visible debris within the collecting system, accompanying perirenal inflammation or abscesses will permit diagnosis. Xanthogranulomatous pyelonephritis usually involves the entirety of the kidney; the commonest pattern is renal enlargement with evidence of obstruction (usually due to a visible stone), nonfunction and proliferation of sinus and perirenal fat. This disease may appear focally (tumefactive xanthogranulomatous pyelonephritis), in which case it almost always is sufficiently indistinguishable from renal carcinoma so that it is resected; parenchymal malacoplakia appears similar. Chronic pyelonephritis is a condition characterized by focal parenchymal atrophy with focal calyceal blunting at the sites of atrophy; it is diagnosed radiologically or pathologically and does not constitute a clinically-diagnosed syndrome. Patients with this condition often have a history of urinary infection, and occasionally serial radiologic exams may demonstrate the progression of acute pyelonephritis to chronic pyelonephritis, but the association is not absolute. In children and young adults, vesicoureteral reflux usually is – or has been – present, whereas in older adults the condition is more likely to be associated with calyceal stone disease. Renal tuberculosis almost always appears as a unilateral disease. Early disease may appear as papillary necrosis only; with progression, there is worsening parenchymal loss, calcification, cavitation, inflammation and subsequent stenosis of any hollow part from calyx to ureter, and loss of function. Varying rates of progression of these processes leads to a bewildering array of appearances: kidneys may be of any size, demonstrate focal or global hydronephrosis, a wide variety of patterns of calcification and any degree of focal or global loss of function. Despite the variety of findings, the association of scarring and tissue calcification is a simple and effective indicator of tuberculosis. Schistosomiasis shares some CTU features with tuberculosis, notably strictures and calcification, but the disease are usually easy to distinguish. Renal tuberculosis is usually unilateral, and the disease is more severe in the upper tract than the lower; the strictures and calcification in schistosomiasis involve the bladder and ureters and are often bilaterally symmetrical, and if the kidneys are abnormal at all, they usually display simple hydronephrosis. As CTU techniques have been refined, inflammatory conditions involving the urothelium have proved to be identifiable. Leukoplakia (squamous metaplasia) may appear as a flat mass in the collecting system or ureter which is difficult to distinguish from neoplasm. Malacoplakia may cause a similar appearance, but is easier to distinguish from tumor by virtue of its diffuseness. Pyeloureteritis cystic produces multiple small urothelial blebs or cysts which produce uniform hemispheric filling defects which protrude into the calyceal or ureteral lumen. Conditions which predispose to urinary infection, and which usually require imaging diagnosis for the treatment which is necessary not only for themselves but to make subsequent upper tract infection less severe or likely, are numerous, and to describe the appearances of each is beyond the scope of this abstract. The common ones will be enumerated and illustrated in the lecture, however; these include stones, diverticulae, fistulae, reflux and any congenital or acquired disease which produces obstruction. Many of the findings of CT urography performed in patients with urinary infection often lead to specific therapeutic maneuvers; the degree to which other findings might be helpful in management remain to be investigated. The combinations of situations and findings are numerous, of course; some of those for which research would be useful follow.

a. Choice of exam. It is well established that CT is more sensitive for certain findings than US; whether a normal US in an infected patients suffices to exclude important abnormalities is still undecided.

b. CT protocol. Whether for infected patients CTU or some variant of CT is best has not been fully investigated.
c. Acutely infected patient; normal CTU vs. focal parenchymal inflammation. In children, visible parenchymal disease often indicates the need for longer antibiotic courses; whether the same is true in adults is not firmly established.
d. Renal and perirenal abscesses. Common practice is to drain them (usually percutaneously); many relatively small abscesses resolve with antibiotics only, however.
e. Obstructive pyonephrosis. Percutaneous or retrograde drainage nearly always indicated in addition to antibiotic therapy. Which techniques and thresholds (Scintigraphy? Parenchymal volume measurements?) are best to determine whether patients are better served subsequently by repair or nephrectomy may pose difficulties.
f. Chronic pyelonephritis. Utility of subsequent evaluation for stone-forming conditions and reflux are not clear.
g. Advanced tuberculosis. Radiologic findings which indicate necessity for resection are not clear.

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CT UROGRAPHY AND THE LOWER URINARY TRACT

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Introduction

Urothelial cancer is the second most common genitourinary tract cancer (after prostate cancer). The vast majority of neoplasms are located in the bladder, likely due to the disproportionate amount of urothelium present in the bladder. These tumors are believed to result from a combination of genetic and environmental factors, with the most common environmental risk factors being cigarette smoke and occupational exposure to carcinogens (1, 2). Traditionally, imaging has played a limited role in the detection and staging of urothelial cancers, due to its limited utility in evaluating the bladder; however, recent studies have shown that CT urography (CTU) is often able to detect urothelial neoplasms in the bladder.

CTU technique

Optimal CTU technique for imaging the upper tracts and the bladder requires that thin section images (no more than 2.5 mm thickness reconstructed at no greater than 2.5 mm intervals) be obtained for
review and that axial images be supplemented with reformatted images in orthogonal planes (usually in the coronal plane).

There is a difference in opinion concerning the optimal CTU technique that should be used to optimize sensitivity for detection of bladder abnormalities. Some investigators obtain uniform opacification of the bladder with excreted contrast material (which often requires that the patient be moved and turned prior to image acquisition) (3), while others believe that bladder cancers are usually equally well detected when outlined by opacified or unopacified urine (4). Most CTU protocols employ imaging of the bladder during the excretory phase of excretion beginning at least 5-7 minutes after contrast material administration (3-6), although a few researchers have shown that many bladder cancers can be detected when imaged during the portal venous phase (at 60-70 seconds after contrast material administration) due to the fact that they enhance more than does normal urothelium (7).

Our current protocol utilizes a double split-bolus technique with the bladder imaged 12 minutes after the first injection (of 100 ml of 300 mg I/ml nonionic contrast material) and 2 minutes after the second injection (of 75 ml). We do not move the patient after contrast material has been injected. When patients are imaged in this fashion, bladder tumors often demonstrate residual abnormal enhancement, while the majority of the bladder lumen is also opacified with excreted contrast material.

**WHO classification of urothelial neoplasms**

The recent World Health Organization classification system (8) organizes bladder tumors in the following fashion: 1) *dysplasia* – a premalignant condition, 2) *carcinoma in situ* – noninvasive flat lesions, which are almost always of high grade, 3) *noninvasive papillary neoplasms* – consisting of *papillomas* (benign tumors that usually occur in young patients and that have a very low risk of recurrence), *papillary neoplasms of low malignant potential* (which rarely are invasive or metastatic, but which can recur), *low-grade tumors* (many of which recur, sometimes at higher stages and grades), *high-grade tumors* (which recur more than half of the time and which have a 15% cancer related mortality), and muscle invasive tumors (which include all tumors that have spread to the muscularis mucosa).

**Cell types**

In the past, it was thought that the vast majority of patients with bladder cancers had transitional cell carcinomas, with much smaller numbers of patients having squamous cell carcinomas (except in areas where Schistosomiasis is endemic), and adenocarcinomas. For this reason, the terms bladder cancer and transitional cell carcinoma have been used interchangeably. Recent research has found that 25% or more of bladder neoplasms actually are of mixed histology (sometimes demonstrating large components of clear cell, glandular, lymphoepithelial, micropapillary, plasmacytoid, and squamous, as well as transitional cell, differentiation, or a “nested” growth pattern) (9). For this reason, some pathologists now prefer to use the term “urothelial cancer” to refer to malignant lesions in the bladder. Identification of mixed or divergent histology tumors is important, as these are more often of high-grade and invasive. Mixed histology neoplasms also can metastasize more aggressively than pure transitional cell carcinomas.

**CT urographic detection of bladder cancers in previously untreated patients**

Recent studies have demonstrated that CTU has a high sensitivity (79-100%) in detecting bladder cancers (3-6, 10). On CTU, bladder cancers most often produce areas of asymmetrically increased bladder wall thickening. Sometimes, the thickening is so pronounced that mass-like areas are produced. Conversely, when the neoplasms are small, they may appear as tiny projections into the bladder lumen. In these instances, a specific diagnosis usually can be suggested. Rare bladder cancers may produce diffuse symmetric circumferential wall thickening. In these cases, the abnormality can be mistaken for cystitis.

![Two bladder cancers: a large mass on the left and a small papillary tumor on the right](image)
Several previously published series have found that certain types of bladder neoplasms are more likely to be missed by CTU. Those that have been most frequently missed are flat, small, and located at the bladder base (4, 5). Bladder base lesions are problematic, because the bladder mass may not be distinguishable from adjacent prostatic or perineal tissue.

False positive diagnoses may also occur. On rare occasions, patients with cystitis can have focal bladder abnormalities that mimic small urothelial neoplasms.

**CT urographic detection of bladder cancers in previously treated patients**

Once a patient has been treated for superficial (noninvasive) bladder cancer, the bladder wall often demonstrates residual areas of inflammation and fibrosis. These changes can produce CTU findings that can be confused with cancers, such as lobulated or irregular bladder wall thickening or small masses projecting into the bladder lumen (3, 11). Conversely, some bladder cancer recurrences in treated bladders can be misdiagnosed as areas of post-treatment change.

**Staging of bladder cancer**
Bladder cancer is staged according to the TNM system as follows:

**LOCAL TUMOR (T STAGE):**
- Ta – superficial papillary
- Tis – superficial flat
- T1 – extending into the lamina propria, but not into the muscularis mucosa (still considered to be non-invasive)
- T2a – invading inner half of muscularis mucosa
- T2b – invading outer half of the muscularis mucosa
- T3a – microscopic perivesical spread of tumor
- T3b – gross perivesical spread of tumor
- T4a – invading adjacent organs (including prostate, uterus, vagina)
- T4b – invading pelvic sidewall

**LYMPH NODES (N STAGE):**
- Nx – indeterminate lymph node involvement
- N0 – no lymph node involvement
- N1 – single regional lymph node involved, which measures < 2 cm
- N2 – single regional lymph node involved, which measures > 2 cm or multiple involved lymph nodes
- N3 – at least one involved lymph node measuring > 5 cm.

**DISTANT METASTASIS (M STAGE):**
- Mx – indeterminate for distant metastatic disease
- M0 – no metastatic disease
- M1 – distant metastases known to be present.

Patients with noninvasive bladder cancers (< T2 disease) are usually treated with local therapy, consisting of transurethral resection and, often, local immunotherapy with Bacille Calmette-Guerin (BCG) instillation. Invasive bladder neoplasms (≥ T2 disease) are treated with radical cystectomy, while stage T3 and T4 tumors may also be treated similarly, albeit after a course of neoadjuvant chemotherapy and/or radiation therapy (12).

CTU is of limited utility in staging bladder cancers. CT cannot determine whether or not the muscle layer of the bladder wall is invaded with tumor, although larger bladder masses are more likely to be invasive (13). CT has limited value in assessing patients for perivesical spread of tumor (unless such spread is gross) (13). Finally, bladder cancers often spread to pelvic lymph nodes without enlarging them (13). Normal sized metastatic lymph nodes cannot be identified on CT.
Despite these limitations, the radiologist can assist the urologist in planning bladder cancer treatment. When interpreting a CT in a patient with known or suspected bladder cancer, the radiologist should assess the degree of asymmetric bladder wall thickening. He or she should suggest the possibility that perivesical spread of tumor has occurred when the outer wall of the bladder adjacent to the tumor is seen to be ill-defined or when there is increased stranding in the perivesical fat, providing that the patient has not had a recent bladder biopsy or resection. In addition, images should be evaluated to determine whether there are additional tumor foci in the bladder or upper tracts, or if there are any enlarged lymph nodes (including along the internal iliac chains - regions not sampled routinely during pelvic lymph dissection, or any lesions in the lungs, liver, adrenal glands, omentum and peritoneum, or bones (14).
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WORKSHOP II

TOPIC: RENAL GRAFTS
Moderator: M Cova (IT)

EVALUATION OF LIVING DONORS
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Renal transplant remains the mainstay of the treatment of end-stage renal disease. With improvement in management strategies and the diverse imaging options, the yearly survival of recipients with functional kidneys has improved significantly. Living-donor kidney transplants are playing a vital role in bridging the gap between decreased supply of, and increased demand for, kidneys for transplant. Living donor renal transplantation has better renal survival rate than cadaveric graft survival rate. With the advances in several imaging options like multidetector CT (MDCT) and MR imaging, along with recent technical upgrades in image postprocessing, meticulous donor selection is now possible (1,2). A thorough radiologic evaluation of the kidney donors before renal transplantation is necessary for surgical planning. An accurate understanding of renal vascular anatomy has become more important with the emergence of laparoscopic donor nephrectomy and minimally invasive techniques (3,4). Detection of accessory arteries that may be present in more than 20% of subjects (5) is crucial, because it may complicate laparoscopic surgery. Furthermore, lower pole accessory arteries may provide a substantial blood supply to the renal pelvis and upper ureter.
Historically, donors were evaluated by arteriography and excretory urography. Although conventional arteriography has remained the gold standard for evaluating renal vascular anatomy, accessory vessels can be missed in up to 8% of patients (6, 7). In addition, angiography is invasive and may be associated with several complications including arterial dissection, thrombosis, hematoma, allergic reaction, and even death. The rate of major complications associated with angiography is 2.9% (8). MRA and CTA have the potential to replace angiography because both have minimal invasiveness, multiplanar capability and can evaluate the renal parenchyma as well as the vascular anatomy. At the same time, additional costs incurred by hospital admission (as for DSA after the arterial puncture) do not occur. Gadolinium-enhanced MRA is an attractive choice as it provides the benefit of transmitting no radiation, and gadolinium contrast media has minimal nephrotoxic effects. However, there has been concern about the accuracy of predicting renal vascular anatomy.

With the advent of MDCT and advances in the MR scanner, current donor evaluation protocols are improving rapidly. Both these imaging modalities have proven promising in detecting vascular and collecting system variants with an established increase in readers’ confidence (9). With this development, the use of catheter angiography for mapping renal vasculature has virtually faded. Furthermore, the value of image postprocessing has added to increased acceptability of the CT and MR images to referring physicians because postprocessed images provide a close simulation to the operative findings during surgery (10). The high–resolution, thin-slice acquisitions provided by the newer CT and MR imaging scanners make it now possible to detect thin accessory renal arteries. CT and MR urography also provide a clear delineation of the pyeloureteral anatomy, with added benefits provided by three-dimensional (3D) postprocessing (11).

Multidetector CT versus MR imaging for evaluation of renal donors

Both MDCT and MRI can be used as all-in-one modality for morphological and functional evaluation of potential kidney donors (12-14). The better spatial resolution, faster speed, and greater cost effectiveness of CT have led to a wide acceptance of CT over MR imaging in most centers. Although CT and MR angiography have demonstrated substantial agreement in the preoperative evaluation of renal donors (15), more published research data on the integrity of CT technique, contrast volume, and injection rates, and various revolutionary CT protocol techniques, have definitely tilted the balance toward MDCT, leading to its widespread acceptance for imaging renal donors. The interobserver disagreement in the interpretation of CT and MR angiography is related to overreading and underreading of small vessels (1–2 mm in diameter) (16). With the similarity of CT and MR imaging accuracies, the potential advantages and disadvantages associated with each modality will be discussed in this lecture.

MR angiography is a safe and noninvasive technique for comprehensive evaluation of renal donors. It is radiation free and particularly advantageous in patients who are prone to allergic reaction from iodinated contrast media. The limitations of MR imaging include decreased spatial resolution and restrictions in slab length, which can lead to failure to image large volumes. These limitations can lead to misinterpretations, especially in cases where the accessory artery arises from the iliac vessel or where the lower ureter has a tiny stone (17). Such considerations have led to increased acceptance of CT angiography for the preoperative evaluation of renal donors.

Objectives

- Describe MDCT and MR imaging techniques used for preoperative evaluation of subjects considering donor nephrectomy.
- Illustrate imaging appearance of surgically relevant arterial, venous, parenchymal and urinary tract variants.
- Demonstrate MDCT and MRI protocols for comprehensive morphological and functional evaluation.

References


EVALUATION OF POTENTIAL RENAL GRAFT RECIPIENTS
M. Sebastià

In the last 20 years, four important advances have taken place in renal transplantation:
- Living renal donor transplantation that allows non emergency surgery for high risk recipients with the possibility to plan multidisciplinary surgery.
- Improvement in surgical renal transplant procedures
- More sensitive techniques for the cross match to detect pre-existing antibodies
- Modern immunosuppression

All these advances allow us to expand the pool of renal donors and also patients with end-stage renal disease previously excluded as renal transplant recipients can now been transplanted (1). Because of the increasing complexity of these marginal recipients, radiological evaluation is becoming more and more important (2). Some patients will require urinary tract radiological evaluation. Aortoiliac vascular map will be necessary in other patients. Also tests predicting probability of cardiovascular complications must be performed on most recipients. During this speech we will explain the radiological approach for these three topics.

The majority of the patients awaiting renal transplant do not require evaluation for the lower urinary tract. Pretransplant study should be limited to patients in which we need:
- To assess bladder capacity (specially if the patient has been on dialysis for a long period time)
- In cases of suspicion of bladder disease (like neurogenic bladder…)
- If urinary reflux is suspected (namely in paediatric patients and patients with recurrent urinary tract infection)
- If the patient has urinary diversion, in this case a conduitography must be performed

Study of the lower urinary tract could be performed with cystogram, ultrasound and contrast enhanced ultrasound, CT cystography, cystoscopy and with functional tests (urodynamics).

In our hospital we perform voiding cystourethrogram in these patients because with this test alone we can evaluate several points: vesicoureteral reflux, bladder capacity, postvoid residual urine volume, bladder diseases and urethral problems (3).
We perform an abdominal X-ray in all patients to rule out vascular calcifications, but in patients over 40, with cardiovascular risk factors, with second or third renal transplant or with diabetes mellitus a more precise evaluation is required. Kidney grafts are usually located in the pelvis with arterial and vein anastomosis to the external iliac system. Knowledge of the condition of iliac vascular system is necessary in order to find out calcifications, aneurysms and stenosis in this sector that can impede or change kidney graft location. Multidetector CT is the most efficient test to assess vascular calcifications and associated diseases in potential renal recipients (4).

In our hospital abdominal X-rays is performed in all recipient candidates. If the patient is over 40, is diabetic, has cardiovascular risk factors or is the second or third renal transplant but is on dialysis, contrast enhanced MDCT is performed. If these patients are not in dialysis we hospitalize them to prepare them with prophylaxis treatment for CIN and late perform also contrast enhanced MDCT (5). This MDCT is repeated each two years if vascular disease is detected or each 5 years if no findings have been chosen in the first MDCT.

Unenhanced phase is used to detect calcifications and serves as a baseline for enhancement of any selected lesion. The arterial phase depicts the aortoiliac map. A venous phase is performed only if there is the suspicion of abdominal venous disease. According to the experience at our institution an arterial segment of 3cm or longer, free of parietal calcifications, is necessary to achieve a correct arterial anastomosis. In more advanced atherosclerotic patients we need at least 2 gaps of 1cm free of calcifications to put proximal and distal clamps and another gap in the between to perform arterial anastomosis (6).

Space in the renal fossae can be diminished in patients with polycystic kidney disease because of the nephromegaly of these kidneys (7). From a radiological point of view if the lower pole of the kidneys are behind a line drawn following the pelvic crests we must alert the surgeons of the lack of space for the transplant and the need for nephrectomy. The location of previous grafts and their arterial and vein anastomosis must also be reported.

An increased incidence of renal tumours has been reported in patients with end-stage-renal-disease. A very strong association with acquired renal cystic disease and an increased incidence of papillary renal tumours was observed in many studies (8). although renal tumours are best depicted in the nephrographic phase, the enhancement presented in the arterial phase as takebayashi claims would be sufficient (9).

In difficult vascular conditions such iliac universal calcifications, stenosis or aneurysms, lehre syndrome and associated abdominal aneurysms we have more complicated surgical options for transplantation like orthotopic transplantation or previous or simultaneous aortoiliac by-pas and renal transplant (10).

To perform these types of surgery information about suprarenal and infrarenal aorta must be reported, for proximal aortoiliac bypass anastomosis and the state of femoral arteries and in most cases state of inferior extremities vascular map must be depicted for distal by-pass anastomosis. In high risk patients mortality from cardiovascular events with a normal functioning renal graft is the biggest handicap. We need to study the patients to depict the presence of current cardiovascular problems and perform other tests to predict cardiovascular problems in the future (11). Several radiological and clinical tests have been published in the recent literature for prediction of cardiovascular risk. Most of them can be achieved if toracoabdominal MDCT with cardiac study is depicted. In the future, if a score based in all these findings is elaborated, MDCT could be a one stop-shop test for this prediction.

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EVALUATION OF RENAL GRAFT DYSFUNCTION

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US is the most useful technique for early and late transplant follow-up. Implantation of the graft within the iliac fossa improves its accessibility and makes possible the use of high frequency probes, which provide high resolution and high Doppler sensitivity. On gray-scale US, the normally functioning grafted kidney shows the same corticomedullary differentiation as a native kidney. High frequency probes (10–15 MHz) show clear separations of all the kidney compartments: the cortex, the outer medulla and the inner medulla, with a decreasing echogenicity gradient from the capsule to the papilla. Color Doppler is now essential for detection of intra- or extrarenal arterial or venous abnormalities. The entire graft, venous and arterial anastomoses can be imaged with a 3.5–5 MHz probe. A high frequency (7.5–14 MHz) probe allows examination by generating high-resolution images of the anterior distal intrarenal vasculature (interlobular and arcuate arteries), which are better delineated with the power mode. Spectral sampling of renal artery flow and interlobar arteries at two or three levels of the graft is also mandatory in all cases. The renal artery velocity profile is analyzed and the peak systolic velocity, after angle correction, is measured. Flow sampling of interlobar arteries enables calculation of the resistivity index (RI).

MRI of the renal graft is performed with body phased-array coils, using adequate sequences for visualizing successively the renal parenchyma and its environment, the vascular tree, and the excretory system. On T1-weighted (T1w) (spin-echo or gradient-echo) sequences, the normal corticomedullary differentiation is visible on normally functioning kidneys: the medulla generates a lower signal intensity (SI) than the cortex. On T2-weighted (T2w) sequences (usually obtained with a fast spin-echo technique), the medulla generates a higher SI. Gadolinium (Gd) injection gives an accurate delineation of perfused and non-perfused areas of the graft and high-resolution 3D-MR angiograms can be obtained for the entire arterial tree – from the iliac axis to the third or fourth order branches. However, the distal vascular tree (from interlobar to interlobular arteries) cannot be visualized. The same 3D sequence must be repeated 5 minutes after Gd injection (or later if necessary) to obtain MR-urograms and furosemide injection is generally not necessary for that purpose.

CT has always played a minor role in kidney transplant-imaging because it requires normal renal function for analysis of the renal parenchyma or renal vessels.

1. Early graft complications (first year)
   1.1. Urological complications
   Urological complications, often of technical origin, can be a source of morbidity and sometimes mortality after kidney transplantation. The current urological complication rate ranges from 4% to 7% [Gogus, et al.2002, Kocak, et al.2004] and death is highly unusual.

   1.1.1. Urinary fistulas
   The urinary fistula frequency ranges from 1 to 5%, the most common early complication, occurring during the first 2 weeks after transplantation. The majority of urinary leaks are attributed to ureteral ischemia. The other causes of urinary leaks are failure of ureterovesical anastomosis or a missed ureteral duplication. Leakage may be suspected when increasing volumes of a clear liquid are collected by drains, while diuresis tends to decline during the days following surgery. Determination of fluid electrolytes, ingestion of methylene blue thereafter found in the fluid collected and US showing a
perirenal fluid collection can confirm the diagnosis. US usually finds a well-defined anechoic collection at the lower pole of the kidney. This fluid appears hypointense on unenhanced MR T1w and hyperintense on T2w sequences. T2w-MR urography shows the collection and the entire dilated excretory system. The differential diagnosis includes lymphoceles, which usually occur later. Chemical analysis of the fluid may suggest the diagnosis, if the creatinine concentration is higher than that in blood. However, the definitive diagnosis of urinoma is based on the demonstration of an extravasation of contrast medium into the collection after intravenous injection. This can be obtained with Gd-enhanced MRI, iodine-enhanced CT or radionuclides. Urine collection contamination by the contrast agent or the radiotracer often requires delayed imaging (5–15 minutes after injection).

Whereas the treatment of most of these leaks is surgical, small ones can be treated by nephrostomy and/or ureter stenting. Open surgery consists of reimplanting the ureter, with the technique to be used chosen as a function of its remaining healthy length.

1.1.2. Ureteral stenosis
This complication develops later (several months) and its frequency tends to increase with time, 5% at 1 year and 10% at 5 years. In 80% of the cases, it is the consequence of progressive fibrosis of the ureterovesical anastomosis but it can also result from inflammatory infiltration of the ureter-wall during rejection. The differential diagnosis includes intraluminal causes of obstruction, such as lithiasis or blood clot and extraluminal compression by perigraft fluid collections.

The diagnosis is suspected when decreased renal function is associated with dilatation of the collecting system on US. Differentiation between obstructive and non-obstructive pyelocaliectasis remains difficult and Doppler RI measurement is neither sensitive nor specific in transplanted kidneys [Platt, et al.1991]. Renal scintigraphy may characterize the obstruction when the tracer accumulates within the collecting system on delayed images and by measuring increased clearance time after furosemide injection.

When obstruction is suspected, visualization of the entire upper urinary tract is mandatory to determine its exact location and cause. The least invasive method for that purpose is MR-urography because most of these patients have decreased renal function. Both type of sequences (T2w and Gd-enhanced T1w) have to be obtained. When dilatation is sufficient, T2w sequences demonstrate the entire collecting system up to the anastomosis or the site of obstruction. If not, T1w Gd-enhanced sequences, with delayed acquisitions, usually do.

1.1.3. Graft infection
Urinary infections are common during the first month following transplantation. They are usually nosocomial bacterial infections, sometimes facilitated by the presence of catheters, which can lead to real pyelonephritis of the graft or the development of renal or perirenal abscesses. Sometimes, perigraft abscesses may be secondary to bacterial contamination of a preexisting fluid collection (hematoma, lymphocele or urinoma).

US, using B-mode and Doppler techniques, should be performed first, and will show a perigraft collection, often extending towards superficial planes, which, in this context, must always be considered infected. Thin or coarse echoes, sediment, septa and a thickened hypervascularized peripheral wall are evocative of infection. When infection of a perigraft collection is suspected, contrast-enhanced MRI or CT will help to assess their exact extension before treatment. Fluid aspiration from these collections, under US control, may be necessary for confirmation of the diagnosis, and optimal treatment combines percutaneous or surgical drainage and systemic antibiotic therapy.

Renal parenchyma infection may be seen as an increased graft volume and/or areas of decreased or increased echogenicity with decreased flow on color Doppler examination. Gd-enhanced MRI and enhanced CT are able to distinguish between infection and infarction in most of cases, because enhancement is observed in the former and not in the latter, except for a thin peripheral capsular rim. Urinary infections with Corynebacterium urealyticum is uncommon but can expose the transplant to complications, such as ureteral obstruction, renal abscess formation or progressive destruction of the graft [Dominguez-Gil, et al.1999]. Color-Doppler US detects these urothelial calcifications that produce a twinkling artifact within the bladder and/or the upper urinary tract.

1.1.4. Perigraft fluid collections
In addition to those associated with fistulas and perigraft abscesses discussed above, these fluid build-ups can be constituted of blood and/or lymph. Postsurgical lymphorrhea causing a lymphocele remain the most frequent cause of perigraft collections, occurring in 1–20% of renal graft recipients, usually after the 4th week posttransplantation. Sometimes, their volume may cause ureteral or venous compression. On ultrasonograms, a lymphocele appears as a well-defined anechoic collection. CT density values and SI on MR sequences are typical of simple fluids, without any enhancement after contrast injection.
When a lymphocele is responsible for ureteral or venous compression, radical therapy is essential. Simple aspiration and drainage are ineffective because they do not prevent lymph leakage. Therefore, percutaneous drainage must be combined with sclerosis of the cavity by repeated instillations of doxycycline, tetracycline, acetic acid, alcohol or povidone–iodine. Multiple sessions until daily drainage falls below 10 mL are necessary for larger ones [Karcaaltincaba, et al.2005].

Hematomas account for approximately 9% of peritransplant collections and usually occur during the immediate postoperative period, due to surgery. The other main causes are: 1) early renal biopsy complicated by a cortical pseudoaneurysm, which may increase in size and subsequently rupture in the perirenal space; this complication occurs immediately (24–48 hours) or several weeks after biopsy; 2) graft rupture secondary to severe acute rejection, which occurs in 3–6% of renal transplants and during the first 2 weeks after transplantation. During the early postoperative period, hematomas are echogenic collections without flow on US images and are hyperattenuated on unenhanced CT images. MRI is more specific, showing high intensity on both T1w and T2w sequences [Neimatallah, et al.1999].

1.2. Vascular complications

1.2.1. Renal artery thrombosis

Arterial thrombosis is very unusual, occurring in <1% of renal graft recipients, but is extremely severe, leading in most cases to graft loss. It occurs early, caused by a hypercoagulable state, hypotension, hyperacute rejection, immunosuppressive therapy or a surgical complication: anastomotic occlusion, arterial dissection, renal artery kinking when it is too long or torsion of the renal artery when implanted intraperitoneally. Its diagnosis is suspected soon after transplantation, when severe renal impairment is associated with anuria. Confirmation is easily obtained with color flow Doppler US showing arterial flow in the iliac artery, absence of flow within the entire graft, which is swollen and hypechoic, and a persistent ‘to-and-fro’ flow pattern within renal veins [Grenier, et al.1997, Grenier, et al.1991]. If confirmation is necessary, Gd-enhanced MRI examination can demonstrate the complete devascularization of the graft [Helenon, et al.1992]. Only rapid reintervention, within 12 hours for surgical thrombectomy, can save the graft and does so in half of the cases. Percutaneous endovascular revascularization has been described for allograft salvage, but only for late thrombosis [Juvenois, et al.1999].

1.2.2. Infarctions

Segmental infarcts can also be due to segmental or reimplanted accessory renal artery thrombosis or be associated with acute rejection. They are usually asymptomatic and renal function impairment depends on their size. Doppler US is not specific, showing wedge-shaped areas of decreased or increased echogenicity without flow [Dodd, et al.1991, Grenier, Claudon, Trillaud, Douws and Levantal.1997]. Injection of ultrasound contrast agents may help differentiate with infection [Lefevre, et al.2002]. Similarly, contrast-enhanced MR images demonstrate the absence of enhancement within the infarcted segments, except for the subcapsular cortex corticis [Neimatallah, Dong, Schoenberg, Cho and Prince.1999, Sebastia, et al.2001].

1.2.3. Renal artery stenosis

The frequency of renal artery stenosis (RAS) in transplanted kidneys varies from 1% to 23% and they may represent around 75% of all posttransplant vascular complications [Bruno, et al.2004]. It develops most often during the first year following surgery. Their origin is multifactorial: atherosclerotic plaque in the donor’s renal artery or in the recipient’s iliac artery; dissection, kinking or twisting of the renal artery (due to excessive vessel length); malpositioning of the graft; flow turbulences generating intimal hyperplasia; graft perfusion catheter during cannulation causing intimal damage; wall ischemia due to excessive dissection with destruction of vasa vasorum. It is also possible that prolonged cold ischemia may play a role through ischemia–reperfusion injury [Halimi, et al.1999, Patel, et al.2001].

Severe hypertension with or without allograft dysfunction is the most frequent clinical symptom. Hypertension is a common feature in transplant recipients (up to 80%). Therefore, RAS is suspected when hypertension develops suddenly, rapidly becomes more severe and resistant to medical therapy, and is associated with graft dysfunction without any other cause or when associated with an audible bruit over the graft [Palleschi, et al.1980, Rijksen, et al.1982]. It may account for around 1–5% of posttransplant hypertension. US is able to detect renal artery stenoses. Both velocity-profile changes, responsible for spectral broadening and perivascular color artifact, and systolic acceleration must be observed to make this diagnosis. A systolic velocity threshold of 190–200 cm/sec [Grenier, Douws, Morel, Ferriere, Le Guillou, Potaux and Broussin.1991, Loubeyre, et al.1997] or a systolic velocity ratio between renal and external iliac arteries of 1.5 [Loubeyre, Abidi, Cahen and Tran Minh.1997] have been proposed for significant stenoses. When the renal artery is too long, kinking is easily demonstrated on the color display but only spectral sampling is able to confirm the presence of a stenosis. As described for
native kidneys, intrarenal sampling of interlobar arteries and looking for dampened waveforms may help detect severe proximal stenosis [Gottlieb, et al.1995]. However, these intrarenal features are less useful in transplanted kidneys because the proximal changes are more easily accessible than in native kidneys.

MRA is the most suitable to confirm this diagnosis. 3D Gd-enhanced acquisitions were recommended [Fang, et al.2001, Ferreiros, et al.1999], using body phased-array coils and a parallel imaging technique. But today, non-contrast techniques allow to avoid injection of contrast agent in patients with severely impaired function. The sensitivity and specificity of MRA in detecting significant stenoses were 100% and 98%, respectively, and interobserver kappa concordance values exceeded 0.85 [Ferreiros, Mendez, Jorquera, Gallego, Lezana, Prats and Pedrosa.1999]. Percutaneous transluminal angioplasty, with or without stent placement, is the preferred primary treatment of RAS, when medical therapy can no longer control blood pressure and/or renal function progressively deteriorates. Artery stenting is an effective method for recurrent stenosis [Sierre, et al.1998]. The clinical success rate varies from 82% to 94% [Beecroft, et al.2004, Patel, Jindal, Wilkin, Rose, Johnson, Shah, Namyslowski, Moresco and Trerotola.2001] and the reported midterm patency (mean of 30 months) reached 100% [Beecroft, Rajan, Clark, Robinette and Stavropoulos.2004, Sierre, Raynaud, Carreres, Sapoval, Beyssen and Gaux.1998].

1.2.4. Renal vein thrombosis

Acute venous thrombosis occurs in approximately 1–4% of renal transplant recipients and usually during the early postoperative period. When it is complete and abrupt, graft pain and swelling are observed, associated with oliguria and proteinuria. Acute venous thrombosis is often due to faulty surgical technique, with hypovolemia, hypercoagulation state or renal vein compression by a perigraft fluid collection as predisposing factors. It may also be a complication of postoperative lower limb or iliac vein thrombosis extending into the renal vein. Diagnosis of renal vein thrombosis is difficult. On Doppler images, no venous flow is present and arterial flow appears decreased and highly resistive, showing protodiastolic or holodiastolic reflux. On B-mode, the kidney is often enlarged and sometimes heterogeneous. When seen later, transcapsular collaterals may have developed that drain venous flow towards the iliac veins. In difficult cases, using either unenhanced “white blood” axial gradient-echo or Gd-enhanced T1w MRI sequences may help visualize the venous thrombus. In the case of partial venous thrombosis, anticoagulants administration is usually sufficient. However, when confronted with early complete thrombosis, rapid surgical revascularization is required. Percutaneous thrombectomy, associated with anticoagulation has also been proposed [Melamed, et al.2005].

1.2.5. Vascular complications of biopsy

Intrarenal arteriovenous fistulas and pseudoaneurysms occur in approximately 1–18% of the grafts after percutaneous transplant biopsies. Most of them are asymptomatic and resolve spontaneously. But they may be responsible for severe perirenal hemorrhage or hematuria. Pseudoaneurysms present as localized vessel dilatations, anechoic on B-mode US, with a rotative flow inside on color-encoded images [Dodd, Tublin, Shah and Zajko.1991] and, when isolated, with a to-and-fro flow pattern of the spectral waveform in the neck. Shunts are responsible for enlargement of the supply artery and draining vein associated with high-grade turbulence responsible for a perivascular artifact [Grenier, Douws, Morel, Ferriere, Le Guillou, Potaux and Broussin.1991, Middleton, et al.1989]. On arterial spectral waveforms of feeding arteries, the flow profile is severely altered, with increased velocities and decreased RI [Hubsch, et al.1990]. Venous flow resembles arterial flow with systolic enhancement. When a clinical complication occurs, they can be treated by transcatheter embolization, using microcoils and providing a 95% technical success rate [Perini, et al.1998].

1.2.6. Parenchymal necrosis

Allograft necrosis is a rare and extremely severe complication. It results from defective distal perfusion occurring immediately after graft implantation (primary non-function) or as a consequence of severe acute tubular necrosis (ATN) or acute rejection. It is most often limited to the cortex (cortical necrosis) or extends into the medulla (total necrosis). In cortical necrosis, the graft may appear normal on gray-scale ultrasonograms, when imaged early, or show a hypoechoic cortex. Using a high-frequency probe on the anterior cortex, the cortex on power Doppler ultrasonograms appears to be partially or entirely devascularized. Gd-enhanced MRI confirms the diagnosis and clearly shows the in-depth extension of the parenchymal devascularization [Helenon, Attlan, Legendre, Hanna, Denys, Souissi, Kreis and Moreau.1992].

1.3. Medical complications

1.3.1. Clinical considerations
Different causes can be responsible for the failure or deterioration of renal graft function:

- **Primary non-function**, characterized by immediate anuria without subsequent improvement. It is favored by elderly donor, hypertension, prolonged ischemia, kidneys from children implanted into adults.

- **ATN**, characterized by delayed recovery of renal function. It becomes manifest 12–24 hours after revascularization as anuria or renal insufficiency with preserved diuresis. It is favored by the donor's age and vascular history, intensive care of the donor (hemodynamic status) and drugs used, difficulties encountered during organ excision (multiple organs), perfusion and cooling fluids used, duration of cold ischemia. It resolves spontaneously over the first 2 weeks.

- **Acute rejection**, remains the primary cause of graft loss in the short term and represents a major risk factor for the development of chronic graft dysfunction. Its rate is 10–15%. Clinical signs are few in number and become manifest late, with a painful and enlarged graft, markedly diminished diuresis and febricula. Notably, a serum creatinine rise of >20% is an important warning signal. The definitive diagnosis and the severity of the episode are provided by a renal biopsy. First-line therapy consists of high-dose corticosteroids and, in the case of corticoresistant rejection, administration of anti-lymphocyte globulins or monoclonal antibody OKT3. Acute cellular rejection is reversible in the majority of cases.

- **Acute cellular rejection** has to be excluded, either directly caused by calcineurin inhibitors (cyclosporin A, tacrolimus) or more indirectly amplified by drug interactions. Again, the definitive diagnosis is provided by the biopsy.

1.3.2. **Imaging**

Distinguishing between these medical entities may be difficult and, unfortunately, imaging techniques have not yet played a major role in alleviating that difficulty, thereby still justifying renal biopsies. Many US features have been described as being highly suggestive of acute rejection: enlarged graft, effacement of the central sinus–echo complex, enlargement of pyramids, increased or decreased cortex echogenicity, loss of corticomedullary differentiation, thickened collecting system walls. Unfortunately, these features are subjective and not specific, and have low reproducibility [Frick, et al.1981, Fried, et al.1983, Hoddick, et al.1986, Hricak, et al.1987, Kelcz, et al.1990, Linkowski, et al.1987].

Duplex Doppler RI >0.75 or >0.80 can be observed in each of these medical complications [Allen, et al.1988, Don, et al.1989, Genkins, et al.1989, Kelcz, Pozniak, Pirsch and Oberly.1990, Linkowski, Warvariv, Filly and Vincenti.1987]. However, the extent of RI increase directly reflects the degree of cortical hypoperfusion. Thus, it seems that the degree of RI increase might be associated with the clinical outcome: in the most severe cases, protodiastolic or even holodiastolic reverse flow, evocative of severe acute rejection, severe ATN or renal vein thrombosis, is associated with a poor functional prognosis [Kaveggia, et al.1990].

Power Doppler US using high frequency transducers to delineate cortical blood flow visualizes the dense cortical interlobular pedicles all the way to the cortex cortices [Martinoli, et al.1996]. In renal grafts with impaired function, focal or diffuse absence of interlobular signals can be observed. These changes can be reversed with treatment and are associated with a prediction of poor functional recovery at 12 months [Trillaud, et al.1998].

Findings on MR T1w-sequences detecting these entities overlap too. Initially, decreased corticomedullary differentiation (CMD) on T1w sequences was considered specific to acute rejection [Hricak, et al.1986, Rholl, et al.1986]. Now, this feature is considered non-specific for any nephropathy [Neimatallah, Dong, Schoenberg, Cho and Prince.1999].

2. **Long-term follow-up**

2.1. **Chronic allograft nephropathy (CAN)**

CAN can be defined as a progressive deterioration of renal function appearing several months after transplantation, independently of acute rejection, another nephrotoxicity phenomenon or recurrence of the initial nephropathy with a suggestive histological appearance [Halloran, et al.1999]. Different scores have been devised to classify CAN according to its severity. The mechanism leading to CAN development is complex and poorly understood, bringing together causes dependent on and independent of the allogeneic reaction. Its natural history shows that it comprises two very distinct phases: an early phase (first year), with an exponential increase of fibrotic interstitial lesions and tubular atrophy; and a late phase (after the first year), during which lesions caused by the nephrotoxicity of anti-calcineurins predominate and play a major role after 3 years posttransplantation.

Kidneys suffering from CAN are decreased in size and have poorer corticomedullary differentiation and, sometimes, mild dilatation of the renal calices and pelvis. Most imaging techniques focus on the loss of parenchymal vascularity in the cortex to recognize this entity. However, neither RI measurement nor evaluation of intrarenal vessel density with power Doppler mode help to identify
transplants developing CAN. Although RI measurements have no value for this diagnosis, they could have a prognostic value for long-term allograft outcomes: Radermacher et al. [Radermacher, et al.2003] showed that renal arterial RI ≥0.80, measured at least 3 months after transplantation was associated with poor subsequent allograft performance and death.

2.2. Recurrence of the initial nephropathy
Glomerular nephropathies represent the primary cause of chronic renal insufficiency (CRI) and are the principal entities that recur in the graft. According to the type of glomerulonephritis, the risk of recurrence ranges from 6 to 19% [Hariharan, et al.1999], which corresponds to the third cause of graft loss (after CAN and patient death with a functional graft), and it rises with the duration of the transplant.

3. Conclusion
The culmination of more than a century of trials and errors, renal transplantation, as it is practiced today, is a relatively simple intervention that gives excellent results as long as a rather strict procedure is respected. It requires a multidisciplinary approach to the patient, harmoniously combining the competencies of the nephrologist, radiologist and urologist. This close-knit association and the contribution of each specialist before and after surgery should optimize the chances of successful transplantation and limit perioperative complications. Development of non-invasive imaging techniques has already transformed the diagnosis of many of these complications, by rapidly providing complete useful morphological information. Emerging methods, once they have found their place, will soon further enhance that knowledge by adding functional data obtained during the same imaging sessions.

References


TUMORS IN RENAL GRAFTS

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The incidence of malignancies in transplantated patients is higher compared to non-immunosuppressed patients [1]. Since the first observation reported by Penn et al. in 1969 the increased risk of malignancies developing in organ-transplanted recipients has been evaluated up to 100 times than the normal population [2-4]. The most frequent cancers are lymphomas and skin cancers, followed by cancer of the bladder, prostate and testes. The most important risk factors for developing malignancies in transplant recipients are immunosuppression, uremia, oncogenic virus, chronic stimulation of antigen, loss of T suppressor function and intensification of the normal age related incidence of cancer [1].

De novo renal cell carcinoma (RCC) in a renal allograft is a rare event. However, this finding has special implications on various aspects of patient's management, including diagnosis and treatment. It also raises for the population of recipients the question of screening. The role of imaging is essential, as already demonstrated for tumors of native kidneys.

General considerations
Incidence of tumors of the renal transplant
Acquired cystic disease (ACKD) is recognized as a disease of consequence in patients who undergo long-term maintenance hemodialysis. ACKD affects one third or more of long-term (> 3 yr) hemodialysis patients and approximately 20% of those with ACKD will have RCC, representing approximately 5%. The activation of proto-oncogenes may be responsible for the development of RCC [5]. The association of ACKD and RCC has been first described in allograft kidney in 1995 [6]. In a review by Penn in 1995, RCC cases have been evaluated as 4.6% of post-transplant cancers, compared with 3% of tumors in the general population [3]. RCC most often develops in native kidneys and only rarely in grafted kidneys, representing only 4.6% of cancers in transplant recipients and 10% of cancers in kidney grafts [4, 7, 8]. Incidence rates of 0.24%, 0.34% and 0.46% have been reported in three series published in the last six years [8-10]. It was found of 0.75 % in our institution. The incidence of neoplasm after transplantation has been shown to be higher in elderly recipients in some series [11] but not in others [8]. Delay after transplantation may be as long as 20 years [6, 8]. Renal cell carcinomas (RCC) in transplants appear to be similar in their biological behavior to those in patients without immuno-suppression, and tumor progression seems rather low [12, 13]. However, cases of death because of metastatic disease or febrile paraneoplastic syndrome were described [3, 8], and, for some authors, RCC may be soon the leading cause of death late after transplantation [5].

Types of tumors
A review of published literature shows a much higher rate of papillary tumors in renal grafts, compared to non transplanted population. If advanced cases with venous and/or metastatic extension have been initially described [14], most cases reported in the last decade are small tumors, of less than 3 cm in diameter. Histological grades are predominantly grade 1 or 2. Multiple lesions in a graft, with presence of a main tumor and of satellite lesions, so called adenomas, have been described several times in a context of papillary tumor [10, 15, 16]. Occasionnaly, angiomyolipoma, oncocytooma or angiomyxoma
have been reported [17-19]. When performed, microsatellite analysis mostly confirmed donor origin of tumors.

Role of Imaging in the diagnostic

Imaging before transplantation

There were approximately 10% of the cases where a tumor was present at harvesting twenty years ago [3]. Because of the potential RCC incidence in donor candidates, an ultrasound screening of the native kidneys before renal explantation and an immediate preparation of the kidney surface especially in donors older than 45 years has been recommended [1]. CT is nowadays the method of choice for the evaluation of organs in a potential donor.

Place of imaging in screening

Annual US monitoring of transplanted kidneys has been recommended, despite the low incidence of tumors, as this practice would detect smaller lesions amenable to conservative surgery [8]. Screening protocols which have been proposed for the evaluation of native kidneys should include the renal allograft. They are mainly based on ultrasound, with complementary CT or MRI in case of non characterized lesion on US [5].

Characterization of tumoral lesions occurring in renal transplant

The characterization of renal lesions in a transplant is based on the same patterns that have been described on imaging for the various types of tumors in native kidney. However, the evaluation by ultrasound and/or contrast-enhanced ultrasound takes benefit from the superficial location of the graft. Nowadays, as a result of regular follow-up of transplant by imaging, staging shows an increasing number of T1 tumors. Differential diagnosis of focal renal lesions includes pseudotumors (caused by irregular parenchyma atrophy) and infectious lesions. Lymphoproliferative disorders have also to be considered in the case of a lesion infiltrating the kidney hilum and pedicle [20].

Role of imaging in the treatment and follow-up

Treatment of these tumors has been for years consisting of graft removal, modification of immunosuppression, and return to hemodialysis, with obvious psychologic repercussions for the patient [8]. Nephron sparing surgery has been successfully performed, resulting in the preservation of renal function and in short-term cancer control [6]. Minimally invasive therapies such as percutaneous radiofrequency ablation and cryoablation are now the preferred treatment in an increasing number of centres [19, 21, 22]. Imaging has a considerable role in the guidance of percutaneous approach and in the follow-up after procedure.

Conclusion

Imaging has a key-role in the detection, characterization, guidance for biopsy or percutaneous therapy, and follow-up of tumors involving the renal transplant. On another hand, because the risk of tumor development in another organ from the same donor is not negligible, an alert should be given to graft recipients with the same donor, whatever the result of the pre-harvesting evaluation of organs by imaging [8].

References

ABLATION OF PARENCHYMAL TUMORS IN RENAL GRAFTS: RESULTS FROM A SURVEY OF THE ESUR

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Purpose
The risk of cancer in transplant recipients, most frequently skin tumors, is greater than in the general population. In case of renal allograft, a cancer may develop in approximately 20% to 40% of recipients 10 and 20 years after transplantation, respectively. A recent epidemiologic study also demonstrated that patients undergoing kidney transplantation are at a 5-fold increased risk for the development of renal cell carcinoma (RCC) (1). RCC represents 4.6% of all the cancers developed in grafted patients but few of these tumors are reported on the transplant itself with an incidence of 0.39% to 0.5% (2-4). Nevertheless, a significant increase in the number of primary cancer in renal grafts could be attended in future due to two main factors: First, the use of kidneys from elderly donors increases the risk of development of undetected tumor. For example in France, from 2000 to 2006, the percentage of donors 50 to 64 years old and older than 65 years increased from 26% to 35% and from 6.6% to 19%, respectively (5). Therefore, the real age of renal transplant (corresponding to donor age) is now close to the median age of RCC diagnosis in the general population. Secondly, long-term immunosuppression associated with the actual increased of graft survival to a median of 13 years, increases the risk of cancer development.

Surgical nephron-sparing and radical nephrectomy are the classical therapeutic options for these transplant tumors (5, 6). However, in order to decrease the morbidity related to this invasive approach, and to preserve the renal function, percutaneous techniques using either RF or cryoablation under imaging guidance, are now more frequently proposed (5). As only a few case reports have been published to now, the purpose of this multi-institutional review was to evaluate the efficacy, the morbidity and the benefits of these mini-invasive techniques on a larger series.

Materials and Methods
The institutional review boards approved this retrospective study and waived informed consent. Data were compiled after a web-based call through the European Society of Urogenital Radiology network. Between 2003 and 2009, 17 tumors, developed within the renal allograft of 15 transplanted patients
coming from 8 institutions, were treated by radiofrequency (RF) (n=15) or cryo (n=2) ablation under local or general anaesthesia. Maximal diameter of renal masses was 6 to 40mm (median 19.5 mm). Fifteen were solid tumors and 2 were type 4 cystic masses. Pre-ablation biopsy was performed for solid tumors only. Renal function was monitored in all cases.

**Results**

Mean follow-up was 24.9 months (SD: 17). Histology of solid tumors revealed 14 papillary (PC) and 1 clear cell carcinoma (CCC). All tumors were successfully treated under US-guidance in 8 cases and under CT-guidance in 9. One case of infection of the tumor site was the only reported complication. No significant change of renal function was noted after ablation. Subsequent imaging follow-up did not reveal any case of recurrence to now.

**Conclusion**

According to these mid-term results, percutaneous thermal ablation can be considered as an alternative to nephron-sparing surgery to treat tumors developed in renal allografts. The low level of complications makes these procedures well-tolerated and helps preserve graft function. Nevertheless, longer term imaging follow-up remains necessary.

**References**


**WORKSHOP III**

**TOPIC: ADRENAL MASSES AND RENAL PSEUDOTUMORS**

Moderator: J Newhouse (US)

**COMPREHENSIVE IMAGING ALGORITHM OF THE INCIDENTAL ADRENAL MASS**

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The increased use of imaging modalities such as ultrasound, computed tomography, and magnetic resonance imaging has increased the number of incidentally detected adrenal masses. Up to 5% of abdominal CT-examinations performed for reasons unrelated to adrenal dysfunction or suspected dysfuncion will demonstrate an adrenal mass. This percentage could be even increased, since we know from autopsy studies that the prevalence of adrenal masses is about 7% in those 70 years of age or older.

Adrenal incidentaloma is not so much a disease entity as a finding that may or may not represent a disease (Lau et al 2002). The differential diagnosis of an incidentally discovered adrenal mass is extensive, but most are nonsecreting cortical adenomas. In a recent systematic review that combined studies using the broadest definitions, adenomas counted for 41%, metastasis 19%, adrenocortical carcinoma 10%, myelolipoma 9% and pheochromocytoma 8%, with other usually benign lesions such as adrenal cysts comprising the remainder (Aron 2002, Lau 2002). It is evident that this distribution will vary as other inclusion and exclusion criteria are applied.

When confronting an adrenal incidentaloma for which the diagnosis is not certain, one must address the adverse outcomes by which the patient can potentially be harmed: morbidity or mortality from hormonal excess or cancer and the anxiety that comes from knowing about a tumor which might cause problems in the future (Aron 2002). When a hormonal disorder is suspected, clinically appropriate, i.e., targeted diagnostic testing can proceed apace. Controversy arises in the approach to screening for more subtle forms of hormonal excess (Mansmann 2004). However, one should not infer the absence of endocrine activity by the adrenal incidentaloma solely because of the absence of
clinically recognizable signs and symptoms. In fact, subclinical hormonal hypersecretion may be associated with premature morbidity and mortality. Therefore, part of the diagnostic evaluation should aim at assessing the presence of hormonal hypersecretion. In fact, virtually all diagnostic algorithms are variations on this theme (Copeland 1983, Ross und Aron 1990, Young 2000, Grumbach 2003). An algorithm based on the 2002 NIH State-of-the-Science Conference involves, in addition to careful clinical assessment, the biochemical screening of all patients for autonomous cortisol production and for pheochromocytoma and screening of all hypertensive patients for primary hyperaldosteronism. In addition, a size based criterion for surgical removal of nonfunctional lesions is recommended.

Assessment of strategies
Incidental adrenal findings by their very nature pose a risk of overdiagnosis and overtreatment. Although most adrenal incidentalomas are of no significance beyond the anxiety they produce indirectly. Some incidentalomas are clinically significant, and inadvertently leaving them alone might damage the patients’ health. Therefore, detection of an incidentaloma necessitates a conscious decision regarding its management.

All general approaches involve hormonal screening (Aron & Kievit 2003). However, they vary both in extent and in the specific screening tests. Kievit and Hak (2000) showed in a cost-effective analysis of 70 different strategies for the diagnosis and treatment of adrenal incidentalomas that there was no strategy that was clearly ideal. The evidence-based medicine movement has promoted transparency and accountability about the information.

In this talk strengths and limitations of the various imaging techniques in adrenal mass imaging and characterization of adrenal masses will be addressed. A comprehensive imaging algorithm and the clinical management of an incidental mass will be considered.

Learning objectives
To describe the prevalence of adrenal incidentalomas
To learn how to differentiate benign and malignant adrenal masses
To understand how to manage incidental masses

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CHARACTERIZING AND ABLATING NON-ADENOMAS
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Adrenal tumors are not uncommon and are diagnosed on up to 5% of CT scans of the abdomen. Imaging features of non-adenomas are often indeterminate. Non-adenomas include adrenal cortical carcinoma (ACC), metastases, pheochromocytoma, myelolipoma, hematoma, and adrenal cysts. Imaging features will determine the exact diagnosis in many cases. Imaging diagnosis of myelolipomas is relatively straight forward and is made by detecting fat within the mass, diagnostic of this lesion.

Adrenal cysts are diagnosed when a non-enhancing water density mass is present. Adrenal hematomas are higher attenuation, greater than water density, and also non-enhancing or have typical MRI characteristics. Pheochromocytomas, ACCs, metastases, and adenomas can have overlapping features. ACCs are generally large, heterogeneous, solitary masses. Metastatic disease is present in up to 70% of these patients at time of diagnosis.

Pheochromocytomas do not have diagnostic imaging features on CT or MRI. Pheochromocytomas are usually smaller than adrenal cortical carcinomas, due to the fact that they are metabolically active and become symptomatic. While initially solid, cystic areas are often present in larger pheochromocytomas. In patients with laboratory values, elevated serum or urine metanephrines, a pheochromocytoma should be presumptively diagnosed when an adrenal mass is detected. Radionuclide scanning with MIBG can confirm the diagnosis of the pheochromocytoma. Once an adrenal adenoma has been excluded, or if features are indeterminate, then biopsy may be necessary for the diagnosis. Prior to biopsy of an adrenal mass the possibility of a pheochromocytoma should be considered. In a patient who does not have a known malignancy, and who has a solitary adrenal mass, serum or urine metanephrines should be assayed to exclude the diagnosis of metabolically active pheochromocytoma prior to biopsy. In cases where these imaging studies are nondiagnostic surgery may be needed. Some authors have reported using percutaneous image-guided biopsy to diagnose pheochromocytomas, but this can expose patients to the risk of sudden release of large quantities of catecholamines and cause a hypertensive crisis. Biopsy of a suspected pheochromocytoma should not be attempted without proper pre-procedure precautions such as alpha and beta adrenergic blockade. Biopsy of adrenal metastases and adrenal cortical carcinomas is a procedure with low risks of serious complications.

Results of adrenal tumor ablation have been reported in several small series. In most cases ablation has been performed to treat solitary metastases and ACCs. Since ACCs are generally large, curative treatment using ablation techniques is rarely indicated. Some hyperfunctioning adrenal tumors have ablated as well. Techniques for adrenal ablation include radiofrequency ablation, cryoablation, and chemical ablation mainly utilizing alcohol. Adrenal tumors that are ideal for ablation are tumors smaller than 4 cm in diameter, requiring treatment and occurring in patients who are suboptimal surgical candidates. Adrenal gland ablation can also be used to treat uncontrollable adrenal hyperfunction.

In one series RFA had an 85% (11/13) success rate for complete ablation of adrenal tumors. There are no published series reporting cryoablation results for treatment of adrenal tumors, but it should be as successful as RFA. Chemical ablation has not gained popularity in the USA. The largest series
published reports a 92% success rate for treatment of 26 primary adrenal tumors and a 30% success rate for treating solitary metastases in the adrenal gland using chemical ablation. In our institution all patients undergoing adrenal tumor ablation are continuously monitored by anesthesia personnel with an arterial line and continuous blood pressure monitoring. CT guidance is utilized. Anesthesia personnel are prepared to give alpha and beta adrenergic antagonists if needed to control blood pressure. This is usually required. The patient is placed in the ipsilateral decubitus position, sometimes prone. The technique for actual ablation is identical to that used in other solid organ tumors. Hydrodissection may be necessary to prevent damage to adjacent organs such as the pancreas or bowel.

References

RENAL PSEUDO-TUMORS
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Despite advances in imaging diagnosis regarding both technical developments and increasing medical knowledge there are still numerous entities that closely mimic renal neoplasms which may even undergo surgical resection because of concern for the possibility of malignancy. According to their etiology these renal pseudomasses can be broadly categorized as developmental, infectious, granulomatous, vascular, posttraumatic and miscellaneous in nature.

Developmental pseudotumors
Congenital renal anomalies represent a category of potential pitfalls especially in cross-sectional renal imaging renal imaging. Familiarity with the different congenital anomalies and their diverse presentations is usually sufficient to avoid misinterpretation. Examples include horseshoe kidney, cross-fused ectopia, pelvic kidney and duplication anomalies, artifacts caused by the splenorenal relationship.

Organs adjacent to the kidney, particularly the spleen, can lead to artifacts created by partial volume averaging. This may occur with normal and abnormal spleen. For example, in some patients with a prominent median aspect of the spleen, partial volume averaging with the upper pole of the left kidney may incorrectly suggest the presence of an upper pole left renal mass. In most instances this can be ascertained from the axial CT images using thinner slices or direct coronal or reconstructed images from the same study. If this is not diagnostic or available, complementary imaging techniques with direct multiplanar capabilities such as US or MRI may be helpful.

Dromedary hump
A common variation in the contour of the left kidney is the splenic impression and "dromedary hump". An impression represents pressure of the splenic border along the lateral upper half of the renal contour. A dromedary hump represents a focal bulge on the lateral border of the left kidney at the end of the splenic impression, where the kidney reverts to its normal convexity. It is thought to form as an adaptation of the kidney to the adjacent spleen. Reportedly it has the same perfusion as the surrounding renal parenchyma on contrast enhanced sonography.

Splenorenal fusion
Another, albeit rare, potential pitfall representing a developmental pseudotumor is due to splenorenal fusion in which heterotopic splenic tissue arises within the kidney simulating a primary renal neoplasm. Embryologic considerations suggest that fusion of the nephrogenic mesoderm and splenic anlage in the second month of gestation is the cause of the abnormality. It may also be secondarily acquired as a result of splenosis after trauma or splenectomy. Splenorenal fusion usually involves the left kidney, usually with an asymptomatic mass or with the patient presenting symptoms of hypersplenism (anemia). On CT or gadolinium-enhanced MRI, splenorenal fusion appears as a solid renal mass with intense enhancement closely mimicking a renal cell carcinoma. At pathology the lesion consists of hemorrhagic renal tissue that is sharply demarcated from the adjacent renal parenchyma. If the diagnosis is suspected, a 99m Tc sulfur colloid scan may be confirmatory by demonstrating uptake by the splenic tissue. Positive uptake of ferumoxides contrast at MRI or percutaneous fine needle biopsy may also be useful to confirm the diagnosis.

Infectious renal pseudotumors
**Focal pyelonephritis/ Renal abscess**

Acute pyelonephritis is a bacterial infection resulting in tubulointerstitial inflammation of the renal parenchyma. Obstruction of the renal tubules by inflammatory debris and impaired function from tubular ischemia result in decreased concentration of excreted contrast at CT and the classic striated “nephrogram” of the excretory phase.

Focal acute bacterial pyelonephritis may mimic the appearance of a solid renal neoplasm especially in patients in whom symptoms of infection are not clear. Heterogeneously enhancing mass-like lesions can be confusing. A poorly defined interface between the infection and the renal parenchyma, edema of the surrounding renal parenchyma, asymmetric perinephric stranding with inflammatory changes with thickening of Gerota's fascia and thickening of the urothelium may provide a hint to the proper diagnosis. Similar patterns may be noted on MRI examination.

Renal cancer may at times be confused with renal infection at imaging. Leukemia and lymphoma may present as infiltrative processes of the kidney with or without associated adenopathy. Centrally based renal cell carcinoma, medullary carcinoma and transitional cell carcinoma are also common mimics of pyelonephritis. A high index of suspicion would help the correct diagnosis which is commonly made at image guided biopsy.

Occasionally, scintigraphy performed with radiolabeled white cells or gallium is used to locate renal infection, but infection cannot be definitely distinguished from sterile inflammation with any radiotracer. In addition, photopenic defects caused by acute infectious nephritis may be mischaracterized as scars if the nuclear medicine studies are interpreted without the benefit of correlative imaging or comparison studies.

**Renal abscess**

Most renal abscesses develop as a result of the coalescence of small microabscesses that are present in acute pyelonephritis. Risk factors include IV drug use, skin infection and sources of vascular contamination. Today are more likely due to ascending gram –negative infection replacing Staphylococcus or Streptococcus septicemia. CT is the imaging of choice for the diagnosis of an acute renal abscess but US and MRI may also be used for diagnosis and percutaneous drainage especially with US guide. At CT, renal abscesses appear as a low-attenuation rounded or ovoid mass that may enhance after contrast administration although not to the extent of a solid renal tumor but occasionally will simulate a renal malignancy .The borders of the mass are usually indistinct due to the surrounding inflammatory process. Thickening of Gerota's fascia and increased density of the adjacent perinephric fat and perirenal fluid are helpful clues. A subacute or chronic renal abscess usually presents as an avascular intrarenal mass with a prominent hypervascular rim at CT and MRI. Although this hypervascular rim is characteristic of a chronic renal abscess, it may also be found in some necrotic or cystic renal neoplasms. Differentiation from a renal malignancy may be problematic if the clinical history does not support the presence on an infectious process.

**Scarred kidney / Regenerating nodule after reflux**

Kidneys affected by severe focal disease such as reflux nephropathy or renal infarcts frequently have islands of unaffected parenchyma adjacent to the renal lesions. The residual normal renal parenchyma may mimic a mass lesion in the nephrographic phase of CT and MRI. Appropriate corticomedullary differentiation in the early phases of enhancement at CT or MRI as well as delayed views in the excretory phase will commonly resolve the issue.

**Granulomatous renal pseudotumors**

**Renal TB**

Parenchymal masses can develop which may be calcified, sometimes diffusely in a lobar pattern or involving the entire kidney in the so-called "putty kidney". A heavily calcified renal mass is usually indicative of a malignant process. In some cases it may be difficult to determine enhancement of a heavily calcified renal mass at CT because the calcification may obscure the enhancing components of the mass. In such cases MRI has been advocated because the calcification would not be depicted in the MR images and any possible enhancement could be better appreciated. The most common CT findings of renal TB are caliectasis (88%), parenchymal scarring (80%) and calcification (37-71%). Low density parenchymal lesions, probably representing areas of caseous necrosis, may be seen in up to 37% of cases.

In most patients with renal TB multiple abnormalities are present including cortical low attenuation masses, pelvoinfundibular strictures, scarring, papillary necrosis and calcification, which may be seen in other conditions, but the combination of three or more of these findings is highly suggestive of tuberculosis. The key to the diagnosis is pattern recognition.

**Focal xanthogranulomatous pyelonephritis**

Xanthogranulomatous pyelonephritis (XGP) is a chronic granulomatous process, most commonly seen in diabetics, induced by chronic bacterial urinary tract infection usually related to
obstruction by stone disease histologically characterized by the replacement of the renal parenchyma with lipid-laden macrophages. The classical triad of the diffuse variety of XGP (85% of cases) with a nonfunctioning enlarged kidney with a central staghorn calculus and absent or diminished excretion makes it diagnosis relatively straightforward. However the less common focal or segmental form (15% of cases) is easily confused with a renal tumor demonstrating a low attenuation mass with associated calcification (stone) in a patient with the usual subacute clinical presentation earning his other name of "tumefactive" XGP. The presence of associated stone disease and soft tissue stranding in the perinephric fat in a diabetic patient may help with the diagnosis. However especially when there is no associated calculus a surgical resection is commonly performed because of suspected malignancy.

**Sarcoidosis**

Sarcoidosis is a systemic disease characterized by non-caseating granulomas that can involve any organ in the body including the kidneys. Renal granulomas are rarely evident at imaging but may appear on contrast enhanced CT as multiple small (2-3 cm) low attenuation renal masses that simulates renal lymphoma or metastases. Diffuse granulomatous infiltration is a more rare presentation than multiple nodules. Because of the avid uptake of FDG by sarcoid tissue PET may be helpful in evaluating pulmonary sarcoidosis and extra pulmonary involvement.

**Vascular renal pseudotumors**

**Arteriovenous Malformation (AVM)**

Renal AVMs can be congenital or acquired, usually after penetrating trauma, including renal biopsies. On a plain CT, such as a renal colic CT, a renal AVM may appear as a soft tissue mass especially if there has been a recent bleed. Sonography may help exclude a solid mass by demonstrating anechoic spaces in the lesion that fill with color on color Doppler U/S imaging. A typical arteriovenous flow pattern in the lesion confirms the diagnosis of AVM. In cases suspicious for renal AVM, early and delayed phase CT images should be obtained after bolus injection to recognize the enhancement characteristics, exact size, and relation to the pelvicaliceal system. Renal AVMs may be intraparenchymal or arise in the renal sinus and therefore may be difficult to distinguish from a renal malignancy such as renal cell carcinoma or transitional cell carcinoma (TCC) on contrast enhanced CT since these lesions will show enhancement. MRI may be able to differentiate an AVM from a malignancy by showing internal flow voids within the lesion. Gadolinium -enhanced MRI can confirm an AVM during early arterial phase imaging by demonstrating abnormal tortuous vessels and an early draining vein characteristic of an AVM.

**Subepithelial renal pelvic hematoma**

Bleeding complications involving the genitourinary tract are rather common in patients receiving long term anticoagulants. Renal hemorrhage may occur in subcapsular, intraparenchymal, perinephric, intraluminal and intramural location within the walls of renal pelvis and ureter.

When the spontaneous hemorrhage occurs in the suburothelium, plain CT will reveal increased attenuation material (i.e. blood) infiltrating the renal sinus with thickening of the wall of the upper urinary tract with extrinsic compression of the pyelocaliceal system closely mimicking renal pelvic malignancy. The lesion will show no or minimal enhancement after intravenous contrast administration. Uncomplicated renal sinus hemorrhage should disappear spontaneously in 3-4 weeks. If this does not occur, consideration should be given to alternative diagnosis and further studies performed.

The major differential diagnostic considerations of high CT density lesions located in the renal sinus includes renal sinus hemorrhage, a parapelvic cyst filled with blood, pus, or contrast material, large renal artery aneurysm and neoplasm, such as transitional cell carcinoma, lymphoma, hemangioma extramedullary hematopoesis, and Castleman's disease. Submucosal / suburothelial hemorrhage, also called the Antopol-Goldman lesion, is most commonly associated with anticoagulant therapy, but may also be the result of thrombocytopenia, hemophilia and other coagulopathies and vasculitis. It may have a lesser association with occult renal neoplasms than other types of renal bleeding. The submucosal impressions resolve rapidly when coagulation returns to normal. Knowledge of this lesion and a high index of suspicion may dictate a watchful waiting approach and avoid unnecessary nephrectomy.

**Extramedullary hematopoesis**

Extramedullary hematopoesis (EMH) is a response to erythropoiesis failure in the bone marrow and a common feature of chronic myeloproliferative disorders such as CML, polycythemia vera and especially myelofibrosis with myeloid metaplasia. Renal involvement may be intraparenchymal, intrapelvic or perirenal. In the parenchymal type, the kidneys may be enlarged diffusely or have either single or multiple small focal lesions. Perirenal EMH is rare compared to the more common involvement of the pelvicaliceal system. Both are commonly bilateral. The presence of marked splenomegaly and CT findings in the bony pelvis and spine such as coarsening of the bone matrix and
thinning of the cortices are supportive of the diagnosis. Bone marrow imaging with 99m Tc-sulfur colloid may fail to depict renal EMH. A biopsy may be necessary to establish the diagnosis since the CT, MRI and US features of perirenal EMH may be indistinguishable from perirenal lymphoma.

Post Traumatic and Miscellaneous

Anticoagulant induced renal and subcapsular hemorrhage

Problems related to cystic renal masses

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LECTURES SESSION IV

TOPIC: RENAL MASSES
Moderators: M Amendola (US), S Joniau (BE)

IMAGING OF VERY SMALL RENAL PARENCHYMAL TUMORS: OFTEN NOT TOO SMALL TO CHARACTERIZE

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Detection of renal parenchymal tumors became much easier than it was thanks to advances in imaging including US, CT and MRI. Especially recent advances in CT and wide use of it resulted in increased detection of small renal parenchymal tumors often with less than 2 cm or even less than 1 cm in diameter. When a renal tumor is found, one of the most important roles of imaging is differentiation between benign and malignant lesions, mostly renal cell carcinomas (RCCs) and benign tumors such as angiomylipomas (AMLs) and oncocytomas (OCTs).

There are various types of RCCs with clear cell type being the most common and papillary and chromophobe types less common. Clear cell RCC is usually hypervascular and shows heterogeneous strong contrast enhancement in early-phase CT, which is a characteristic finding. However, papillary or chromophobe RCCs commonly show more homogeneous and less strong contrast enhancement, and it may be difficult to distinguish from minimal fat AMLs or OCTs.

The diagnosis of AML is straightforward if it has gross amount of fat on CT or MRI, but not infrequently AML does not have enough fat that can be visible at CT or MRI. There has been number of studies focusing on differentiation between AML with minimal fat and RCC using various techniques and criteria with none of them showed perfect solution. Renal OCT is the second most common benign renal parenchymal tumor after AML. Central stellate scar and spoke-wheel pattern of arterial enhancement have been reported as characteristic imaging findings of OCT, but those findings are usually not seen when OCTs are small. Recently segmental enhancement inversion during corticomedullary and excretory phase CT images was reported as a characteristic enhancement pattern of small OCTs. In that study, eight of 10 OCTs showed this finding but only one of 88 RCCs did.
Still preoperative imaging characterization of small renal parenchymal tumors is an unsolved and ongoing issue, but familiarity with findings at multimodality imaging studies will be helpful.

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BIOPSY OF RENAL MASS LESIONS: WHEN AND WHY
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The current diagnostic paradigm for evaluating renal masses is primarily dependent on cross-sectional imaging modalities; ultrasonography (US), computed tomography (CT) and magnetic resonance (MR) imaging. These techniques allow the overwhelming majority of renal masses to be evaluated and characterized accurately using specific imaging criteria. As a result, when a renal mass is diagnosed with confidence, appropriate management can be instituted without further investigation. For example, when a mass demonstrates characteristic features of malignancy, surgical resection, if warranted, can be performed without a pre-operative biopsy because the prior probability of disease is sufficiently high; a negative biopsy result would not likely alter management. Similarly, published imaging criteria exist for some benign masses, such as simple cysts, hyperdense cysts and fat-containing angiomylipomas which can be diagnosed with a high degree of confidence. Historically, therefore, renal mass biopsy has been reserved for a limited number of indications. These have included the diagnosis of metastatic disease, infection, and lymphoma. Biopsy has also been used to diagnose unresectable renal cell carcinoma and diagnose masses in patients who are poor surgical candidates. Percutaneous biopsy of renal masses is now being increasingly used also to differentiate between benign and malignant entities safely and accurately. In fact, biopsy has been shown to alter clinical management in 60.5% of patients in whom a biopsy is performed. As a result, the approach to the diagnosis and management of renal masses has changed.

The growing need to biopsy renal masses can be ascribed to several factors. More renal masses are being detected than ever before largely due to the increased utilization of US, CT and MR imaging. Just as important, advances in imaging technology allow more small renal masses to be characterized as solid and therefore potentially malignant. Many small masses are being identified in patients with no symptoms attributable to the urinary tract. This has lead not only to an increase in the incidence of renal cell carcinoma but also a corresponding increase in the incidence of benign renal neoplasms. Concomitantly there has been an increasing awareness in the literature that solid, enhancing renal masses cannot be presumptively diagnosed as renal cell carcinoma and proceed to surgery. In fact, multiple studies have demonstrated that between 8% and 27% of surgically resected solid renal masses were benign. Furthermore, based on a review of 2,770 solid renal masses treated by radical nephrectomy or nephron-sparing surgery, the percentage of benign lesions increased as the size of the lesions decreased; 25% of masses less than 3cm, 30% of masses less than 2 cm and 46% of masses less than 1 cm are benign. Finally, technological advances in the acquisition and interpretation of renal biopsy specimens has had a major impact on the diagnosis of renal neoplasms. Biopsy using fine needles (20 gauge or thinner) has been shown to be accurate in the diagnosis of renal masses, in large part due to enhancements in cytological techniques, (both immunocytochemistry and cytogenetics) that have allowed for the accurate diagnosis of both benign and malignant neoplasms and in some cases, determination of renal cell carcinoma subtype and Fuhrman nuclear grade.

Indications for Percutaneous Biopsy of Renal Masses
In our clinical practice, we have eight established indications for renal mass biopsy. These have been derived from published literature and a wealth of clinical experience. The established indications include patients with masses that are likely malignant, but surgical resection is not indicated and patients with indeterminate masses that may be benign and therefore do not require treatment. A new, emerging indication includes patients with small (less than or equal to 3cm) solid masses. The rationale for biopsying these masses is based principally on data that show that the smaller the mass
the more likely it is benign. Although there may be multiple indications in a given patient, only one indication is needed to proceed with a biopsy.

Established Indications

- Patients with known extrarenal primary cancer
- Patients with imaging findings suggestive of unresectable renal cancer
- Patients with comorbidity in whom surgery is planned
- Patients with a renal mass that may be caused by infection
- Patients with a small (≤ 3cm) hyperattenuating homogenously enhancing renal mass
- Patients with a renal mass for which percutaneous ablation is considered
- Indeterminate cystic renal mass
- Multiple solid renal masses

Emerging Indication

- Small (≤ 3cm) solid masses

Summary

Although imaging is the primary diagnostic tool in the evaluation of renal masses, in many specific clinical scenarios, percutaneous renal mass biopsy plays a crucial role in determining clinical management. Unlike years past, biopsy can now be used to diagnose benign neoplasms that previously underwent inadvertent surgical resection. The burgeoning field of tumor ablation has necessitated the use of percutaneous biopsy; the only means to render a tissue diagnosis. Finally, biopsy may be helpful in characterizing some small renal cancers as indolent, thus allowing a watchful waiting approach to be considered in selected patients.

Suggested Reading

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Treatment of renal cell carcinoma (RCC) can be accomplished using surgery, or ablative techniques. Prior to treatment both radiologists and surgeons want to know the tumor size, tumor number, and tumor location within the kidney. Also, crucial information for management decision making is whether the tumor is organ confined or not, the growth pattern of the tumor; exophytic or non-exophytic, and the status of the contralateral kidney. The status of the patient's renal function and future outlook for renal functional deterioration, including risk factors such as diabetes mellitus, hypertension, vesico-ureteral reflux, and arteriosclerosis can be important prognostic indicators helping to determine the need for renal sparing techniques. Patient co-morbidities and coagulation status are both important to radiologists and surgeons planning treatment. Particularly influential patient factors include co-morbidities: can the patient tolerate general anesthesia? If not, percutaneous ablation is a better treatment option because it can be accomplished with conscious sedation. Is the patient's renal function impaired? If so, percutaneous ablation can be employed as it is the best technique for renal preservation compared to surgery. Does the patient have a situation predisposing them to development of multifocal renal cell carcinomas? If so, percutaneous ablation, due to the need for repeated treatment, is a better option. Is the patient on anticoagulants? If so, these will need to be discontinued for either surgery or ablation. For ablation the discontinuation can be for a period of hours only, making this favored over surgical treatment. Has the tumor spread beyond the kidney? This includes venous extension, adrenal involvement, and invasion of adjacent organs or lymph nodes. In this situation surgery is the only potentially curative option and this would be the favored approach. Is the tumor large? Tumors larger than 4 cm are more likely to be cured with surgery than with percutaneous ablation techniques.

Surgical techniques include open nephrectomy, open partial nephrectomy, laparoscopic partial and complete nephrectomies, robot-assisted partial and complete nephrectomies, and laparoscopic thermal ablation. For the surgeon to choose the best approach for surgical treatment numerous tumor features should be determined with imaging. These include tumor size, tumor location, and tumor shape. One system for evaluating kidney tumors for surgical planning has been described as renal nephrometry. This system classifies tumors by size, growth pattern, proximity to vital structures, and the tumor location within the kidney. With this technique factors that have been shown to increase the complexity of the surgery are used to aid treatment selection. Factors favoring open resection over laparoscopic resection include tumors larger than 4cm, less exophytic tumors or those which are purely endophytic, tumors close to the renal sinus, calyces, or vessels, and interpolar and hilar tumors. Additional findings on pre-treatment scans of importance for surgical planning include renal vasculature, particularly vascular anomalies and the presence of large collateral vessels. For smaller tumors surgery and percutaneous ablations have similar oncologic efficacy based on relatively short term follow-up studies for ablation. Laparoscopic thermal ablation has no advantages compared to percutaneous ablation, and in fact has increased costs and morbidity compared to percutaneous approach. Targeting may be more difficult laparoscopically than with imaging guidance. If ablation is considered the best option for a patient then an image guided percutaneous approach should be used.

For percutaneous thermal ablation factors that are important include tumor size, location, proximity to vulnerable structures such as intestines, and the presence of a pacemaker when performing radiofrequency ablation. Tumors less than 4cm are ideal for high success rates with percutaneous thermal ablation. Larger tumors can be successfully treated with both radiofrequency ablation and cryoablation. Cryoablation may have a slight advantage over radiofrequency ablation for larger tumors. The location of the tumor, exophytic vs. non-exophytic, does not appear to influence the success of either percutaneous radiofrequency ablation or cryoablation. Size does appear to be an influential factor on the success rate of ablation, particularly with radiofrequency ablation. Tumors located near vulnerable structures can be successfully treated using hydrodissection and pyeloperfusion to protect those adjacent organs and the ureters. Patients with pacemakers who are undergoing radiofrequency ablation should have a specialized magnet applied over the pacemaker during the procedure to suppress its sensing mode.
Using these guidelines, radiologists and surgeons can optimally plan proper curative techniques when treating renal tumors.

References

IMAGING ASPECTS AFTER NEPHRON-SPARING SURGERY AND ABLATION: ARTIFACTS, RECURRENCES AND PSEUDOTUMORS
FM Danza, G Cardone
Italy

The diffusion of nephron sparing therapies of renal masses has opened a new charter of radiological imaging either in diagnosis of small renal masses or in their stagind procedure an follow-up. An initial description of different surgical techniques are discussed to furnish to radiologist adequate clinical and technical informations for interpretation of imaging: the enucleation of a tumor can be achieved by polectomy or more frequently with wedge resection or enucleation. It is also important to know the surgical approach used because surgery con open new way to diffusion. The cavity of resection usually is filled with varying materials, natural as fat or synthetic as sponge or other. Often adhesion with the adjacent fat and local fascial planes are common. Consequently sometime interstitial structures can appear adherent to the site of resection or distorted.
Ultrasounds, CT and MRI are utilized for the evaluations of patients submitted to such kind of treatments: frequently US are performed with contras medium, in order to asses the perfusion of tissues and depict residual or recurrent nodules; the same occurs with CT and MRI, but with these techniques the most important advantage is the possibility to obtain a panoramic evaluation.
The objectives of the radiological studies are multiple:
First to asses the effect of resections or ablations in particular if the mass is completely resected or necrotic; in resections, expecially in enucleations, the different techniques can generated findings that can be confounded with residual or recurrent diseases, so radiologist have to be confident with the surgical procedure utilized to avoid misleadings. Enhancement after contrast is the basical sign for evaluation. Non contrast acquisition is also important to correctly evaluate the enhancement in the dynamic study, because often the filling material in the resected area can appear iperdence.
To asses the presence of a viable residual tissue contrast US and MRI with subtraction seems to be superior to CT. Anyway residual or recurrent masses appear as enhancing areas into the site of resection or adjacent to it. The most important differential diagnosis is with fibrosis, sometime enhancing in early fases.
Second goal is to exclude complications on excretory system or adjacent organs. Delayed acquisitions are usually performed to delineate the opacification of the collecting system. Particular attention must be reserved, in particular in early controls, to the wall of adjacent intestinal structures or to detect fluid collections.
In the control of ablations the technique of studies and the timing of follow-up are crucial to obtain a good accuracy. Post ablation fibrosis, more important in respect of enucleation, can appear in different way in relation of time, site and type of energy employed, but its enhancement and volume tends to reduce with time.
The last objective is the restaging: the remnant renal parechima for metachronous neoplasms, lymphonode localizations or distant metastases have to be investigated. Panoramic studies are obviously to be preferred and technique must be adequate, with multiphase studies.
Artifacts possible generated, different kind of recurrences and pseudotumors formation are discussed in relation to different types of treatment.
The best timing of imaging for follow-up are discussed in relation to different istotypes. When possible a contrast US is performed at the end of the procedure of ablation to asses the absence of viable tissue. In all cases a CT at one month, three months and every six months is usually performed in all types of ablation. After surgical resection a six months interval is commonly considered the rule for...
follow-up and restaging. The suspicion of a complication can modify this timing. In absence of residual or recurrence after two years, one year interval are usually utilized.

References

LECTURES SESSION V

**TOPIC: PROSTATE CANCER: DETECTION AND STAGING**
Moderators: F Ameye (BE), M Otero-Garcia (ES)

**TRUS AND TRUS GUIDED BIOPSIES: AN UPDATE**

AT Turgut

**Turkey**

Transrectal ultrasound (TRUS) is the most commonly used imaging test for the diseases effecting the prostate gland. The main indications for the referral of the patients for TRUS are evaluation for prostate cancer and guidance for prostate biopsy.

**Sonographic Anatomy and Technique**

On TRUS, the transition zone can be differentiated from the peripheral zone as it appears as a hypoechoic zone anteriorly, whereas the peripheral zone is relatively echogenic and homogenous in echotexture. Although prostate cancer predominantly effects the peripheral zone, about one fifth of the disease can be detected in the transition zone which is the major site for hyperplastic changes and constitutes a larger proportion of the prostate in older men.

During transrectal prostate scanning, multiplanar imaging in semicoronal, axial, and sagittal projections can be performed by means of the biplane probes with a combination of endviewing and side-viewing transducers. Technically, transverse or semicoronal scanning is started from the level of seminal vesicles adjacent to the prostate base and continues down to the apical level. Later, scanning in the sagittal plane is performed to depict any lobar asymmetry and to confirm any suspicious finding detected on axial or coronal scanning. Importantly, TRUS also enables the operator to perform various diagnostic and therapeutic interventions for prostate cancer, as it can provide better resolution compared to the other routes of ultrasound scanning.

**Prostate Cancer**

Prostate cancer is a significant cause of cancer-related death in men. Although, early detection provides better management of the disease, it may also cause the detection of “insignificant cancers” in addition to the significant ones. The major tools used for the diagnosis of the disease are digital rectal examination, serum levels of prostate-specific antigen (PSA), and TRUS-guided prostate biopsy. Due to the lack of specificity of serum total PSA for screening purposes, it is still necessary to define an ideal protocol combining PSA, TRUS and digital rectal examination for better detecting the disease. Although TRUS has been considered as a the main method for biopsy guidance, its low positive predictive value in diagnosing malignancy poses as a major drawback for its use.

**Gray Scale Ultrasound**

The classical lesion representing prostate cancer is a hypoechoic one, though an isoechoic or hyperechoic appearance may also be consistent with the disease. Today, other less specific imaging findings such as asymmetry of either the echotexture or glandular margin may be required for the diagnosis of the disease as most of the contemporary prostate cancers is isoechoic. In this regard, a
non-specific echo irregularity or a bulge or irregularity in the outline of the capsule can be detected in prostate cancer. Morphologically, only about 30% of prostate cancer appears as a focal nodule whereas an additional infiltrative component can be detected in about 50% of the patients and an infiltrative pattern is the predominant morphological abnormality in the remaining 20%. Unfortunately, a concurrent benign prostate hyperplasia may limit the utility of TRUS for the evaluation for prostate cancer due to its mixed echo pattern or compression effect on the peripheral zone.

**Color Doppler Ultrasound**

Color Doppler ultrasound (CDUS) may be helpful for the differentiation of low-risk, hypovascular tumors from high-risk, hypervascular tumors, as the latter group is associated with hypervascularity representing higher Gleason tumor grades implying higher risk for extraprostatic spread. However, targeted prostate biopsy solely depending on high-frequency color or power Doppler imaging is not recommended, as the technique has inherent risk of missing a significant number of cancers. Importantly, increased microvessel density which was found to be typical for prostate cancer is higher in metastatic tumors.

**Power Doppler Ultrasound**

Power Doppler ultrasound (PDUS) has not been found to be superior to CDUS, though the technique can help more accurate sampling of the prostate by determining sites of focal hypervascularity. It has been reported to be useful only for targeted biopsies with limited number of biopsy cores. Recently, spectral waveform measurements of the capsular and urethral arteries of the prostate by PDUS has been shown to be useful in differentiating prostate cancer from benign hypertrophy.

**Contrast Enhanced Ultrasound**

Based on the fact that the increased microvessel density associated with angiogenesis in prostate cancer is below the resolution of conventional Doppler imaging, microbubble contrast agents may enable better visualization of prostatic microvasculature and cancerous prostate tissue in turn. However, a major limitation of the technique is that it can depict the flow mainly in relatively larger vessels as the microbubbles are destructed by Doppler imaging before reaching the neo vessels. Nevertheless, contrast-enhanced ultrasound (CEUS) may provide a decrease in the number of cores to be sampled by enabling targeted biopsies. The detection of the signals reflected by the microbubbles can be enhanced by the phase inversion (pulse-inversion) technology. The sensitivity for cancer detection can be increased by gray scale harmonic ultrasound. A better parenchymal enhancement can be obtained by intermittent harmonic technique compared to continuous harmonic imaging. More recently, flash replenishment technique in contrast harmonic imaging and cadence-contrast pulse sequencing technology have been developed to improve the visualization of the microvasculature associated with prostate cancer. In spite of the aforementioned progress regarding CEUS technology, the role of CEUS in the routine clinical practice is questionable.

**Elastography**

On elastography, prostate cancer appears as a dark zone representing limited elasticity or compressibility. Depending on the hardness gradient and degree of elasticity loss, cancerous tissue can be differentiated from benign tissues. However, the technique is not sufficient yet to preclude the requirement for systematic prostate biopsies.

**Transrectal Ultrasound–Guided Prostate Biopsy**

TRUS-guided prostate biopsy has been accepted as the “gold standard” tool for the detection of prostate cancer. Abnormal digital rectal examination, elevated serum total PSA levels (>4 ng/ml), and/or suspicious finding on TRUS examination are the main indications for the procedure. Technically, a zone-based systematic sampling of the regions of the prostate where the tumors are most likely to be located is performed. Classically, sextant biopsy protocol involves sampling of the cores at the midway between the lateral border and the median plane at the the levels of base, mid-gland and apex of the peripheral zone of the prostate, respectively. However, extended sampling protocols with 10-12 cores involving additional laterally directed cores at the aforementioned levels have been developed in time, to increase the diagnostic yield.

**Patient Preparation and Anesthesia**

In most centers, an antibiotic prophylaxis of cipro (ciprofloxacin) and a bowel-cleansing rectal enema is used to minimize the risk of infection associated with the procedure. In the last decade, various methods of anesthesia to increase patient comfort during the procedure has been used with an increased frequency. In this regard, TRUS-guided periprostatic nerve blockage has been the most popular one. However, several complications like pain due to puncture with the needle, the need for repeated injections during the biopsy procedure, systemic lidocaine toxicity, distortion or artifact formation on TRUS image and erectile dysfunction can be noted. Moreover, the operator dependent nature and inefficiency of the technique in the presence of risk factors like patient anxiety, repeat biopsies or inflammatory anal disorders can limit the utility of the technique. In such circumstances,
conscious sedation with intravenous midazolam would be an alternative and efficient means of anesthesia.

References

PROSTATE MRI: DETECTION, LOCALIZATION AND STAGING OF PROSTATE CANCER: WHEN AND HOW
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Localisation of prostate cancer

Localisation of the tumor can be useful in at least three circumstances.

- First, in patients with a negative series of TRUS guided biopsies in whom a biological suspicion of prostate cancer persists in patients after one or several series of negative biopsies (1).
- Second, in low risk patients in whom an active surveillance is contemplated with deferred treatment if signs of progression occur (raise of PSA level or high grades on repeat biopsies) (2).
- Third, low risk patients, most of them with a non palpable tumor, might be treated with an alternative to radical treatment represented by focal therapy (cryotherapy, HIFU…. ) (3). Obviously, a highly precise localisation of the tumor is mandatory to deliver the physical agent which treats the tumor.
Functional MRI increases the accuracy of T2-W imaging to localise PCa (4). It includes dynamic contrast enhanced imaging, diffusion-weighted imaging (DWI) and magnetic resonance spectroscopic imaging (MRSI).

Dynamic contrast-enhanced MRI (DCE-MRI) studies the kinetics of the gadolinium through the vascular wall (vascular permeability) and the interstitium of the different components of prostate tissue, whose enhancement and wash out are different.

- The acquisition is performed with a T1 weighted 3D echo gradient sequence with short TR (2.4ms), TE (5.11) and small flip angle (10°). A temporal resolution of 7-14s is usually recommended and an acquisition time not <5mn if a mathematical model is going to be used (see below). A chelate of gadolinium is injected (0,1mmol/kg) with a power injector at a rate of 3ml/s, followed by a flush of 15ml of saline.

- Several approaches are used to describe the enhancement of prostatic tissue. Prostate cancer is characterised by an early and elevated peak of enhancement, followed by a rapid wash-out (4). Qualitative and semi-quantitative approaches study variations of signal intensity whereas the quantitative approach quantifies variations of concentration of Gadolinium when it traverses the prostatic tissue (5).

  - With the qualitative assessment, early enhancement of prostate cancer is detected by visual comparison with adjacent prostatic tissue. Wash out is poorly assessed. According to two recently published series (6-7) the sensitivity and specificity for detection of tumor with a volume >0.5cc are 91 and 88%, respectively.
  - The semi-quantitative approach assesses the shape of the enhancement curve in different regions of interest (ROI). Parameters which characterise parts of the curve (peak enhancement, time to peak, wash-out) can be semi-quantitatively calculated and expressed in percentage relative to the unenhanced phase (8).
  - The quantitative approach uses pharmacokinetic modelling which quantifies, in absolute values, the wash-in and the wash-out (9). The wash-in is assessed by measurement of the vessel wall permeability or forward volume transfer constant ($K_{\text{trans}}$). The wash out is assessed by the reverse reflux rate constant between extracellular space and plasma ($K_{\text{ep}}$). A third constant, the area under the gadolinium concentration curve (AUGC) in the first 60 or 90 seconds after injection can also be measured (10). $K_{\text{trans}}$, $K_{\text{ep}}$ and AUGC values are significantly higher in PCa than in normal peripheral zone.
  - Sensitivity of dynamic MR in the detection of PZ tumor volumes >0.5cc is 70-80% in most studies and specificity is higher (80-90%) than that of FSE-T2 imaging (50-60%) to detect PZ cancers whose volume is > 0.5cc (11).

- Limitations of DCE
  - Enhancement of benign sextants is a frequent pitfall, explaining that the specificity of dynamic MRI is not >70% (10). Benign hyperemia is attributed to prostatitis in most series (10), but can be generated by other causes such as areas of benign hyperplasia originating in the PZ or by the resorption of biopsy artefacts (5).
  - Detection of TZ cancer remains difficult due to the high vascularity of BPH, particularly when it is detected within hypointense nodules. FSE-T2W imaging remains an indispensable tool to accurately interpret a positive dynamic MR within the TZ. A study (12) described the signs suggesting the presence of TZ Ca: homogeneous hyposignal, with a lenticular shape, anteriorly located and invading the anterior fibromuscular stroma. In most of the studies, accuracy of Ca detection by DCE is lower in the TZ than for the PZ, whatever the technique used (6, 8, 13).

Diffusion-weighted imaging

- PCa has a significantly lower Apparent diffusion Coefficient (ADC) value than that of benign prostate tissue (14), and DWI increases the accuracy of T2-Weighted imaging to localise PCa. However, there is an important overlap between tumor and benign tissue for intermediate values (1200-1500).

- In the TZ, the ADC is commonly low in stromal hypointense nodules (15-16). A low ADC has thus a much less specific value than in the PZ and localisation of a TZ cancer requires, like for DCE MRI, the presence of a homogeneous ill-defined hyposignal on the T2 sequence.

- The prognostic significance of a low ADC has been recently suggested in a study which showed that significant differences in tumor ADC values existed between patients with low-risk, and those with higher risk localized prostate cancer if slow ADC value is measured (b200 to b1000 in a multi b sequence) (17).

Magnetic Resonance Spectroscopic Imaging (MRSI)
• Principle: MRSI exploits the chemical shift (difference in resonance frequency) of hydrogen protons to produce a map of signal intensity versus frequency of different prostatic metabolites (choline, creatine and citrate) (18).

• Normal prostate tissue. The ratio of choline and creatine-to-citrate in sextants with normal prostatic tissue and those with cancer has been established (19-20). Using a simplified scale (21), benign tissue has a ratio <0.6 and cancer a ratio >1. Between 0.6 and 1, there is overlap between benign and malignant tissue. The periurethral glands and the area around the ejaculatory ducts contain a physiological high level of choline.

• Prostate cancer originating in the peripheral zone is characterized by increased choline and/or reduced citrate. According to the findings of FSE-T2W imaging and the cut-off values of CC/Ci values, MRI/MRSI combination shows a wide range of sensitivity, specificity and accuracy for cancer localisation (20). The best accuracy is obtained by combining a positive MRI and a Choline+Creatine/Citrate ratio>0.75.

• Limitations of MR Spectroscopic Imaging
  o MRSI is a moderately robust technique. In 25% of cases, the voxels are not interpretable owing to artefacts or contamination by the periprostatic lipids.
  o Sensitivity is low (44%) for the detection of low grade tumors (22).
  o False positive cases are observed in the PZ in case of chronic prostatitis (22) and in the TZ in case of stromal BPH which can simulate cancer (23)
  o In a recent multicentric study, the value of the area under the ROC curve of MRSI was not more accurate than that of T2 weighted imaging to localise cancer with 1.5 Tesla magnets (24).

Multiparametric functional MRI accuracy of MRI to localise PCa can be improved by combining different functional sequences (11).

• Rationale
  o In a study (25), it was shown that the areas identified in the majority of the tumors on the ADC map and Ktrans maps covered slightly different regions of the PZ. Sensitivity of combined DWI and DCE-MRI was thus significantly improved over that of each technique alone, with a small decrease in specificity.
  o Using a combination of MRSI and DCE, a study showed (26) that some tumors were detected only by elevated Ktrans and not by the (choline+creatine)/citrate ratio, which underlines the significance of combining the two parameters for cancer localization.

• For practical reasons, performing the 3 functional sequences on every patient is a time consuming (60') examination difficult to accept by the patient, the radiologist and the technicians in routine practice. At the moment, due to the technical limitations of MRSI, it seems that the most widespread used protocol is a combination of DWI and DCE. The advent of 3 Tesla magnets might provide a regain in interest in MRSI.

• MRI and local staging of prostate cancer
  The use of a pelvic coil alone is not recommended for staging purposes with a 1.5 Tesla (27). The superiority of the endorectal coil over the pelvic coil has been reported whatever the magnet field strength (1.5 or 3 Tesla) (28-29).

• Extraprostatic capsular extension (ECE). At MRI, ECE can only be detected if at least 1 mm of tumor extends radially to the prostate surface within the prostatic fat (30). The MRI signs of established ECE all related to the presence of tumor within the periprostatic spaces, including obliteration of the prostatic-rectal angle, hypointensity of the neurovascular bundles, and tumor visible within the periprostatic fat (31), including the subapical area (32). They must be strictly applied to obtain a 90-95% specificity and avoid false positive cases. Sensitivity is approximately 40% if focal and established pT3 stages are included and 70% if only established pT3 stage is taken into account (30, 33). In selected cases, DCE-MRI can help to diagnose an extracapsular extension not visible on the T2 sequence.

• Seminal vesicle invasion is related, in most cases, to large volume tumors involving the prostate base. Signs of gross SVI are consistently detected by MRI and have a specificity of virtually 100% (34). Signs of early SVI are subtle and can be confirmed by DCE. Tumors originating in the central zone can cause early SVI without ECE.

References


Summary: There is a clinical need for improved imaging to more accurately predict organ-confined prostate cancer. This presentation reviews the functional MR capabilities available to perform a comprehensive prostate exam. Lecture focus is to discuss the new advances in prostate MR that help localize disease within the prostate for the selection and planning of focal treatment.
The morphological changes in the prostate after irradiation (both external beam radiotherapy and brachytherapy) include inflammation, glandular atrophy, fibrosis, and prostatic shrinkage [5, 6]. These result in diffusely decreased signal intensity of the prostatic stroma and loss of the normal zonal anatomy, causing difficulty to distinguish recurrence from irradiated normal tissue [7, 8]. Reported sensitivities (26%-44%) and specificities (64%-86%) have therefore equally been rather low and many authors recommend the use of additional techniques, especially MR spectroscopy and DCE-MRI [9-11].

In HIFU, tissue heating induces coagulative necrosis in the target area, which becomes completely devascularized and surrounded by inflammation and edema [12, 13]. After 3-5 months, the prostate shrinks and the parenchyma becomes diffusely hypointense and ill-defined, with loss of the normal zonal anatomy on T2-weighted images [14, 15]. This appearance of HIFU induced changes is identical to those associated with cryotherapy [16]. Although residual or recurrent prostate cancer has been reported to be somewhat more hypointense than the surrounding tissue, it remains difficult to correctly discriminate both entities with anatomical T2-weighted MR imaging alone [4, 14, 17].

MR-Spectroscopy
Metabolic evaluation of the prostatectomy bed after radical prostatectomy is not straightforward, due to the absence of a "standard" metabolic background after proper removal of the prostatic tissue. Furthermore, surgical clips in the anastomotic area frequently induce field inhomogeneities and susceptibility artifacts that may preclude successful spectroscopic measurements [18]. Yet, in a recent study, promising results were reported (sensitivity 71%-84% and specificity 83%-88%) [19] and it was suggested to combine MRS with DCE-MRI to detect or rule out a recurrence in patients with biochemical failure.

After external-beam radiation therapy, reparative processes in the prostate may equally alter the "standard" metabolic background [7, 20], resulting in diagnostic difficulties. Nevertheless, metabolic atrophy (defined as the absence of significant metabolite peaks) seems to reliably indicate absence of local recurrence [8, 21]. This may be of particular value for reassuring patients with rising or "bouncing" post-treatment PSA [21], and may provide an early tool for assessing local control after brachytherapy [22] in areas not affected by susceptibility artifacts from implanted brachytherapy seeds [23].

Preliminary data have shown that the addition of MRS to T2-weighted MR imaging may increase the sensitivity for detection of local recurrence, and exclude recurrence in patients with persistently elevated PSA after cryosurgery [24, 25]. After HIFU, on the other hand, MRS seemed to add no additional information to T2-weighted MR imaging [4].

Diffusion-Weighted MR Imaging
So far, the ability of DWI to detect local recurrence after radical prostatectomy has not been systematically investigated. After radiation therapy, recurrences tend to show lower apparent diffusion coefficients (ADC) than the surrounding irradiated benign tissue, and it was suggested to use DWI in combination with T2-weighted MRI [11, 26]. After HIFU, fibrosis and residual benign prostatic hypertrophic nodules may also show lower ADC, compromising the use of DWI to differentiate them from local tumor progression [12].

Dynamic Contrast-Enhanced MR Imaging
After radical prostatectomy, DCE-MRI is useful to differentiate prostate cancer recurrence from fibrosis in the prostatectomy fossa, remnants of normal prostatic tissue or hyperplastic nodules, because recurrence tends to enhance earlier and faster than benign postoperative changes. When used in addition to T2-weighted MR imaging, DCE-MRI has shown higher sensitivity (79%-88%) and specificity (89%-100%) as compared to T2-weighted MR imaging alone [3, 4, 19].

DCE-MRI has also been increasingly used in the early detection and localization of local recurrence after radiotherapy, with improved patient selection before salvage prostatectomy or accurate targeting of minimally invasive therapies [10]. Recurrences can be recognized as early enhancing areas that contrast well with the surrounding tissue that enhances less, presumably because of radiation-induced fibrosis and vascular damage [6, 9-11]. Hence, DCE-MRI has been reported to increase the diagnostic sensitivity (70%-74%) and specificity (73%-85%) as compared to T2-weighted MR imaging alone [9, 10].

Following HIFU, recurrences tend to enhance earlier and more intense, while post-HIFU fibrosis is rather homogeneous, poorly enhancing and hypovascular [13]. After cryosurgery, contrast-enhanced MR imaging has not been shown to be accurate in the prediction of treatment success because...
nonenhancement is not invariably consistent with complete cell death, and enhancement cannot differentiate between residual benign tissue and prostate cancer recurrence [16, 27].

References
LECTURES SESSION VI

**TOPIC:** CHALLENGES IN DAILY PRACTICE

**Moderators:** R Berkenblit (US), G Malachias (GR)

**CYSTS AND CYST-LIKE LESIONS OF THE KIDNEY**

O Hélénon

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**Introduction**

Cystic renal masses result from a wide spectrum of pathology including: renal cysts, benign cystic lesions of non epithelial origin, benign cystic neoplasms and cystic carcinomas. Whereas the diagnosis of a simple renal cyst is easy, differentiation between complex cyst and cystic renal tumor can be difficult. Such a diagnostic challenge is encountered by the radiologist in daily practice and requires a good knowledge of imaging findings and proper characterization of cystic lesions.

Ultrasoundography provides definitive diagnostic informations in most of simple renal cysts that are incidentally screened. CT is the gold standard in detecting and characterizing cystic renal masses. The Bosniak classification system is based on specific CT criteria that rely on the cystic lesion enhancement properties and morphologic features. This classification scheme has been designed to separate cystic lesions requiring surgery from those that can be left alone or followed. MRI is now considered at least equivalent to CT in the characterization of cystic lesions. It also plays a major role in the diagnosis of category IIF cystic renal masses and those that remain not categorizable at CT. Contrast-enhanced ultrasound also has been shown to improve evaluation of complex cystic masses. It can be currently proposed as an alternative to CT in the follow-up of complex renal cysts and in patients with serious contraindication to contrast-enhanced CT or MRI.

1. The Bosniak classification system

Morton Bosniak proposed a classification system in 1986 (2), updated in 1997 (3), in which cystic lesions were divided into five categories (nonsurgical categories I, II and IIF; surgical categories III and
IV) by analysis of specific CT criteria including morphological and enhancement characteristics. In 2004, G Israel et al. originated a new important step in the evaluation cystic renal masses by introducing the role of MRI in the Bosniak classification system (18). It has been shown that the classification scheme can be applied to MRI and can benefit from MR informations especially in the characterization of category IIF complex cysts.

1.1 Field of utilization of the Bosniak classification
Utilization of the Bosniak classification system requires first, previous identification of the cystic nature of a renal mass, with the exception of very small lesions (<5-10mm), and second, to examine if the cystic lesion belong to the field of application of the Bosniak classification system. This classification scheme has been designed to characterize renal cystic lesions including renal cysts and cystic neoplasms of nephron epithelial origin with the exception of: cystic masses originating from the urinary tract (calyceal diverticulum or hydrocalix), complex cystic masses resulting from a chronic infectious process (chronic abscess or hydatid cyst) or acute inflammation (infected and hemorrhagic cysts, renal trauma or recent renal surgery) that require specific imaging workup.

1.2 Bosniak categories (table 1) (fig 1)
The following will describe the CT criteria that define each Bosniak category according to the original classification system. With the exception of their water characteristics (low signal intensity on T1 and bright hypersignal on T2-weighted images with lack of postcontrast enhancement) and the appearance of calcifications (not depicted at MRI) the following morphologic features can be also applied to categorize cystic lesions at MRI (18). The hyperdense category II cyst also reveals specific signal findings at MRI compared to CT.

Category I lesions
Category I lesions are simple benign cysts that require no further imaging or intervention. They satisfy the following imaging criteria on both unenhanced and postcontrast images: homogeneous water density content (> -10HU, <+20HU); no enhancement (postcontrast attenuation variation <10HU) and postcontrast homogeneous pattern with sharp margins; unperceptible wall and no internal septa or solid components; absence of calcifications.

Category II lesions
Category II lesions are minimally complicated benign cysts that are non surgical and do not require further imaging. This group consists of three subtypes of complex cysts that fulfill the category I criteria except for some minimal changes:

- Minimally septated cysts with one or few thin (< 2mm thick) and smooth septa in which perceived enhancement can be present (septa are usually visible only on postcontrast images) but without perceptible wall or any other solid elements.
- Minimally calcified cysts with one or few thin delicate calcifications within the wall or septa. Whereas the cyst wall should not be perceptible except for its calcification, septa can be visible in a minimally calcified-septated cyst.
- Hyperdense cysts that exhibit high attenuation values of at least 50HU (50-100HU) belong to category II providing that the cyst diameter does not exceed 3 cm and that it is subcapsular (with at least on quarter of the mass extending beyond the renal outline) so that the cyst margins can be accurately evaluated on postcontrast images to rule out wall thickening and poorly defined margins. The typical hyperdense cyst therefore fulfill all the characteristics of a simple cyst except for the high attenuation. The differential diagnosis include hyperdense solid neoplasms and cystic neoplasms with internal hemorrhagic debris that can mimic a hyperdense cyst (5,11,13). A hyperdense lesion should be considered surgical or at least indeterminate (with need for further imaging) if it shows at least one of the following features: postcontrast enhancement, inhomogeneous texture on unenhanced or contrast-enhanced images, presence of calcification, poorly defined and irregular contour or interface, and a solid appearance at other available imaging examinations (US, MRI).

Category IIF lesions
This more recently introduced subtype is likely to be benign but require follow-up CT examinations to show their stability over time and prove benignity. The risk for malignancy in this category cystic lesion is approximately 5% as reported by Israel et al. (17). Such lesions are not complicated enough to fall into category III but too complicated for category II. They may contain multiple hairline thin septa but without wall thickening or have minimal smooth wall thickening resulting in a “perceptible” (not measurable) wall with “perceived” enhancement; they may also exhibit thick irregular calcification but without associated enhancing soft-tissue component, thickened wall or septa. Intrarenal (that do not extend outside renal outline) and large (>3 cm) hyperdense cystic masses which otherwise fulfill the
characteristics of a category II hyperdense cyst are also included in this category and require further follow-up.

Category III lesions
This category consists of "indeterminate" cystic renal masses that require surgery (nephron sparing surgery) because of a high risk of malignancy. The latter has been assessed at 59% in the study of Curry et al. and is approximately 50% (range 25 to 100%) according to overall literature. Recently it has been shown that the introduction of the category IIIF would increase the rate of malignancy in surgical lesions of the category III (from 50% to greater than 80%) (19).
It can be divided into two subtypes depending on the presence of septa: multiloculated and uniloculated category III cystic masses. Multilocular cystic masses are consistent with multilocular cystic neoplasms including malignant and benign tumors. Unilocular cystic lesions include benign complicated cysts and unilocular cystic renal carcinomas.
Multiloculated category III is an encapsulated cystic mass that contain numerous thickened smooth or slightly irregular septa, uniform smooth or slightly irregular wall thickening. The cyst wall and septa which are grossly thickened (>2mm) demonstrate unequivocal enhancement after contrast administration but no enhancing soft-tissue components are present. Thick or irregular calcification can be present.
Uniloculated category III demonstrates uniform smooth or slightly irregular wall thickening with unequivocal enhancement after contrast administration. Thick or irregular calcification can be present.

Category IV lesions
Cystic masses that belong to this category are clearly malignant lesions which demonstrate nonuniform enhancing thick wall or septa with nodularity and enhancing soft tissue elements. They can have findings similar to those seen in category III lesions including multiloculated and uniloculated masses, but also demonstrate solid components with unequivocal enhancement.

1.3 Utility and limitations of the Bosniak classification system
Several studies, reported between 1997 and the early 2000s, have examined the validity of the Bosniak classification system with somewhat discrepant results especially regarding the rate of malignancy in category II (assessed between 0 to 80% with a mean rate of 27%). Most of these however suffer from the limitations of retrospective studies with suboptimal CT technique and the small number of proven lesions. The largest reported series reviewed 70 (22) and 82 (10) surgically removed cystic masses that found to have good concordance with the Bosniak classification system. However conflicting result still exists in the number of proven malignant lesions in category II and IV. Siegel et al. (22) found 1 of 8 category II lesions to be malignant (12%) and 3 of 29 category IV to be benign (rate of malignancy 90%) whereas Curry et al. (10) reported a rate of malignancy of 0% and 100% respectively as expected on the basis of the Bosniak classification scheme. It should be noticed that a significant number of lesions (about one half) has been inadequately scanned (eg. without available unenhanced images or with 10mm thick collimation) or interpreted (without available Hounsfield attenuation values) in the work of Siegel. Such limitations may increase the risk of misclassifying complex cystic lesions. Conversely, the study of Curry et al. has been designed with particular attention to CT technique since only patients with technically adequate scans were included to allow proper assignment of the lesion to a category.
One of the major limitation of the Bosniak classification system is that a large number of interpretation criteria are qualitative rather than quantitative. This lead to a high degree of interobserver disagreement especially in the differentiation of categories II, IIIF and III (21). It is also highly dependent on the reader's experience. In cases of indecision or discordance between radiologists in categorizing a cystic mass, the lesion should be placed in the higher category (17).
Although the Bosniak classification system provides a helpful guideline for evaluation and management of a wide majority of renal cystic masses, atypical renal masses with equivocal CT features that cannot fall neatly into a Bosniak category are sometimes encountered in daily practice. These are called "indeterminate renal masses" until they prove to be cystic or solid.

2. Indeterminate renal masses and misclassified cysts
Certain cases of cystic renal masses remain not categorizable at CT using the Bosniak classification scheme because of their small size or their proper atypical attenuation characteristics or enhancement properties. The difficulties in characterizing such masses prevent their cystic nature to be clearly recognizable at CT and therefore to be categorized by using the Bosniak classification system. US and MRI play a major role in the evaluation of such renal masses by providing useful additional diagnostic information that help distinguish between atypical fluid fill masses and atypical solid neoplasms.
Among these, solid papillary renal cell carcinoma which usually shows poor vascularity, represents the differential diagnosis that is most often involved.

2.1 Very small renal mass
As mentioned above, very small renal masses remain indeterminate at CT since attenuation measurements are unreliable to provide accurate characterization. In general population, very small lesions that are incidentally detected are usually not pursued because they are statistically likely to be cysts (3). On the other hand, in patients with genetic predisposition to renal neoplasm at risk of RCC (von Hippel Lindau disease, hereditary papillary carcinomas, Birt Hort Dubbe syndrome,...) or in those with an history of removed RCC or with synchronous RCC, very small lesions should be viewed as indeterminate and further imaged or followed-up. MRI can be useful in characterizing such extremely small cysts because of its higher contrast resolution compared to CT. Definitive diagnosis can be easily obtained on the basis of their T2-weighted signal characteristics alone (uniformly and markedly hyperintense, sharply marginated round mass).

2.2 Renal mass with indeterminate attenuation
Renal masses that exhibit attenuation values between 20 an 50HU on unenhanced images with no significant enhancement on postcontrast images do not neatly fall into the typical profile of simple (category I) or hyperdense (category II) cysts. In these instances it is not possible to securely differentiate an atypical hyperdense (with intermediate attenuation values) cyst from a poorly vascularized solid tumor (mostly papillary RCC) with no significant enhancement (variation of attenuation < 10HU) (7). Further imaging including US or MRI is therefore indicated to establish the true nature of these lesions. At US, hyperdense cysts are typically anechoic in about 30 to 50% of cases (12,23). Contrast-enhanced US using microbubbles has been shown to demonstrate tumor vascularity with a high sensitivity (8), it has therefore the potential to increase US performance in demonstrating the cystic nature of atypical hyperdense cysts. When US fails to ensure the fluid characteristics of the mass, MRI is commonly used as a second step diagnostic modality (14,18). Typically hyperdense cysts demonstrate a homogeneous bright signal or fluid-iron level pattern within the lesion on both T1 and T2-weighted images. Such pattern is encountered in about 50% of hyperdense cysts. The remaining half of these lesions can demonstrate a wide range of signal intensity often with heterogeneous pattern on T1 and T2-weighted images that prevent differentiate atypical hyperdense cyst from a solid neoplasm with intratumoral hemorrhage using morphologic and signal findings alone. Enhancement characteristics at best appreciated using image subtraction (because of high signal intensity) are therefore critical in their proper characterization. Characterization of solid hypovascular neoplasms relies mainly on the ability of postcontrast MRI to clearly depict subtle tumor enhancement. It has been shown that masses with low signal intensity and homogenous pattern on T2-weighted images are highly suggestive of papillary renal cell carcinoma (21).

2.3 Renal mass with indeterminate "enhancement"
With the advent of helical CT it has been shown that pseudoenhancement can occur in simple cysts as a result of inadequate correction of the "beam hardening" effect. A change in attenuation values between 10 and 15HU after contrast administration is therefore considered equivocal. Such finding is consistent with pseudoenhancement phenomenon in a benign cyst or subtle nonsignificant (15HU) enhancement of a hypovascular neoplasm (7,15). For these types of cases appropriate imaging workup is similar to the one mentioned above. Even though such masses are indeterminate, it is sometimes possible to suggest whether the lesion is more likely cystic or solid. A small (less than 20mm) intraparenchymatous water attenuating mass that exhibit borderline postcontrast increase in density at peak enhancement (ie. nephrographic phase) is likely to be a benign cyst with pseudoenhancement. Conversely, findings suggestive of malignancy include: inhomogeneous internal texture or slight variation of texture on postcontrast image; non-water attenuation values (20-50HU) on unenhanced images; lack of sharp margins; atypical appearence (internal echoes, lack of posterior acoustic enhancement) at US examination; previous history of excised papillary cancer or multiple synchronous papillary tumors; known hereditary papillary RCCs.

2.4 Renal cyst with discrepant findings between CT and other modalities
Some discrepancy between CT and US or MRI in renal cyst evaluation are sometimes encountered in routine practice. Such troublesome situations are in agreement with reported data which suggest that intracystic details can be better seen at US and MRI making some cystic masses more complex than at CT. Septa within a complex cyst are often demonstrated with more sensitivity at US and MRI than
do CT (1,18,14,20). Such finding would cause a complex cyst to be reclassify in a higher category than it would be with CT features alone (18). On the basis of the number of depicted septa, it is therefore possible to upgrade a renal cyst from category I or II to category II or IIF respectively. Although upgrading a thin-walled cyst from category II to category IIF as a result of only the increased number of detected septa (with unperceptible wall) may affect patient management, the lesion is likely to be benign as initially suggested by CT.

Another unusual discrepant finding between imaging modalities has been reported in rare cases of microcystic multilocular cystic RCC (with cystic spaces smaller than 5mm) that can exhibit a solid appearance at US and CT (9) whereas it is expected to show a cystic pattern on T2-weighted MR images. We have recently reported two cases of tubulocystic renal carcinoma with a solid hyperechoic appearance at US that appeared as cystic lesions on both CT and MRI of category I and II respectively (unpublished data). Grossly, the tumors showed a spongy appearance related to a microcystic architecture.

MRI as well as contrast-enhanced US also can provide additional information on lesion vascularity and wall thickening compared to CT because of their higher sensitivity to contrast enhancement (18,1,20). It has been shown that MRI can lead to upgrade complex cysts from category IIF to category III (in 3 of 10 cases) and from category III to category IV (in 2 of 9 cases) (18). Such data suggests that MRI can play a role in the management of cystic masses categorized by CT as IIF (lesions requiring follow-up CT) whereas in category III (lesion requiring surgery) it does not significantly affect patient management. It can be therefore recommended to add MRI in the imaging workup of category IIF as a first step evaluation before further follow-up. Depending on the results of MRI the lesion can remain in the non surgical category IIF and be further followed-up or fall into category III that need to be removed surgically. Contrast-enhanced US also has been shown to improve evaluation of complex cystic masses (1,20). It can therefore be proposed as an alternative to MRI and follow-up CT in the management of indeterminate category IIF cysts.

References
17. Israel GM, Bosniak MA (2003a) Follow-up CT of moderately complex cystic lesions of the kidney (Bosniak category III). AJR 181 : 627-631

Table 1: Bosniak classification system of renal cystic masses

<table>
<thead>
<tr>
<th>Category</th>
<th>CT findings</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat I</td>
<td>Water attenuation (&gt;10, &lt;20HU) Homogeneous Smooth margins without perceptible wall Lack of enhancement (variation &lt;10HU)</td>
<td>Simple cyst</td>
</tr>
<tr>
<td>Cat II</td>
<td>Few thin septa (≤2 septa) no perceptible wall Fine calcification (wall or septum) Lack of enhancement (variation &lt;10HU) or minimal (perceptible) enhancement of septa</td>
<td>Complicated cyst</td>
</tr>
<tr>
<td>Cat IIF</td>
<td>Thin septa (&gt;2 septa) Minimal wall thickening (≤1mm) (not measurable) Thick or irregular calcification Hyperdense cyst * except for size (≥4cm) or intraparenchymal location</td>
<td>Complicated cyst Multilocular cyst Cystic tumor cystic carcinoma or cystic nephroma</td>
</tr>
<tr>
<td>Cat III</td>
<td>Numerous thick septa Uniform grossly thick wall Slightly irregular thick wall Thick or irregular calcification Enhancement (septa and/or wall)</td>
<td>Complicated cyst Multilocular cyst Cystic tumor cystic carcinoma cystic nephroma</td>
</tr>
<tr>
<td>Cat IV</td>
<td>Grossly thick and irregular wall Mural nodules or solid tissue component Enhancement of the soft tissue elements</td>
<td>Cystic carcinoma Pseudocystic necrotic RCC</td>
</tr>
</tbody>
</table>

* Small (<3 cm) subcapsular cyst, with high attenuation values (50-90 UH), homogenuous, with smooth margins, without any change after contrast administration

Figure 1: Drawing of the different categories of renal cystic masses according to Bosniak classification. F: follow-up; ML: multilocular.
Renal tumors have a higher incidence in the elderly: the most common histological type is the renal adenocarcinoma, responsible for 85-90% of all cases. The medium age at presentation is 66 years, and 25% of all diagnoses are performed in patients over 75 years of age [1-4].

A comprehensive approach to renal tumors in the elderly must consider the clinical, diagnostic and therapeutic point of views.

In the elderly the imaging findings of the renal tumors are not different from those of other ages. At US these tumors have a "solid" echostructure, varying from hyperechoic, to isoechoic, to hypoechoic. Hyperechoic masses are more common than iso-hypoechoic masses. In general the degree of hyperecogenicity is mild, so that these lesion can be easily differentiated from angiomyolipomas which tend to be more hyperechogenic. Isoechoic masses can be difficult to be visualized since they have the same echostructure of the renal parenchyma, and can be recognized if they modify the renal profile. Color and Power Doppler US can be useful to improve the detection of the small renal masses.

CT is very effective in the detection and characterization of the renal tumor in general and, mainly, of small renal tumors. MDCT has further expanded the possibilities of CT in the detection of the small renal masses. At CT small renal tumors appear as a round, sharply demarcated renal mass, which, depending on the size, can be totally intrarenal or partially intrarenal and extrarenal. Small renal tumors present soft tissue density, with variable degree of contrast enhancement. The density is homogenenous but heterogeneus areas are also common. MRI has also a good sensitivity for these lesions although only few cases are initially detected with this imaging modality, due to the relatively limited use of MRI in the abdomen.

As far as clinical and pathological features is concerned, a number of parameters have been evaluated, also in the recent literature, in order to see if there are differences between renal tumors in the elderly and in young patients. Most of the parameters that have been evaluated, such as sex, tumor size, primary tumor classification, lymph node involvement, distant metastases at nephrectomy did not show statistically significant differences.

The growth rate of renal lesions in the elderly is low in a series of small renal tumors: Bosniak [5] showed that the medium growth rate time was 0.35 cm per year, with a range of 0-10 cm. The same
studies demonstrated a great variance of growth rate with the majority of small renal tumors characterized by a slow growth potential, with a low incidence of distant metastasis as well. Conversely the majority of medium and large size tumors are usually characterized by local invasiveness and distant metastases. More recently, Zhang et al [6] have demonstrated that the median doubling time of renal tumors was 811 days and that tumors of the same histologic subtypes and grades grew at widely varying rates. Increasing age at diagnosis is associated with a slower growth rate. The small renal tumors have usually a low grading, between first and second grade, respect to tumors greater than 3 cm that have a high grading, usually of grade II – III [5-7]. The regularity of the margins, round or oval, seem to be the most suggestive semeiologic aspect correlated to a low growth rate.

Minor differences exist in the histological characteristics of renal tumors in different ages of presentation: patients <40 years old (17%) are more likely to have chromophobe histology while papillary histology increased with age, present in 7%, 13%, and 16% of patients aged <40, 40-59, and 60-79 years old, respectively. Clear cell RCC, which is the most common histological type, was similar across the age groups; 69%, 70%, and 72% of patients aged <40, 40-59, and 60-79 years old, respectively.

The evolution in the imaging techniques has caused the increase of the detection of incidental lesions, determining new problems related to therapeutical approaches, mainly in old patients. These are: which tumors must be resected; what kind of surgical technique must be used; finally in which cases a watchful waiting could be considered an reasonable option? According to guidelines a watchful waiting is suitable in case of small lesions in old patients with high risks correlated to surgical resection; a follow-up each 3 months is recommended in the first year after diagnosis [8]. Recently, less invasive therapies with the potential to avoid open surgery and better preserve renal function have been investigated. These techniques include advanced therapeutic techniques as cryoaablation [9-10-11], radiofrequency ablation [12-13-14], and ablation using high-intensity focused ultrasound [15].

References

Pagina | 102
The past two decades have seen an increase in incidentally detected renal masses attributed to increasing use of and technological improvements in cross sectional imaging. Detected masses are not only smaller, but benign histology is now found in 15-20 % of cases versus 15-20% historically. A contributing factor in the shift can be attributed to the recently updated World Health Organization classification of benign renal tumors in 2004 based on a new understanding of renal genetics. Some tumors previously considered to be malignant such as granular renal cell carcinoma and renal cell carcinoma of oncocytic type have been reclassified as benign.

The WHO Histological Classification of Benign Renal Neoplasm (Adults)

- **Renal epithelial cell tumors:**
  - Oncocytoma
  - Papillary adenoma

- **Metanephric neoplasms:**
  - Metanephric adenoma

- **Mesenchymal neoplasms:**
  - AML
  - hemangioma, lymphangioma, leiomyoma, reninoma, fibroma

- **Mixed epithelial and mesenchymal neoplasms:**
  - mixed epithelial and stromal tumor
  - cystic nephroma

**ONOCYTOMA**

Oncocytoma contributes heavily to the increase in benign renal neoplasms, now accounting for 7-10% of treated renal tumors, especially those smaller than 4 cm. This neoplasm features large epithelial cells with eosinophilic cytoplasm; tumor size ranges from < 1 cm to very large masses. Rarely, oncocytomas are multiple and bilateral (renal oncycytosis and Birt-Hogg-Dube syndrome). There is a histogenetic relationship between oncocytoma and chromophobe renal cell carcinoma both deriving from cells of the cortical collecting duct. Hale colloidal iron stain is positive for chromophobe RCC but negative for oncocytoma.

Before the advent of CT, angiography for these tumors showed spoke-wheel vascularity without venous shunting or vascular puddling. Some are hypovascular. They appear on CT as well-defined, smooth and homogeneous lesions, with central stellate scars in 1/3rd of the larger tumors. Hemorrhage, calcification and necrosis are unusual. A recent study has shown very avid enhancement of oncocytomas, similar to clear cell RCC, but differing from that of chromophobe RCC and lipid-poor angiomyolipoma which showed moderate enhancement. Another recent study has shown a predilection for small oncocytomas to show segmental enhancement inversion on biphasic multidector CT wherein distinct areas of high enhancement and low enhancement within the tumor on corticomedullary differentiation phase correspondingly switch to lower and higher enhancement on early excretory phase images. This effect correlated pathologically to portions of tumor having more densely packed cells versus hypocellular stroma in the other areas. On MR oncytomas have homogeneous low to moderate signal on T1 and relatively high signal intensity on T2. They also have significantly higher apparent diffusion coefficients compared with solid renal cell carcinomas which may aid in differentiation. Breath-hold diffusion weighted imaging may be particularly useful as an alternative to contrast enhanced MR and contrast-enhanced CT in patients with renal dysfunction, avoiding nephrogenic systemic fibrosis in the former and contrast-induced nephropathy in the latter. Percutaneous biopsy results should be regarded with caution due to the potential for sampling error since hybrid oncocytoma-renal cell carcinoma tumors or collision tumors exist. Definitive diagnosis requires whole specimen pathologic evaluation despite advances in imaging and pathologic investigation.

**PAPILLARY ADENOMA:** Papillary adenomas are common epithelial lesions, by definition smaller than 0.5 cm, with no nuclear atypia. They are discovered incidentally, found in 7% of nephrectomy specimens and 10-40% of autopsies. They are most commonly found in older individuals: 10% of patients are less than 40 years of age and 40% are over 70 years of age. They are associated with acquired cystic disease and, in one surgical series, 50% occurred in patients with papillary renal cell
carcinoma. They may, in fact, be the evolutionary precursor to papillary RCC. Due to very small size, these tumors are rarely encountered in practice and if detected, can be safely observed. They are not distinguishable from papillary renal cell carcinoma cytogenetically or by imaging features.

**METANEPHRIC ADENOMA**: Metanephric adenoma of the kidney is a rare benign tumor characterized by monotonous, primitive-appearing, small blue cells forming tightly packed tubular structures and acini with little intervening stroma. Psammoma bodies are frequently found in association. The patients are twice as likely to be female as male and the peak incidence is in the 5th-6th decades. About half are asymptomatic with hematuria and abdominal pain in symptomatic individuals. There is an association with polycythemia in 10%, with resolution after resection. They are identified on imaging as solitary, well-marginated solid masses with high attenuation on non-contrast CT. Twenty percent of tumors exhibit calcification. When large, the tumor is heterogeneous and exhibits hemorrhage or necrosis. The lesion is hypointense on T1 weighted MR imaging and mildly hyperintense on T2.

**MESENCHYMAL NEOPLASMS**

Angiomyolipomas contain vascular, smooth muscle and fat elements with one or more components dominating. They belong to the “PEComa” family of tumors which possess distinctive perivascular epithelioid cells. PEComas are characterized by melanocytic markers such as HMB-45, muscle markers such as smooth muscle actin and are also negative for cytokeratin.

Sporadic AML's, accounting for 80-90% of these tumors, occur in women > 40 years of age. There is a 4:1 F:M ratio. Twenty percent of patients with AML's have tuberous sclerosis, while 80% of TS patients have AML's of the kidney which are multiple and bilateral. Tumors may be very small or very large and have a tendency to bleed when over 4 cm in size due to dysmorphic vascularity and intralesional aneurysms. Bleeding AML's can be embolized. Typical AML's do not undergo malignant change although small satellite deposits may be found in regional lymph nodes, liver and spleen. Extension of tumor into the renal vein or IVC occasionally occurs.

Sonography shows a hyperechoic mass with echogenicity similar to sinus fat. Renal cell cancer may also appear hyperechoic, especially when < 3 cm in size. The identification of adipose tissue on CT or MR is consistent with AML although other tumors may contain fat, including oncocytoma and RCC, very rarely. Calcification is not a feature of AML. There is a newly recognized entity (2006) of a distinct cystic variant of AML which occurs in both men and women with a mean age of 46 (age range 20-76) which is composed of large epithelial cysts as well as the smooth muscle and dysmorphic blood vessels typically seen in AML.

About 4-5% of AML’s do not have macroscopically visible fat which makes them difficult to distinguish from RCC and oncocytomas. The degree of enhancement at CT may be less intense than clear cell RCC and oncocytomas, however. It has been reported that lipid poor AML’s show high attenuation on precontrast scans and uniform, prolonged, homogeneous enhancement post contrast injection. Metanephric adenoma and oncocytomas may show a similar pattern. Rarely, the lipid-poor epithelioid variant of AML shows aggressive biologic behavior.

Leiomyomas arise most commonly from smooth muscle in the renal capsule, but tumors can be found in the pelvicalyceal system or cortex. Small tumors are found at autopsy but are rarely symptomatic. Most have been found in adults although 10% of symptomatic patients have been <20 years of age. The lesions are typically solid although cystic or partially cystic tumors have been reported. Malignant degeneration to leiomyosarcoma can occur. Immunostains for smooth muscle such as actin help characterize these tumors at pathological exam. Imaging findings are variable depending on size and presence of hemorrhage or necrosis. Calcification is not common.

Juxtaglomerular cell tumor (reninoma): This extremely rare, usually small (<3cm) tumor occurs in younger individuals (50% under 20 years of age) with slight female predominance. Plasma renin is elevated with secondary hyperaldosteronism and hypokalemia. Microscopically these tumors resemble hemangiopericytomas and special stains are required to distinguish between them. Imaging findings are non-specific. They have been described as solitary, well-circumscribed hypovascular tumors with delayed enhancement on CT and MR.

Medullary fibromas derive from medullary interstitial cells. They are the most common benign tumor of the medulla and frequently identified at autopsy but are very small (< 5 mm) and rarely clinically evident. Usually found in the renal pyramid, they may present as a smooth mass indenting the renal pelvis or pedunculated mass within the renal pelvis. They can calcify and rarely present in the parenchyma.

Hemangioma is an extremely rare mesenchymal neoplasm thought to arise from embryonic rests of unipotent angioblastic cells. They are composed of multiple, endothelially-lined, blood filled vascular spaces. Usually only 1-2 cm in size, they affect young individuals with no sex predilection and tend to...
occur in the pyramids of the kidneys and the renal pelvis. They may be symptomatic with gross hematuria and renal colic or appear as incidental findings. At sonography the lesion has been described variously as hyper or hypoechoic. A case report of a large cavernous hemangioma had CT angiographic findings of thick, enhancing vascular channels and a dilated renal vein. MR in this case showed T1 hypointensity and T2 hyperintensity with finger-like flow voids and venous phase fill-in.

MIXED EPITHELIAL AND MESENCHYMAL NEOPLASMS

Cystic nephroma has numerous names but is a benign tumor consisting of encapsulated, multiple non-communicating cysts. It is typically unilateral and solitary with honeycombed cystic areas ranging from several mm to several cm. The locules do not intercommunicate, are surrounded by a thick fibrous capsule with mildly thickened, enhancing but non-nodular fibrous septa. There are no solid components or necrosis. Calcification of the cysts and septa can occur. 90% of cases in males occur in the first 2 years of life; in females it occurs in individuals < 5 years of age or 40-60 years of age. They tend to herniate into the pelvis and may obstruct the collecting system. Cystic RCC or Wilms cannot be excluded and surgery is indicated. If cysts are small and solid interstitial components predominate, the lesion may appear echogenic and thus assumed to be solid and the diagnosis may not be suggested. Angiographic studies shows the lesion to be hypo to hypervascular.

Mixed epithelial and stromal tumor of the kidney (MESTK) was first described in 1998 as a distinctive cystic and solid benign neoplasm. It is composed of mesenchymal component of a stroma containing variably cellular spindle cells as well as an epithelial component of large cysts, microcysts and tubules. They have been found almost exclusively in post menopausal older women, suggesting hormonal pathogenesis such as long standing estrogen use. The nuclei of the ovarian-like stroma express estrogen receptors. Most, if not all cystic nephromas reported in the past arising in middle-aged to elderly females are probably MESTK’s. Rarely, these tumors have shown extra-renal invasion and aggressive clinical course which may be due to sarcomatoid transformation. On imaging the lesions are cystic and solid in varying proportions with heterogeneous enhancement. They may be associated with hemorrhage and can herniate into the renal pelvis causing obstruction.

Adult cystic nephroma and mixed epithelial and stromal tumor of the kidney are considered to be separate entities on the 2004 WHO classification of benign renal neoplasms. Recent studies support the theory, however that these are related since they share common clinicopathologic features. The sex predilection and age distribution are similar as are morphologic features of septated cystic structures. The stromal component in both lesions express estrogen and progesterone receptors and both show ovarian-type stroma. On gross appearance, the typical cystic nephroma has no solid areas and the septa are no thicker than 5 mm while typical MESTK are solid and cystic tumors with septa thicker than 5 mm. The histologic criteria to distinguish them are not clearly defined, however, and there is considerable overlap to suggest that rather than distinct entities, they may represent morphologic variants of a spectrum of the same disease process.

References
Murphy AM, Buck AM, Benson MC, McKiernan JM. Increasing detection rate of benign renal tumors: evaluation of factors predicting benign tumor histologic features during past two decades. Urology 2009;73:1293-1297
Retroperitoneal pathologies that can affect the urinary tract include the following:

- Primary malignant and benign tumors
- Inflammatory processes - retroperitoneal fibrosis, pelvic lipomatosis
- Lymphoma, metastatic lymphadenopathy
- Miscellaneous processes - Lymphangiomia, extramedullary hematopoiesis
- Inflammatory aortic aneurysm
- Retroperitoneal hemorrhage, abscess

**Primary Retroperitoneal Tumors**

- Most retroperitoneal neoplasms are malignant, and one third of malignant retroperitoneal neoplasms are sarcomas, with an incidence rate of 1 – 2 cases per million per year.

- About 15% of sarcomas originate within the retroperitoneum, 45% originate in the lower extremity, 15% in the head and neck region, and the remainder in the abdominal wall and chest wall.

- At presentation, 60.8% of retroperitoneal sarcomas are larger than 10 cm, and 21.2% were larger than 20 cm.

- Grow very large in size before producing any symptoms or signs, leading to a delay in diagnosis and subsequent poor prognosis.

- There are approximately 50 histological subtypes of soft tissue sarcoma. Malignant primary retroperitoneal neoplasm in descending order of frequency are:

  - Liposarcoma - 40%
  - Leiomyosarcoma - 30%
  - Malignant fibrous histiocytoma - 15%
  - Malignant primary neoplasm in descending order of frequency

- Sarcomas rarely develop from pre-existing benign soft tissue tumors, with the exception of malignant peripheral nerve sheath tumors that can arise from neurofibromas, usually in patients with neurofibromatosis type 1 (NF-1).

- Benign Tumors are usually of neural origin and include Schwannoma, Ganglieneuroma.

Liposarcoma is the most common retroperitoneal sarcoma, accounting for approximately 40% of such cases, and is the second most common adult soft tissue sarcoma. Liposarcomas originate from primitive mesenchymal cells and not from adipocytes. MFH is the most common adult soft tissue sarcoma, accounting for 14 – 18% of all soft tissue sarcomas. Most liposarcomas occur in deep soft tissue, in contrast to lipomas, which occur more commonly in superficial soft tissue. Retroperitoneal liposarcoma has a mean diameter of 20 cm, and is associated with local recurrence which is responsible for most patient morbidity and mortality. The rate of distant metastasis to both the liver and lung is less than 10%. In comparison, patients with non-liposarcoma retroperitoneal tumors have a four-fold higher risk of metastases compared with liposarcoma. Well differentiated liposarcomas are large multilobular lesions that could be mistaken for lipomas except for their extremely large size and
their tendency to have more fibrous bands, gelatinous zones, or punctate hemorrhage. Subtle differences in the attenuation or SI of normal abdominopelvic fat compared to areas of fat-containing liposarcoma may be seen, and in patients who have undergone surgical resection of liposarcoma, such findings must be viewed with suspicion for possible tumor recurrence. The presence of thick septa and associated non-adipose mass-like areas increase the likelihood of a well differentiated liposarcoma over a lipoma by 9- and 32-fold, respectively. Large exophytic renal angiomylipomas may mimic the appearance of perirenal well differentiated liposarcomas, but presence of a renal parenchymal defect, enlarged vessels within the lesion, and presence of other renal angiomylipomas favor an angiomylipoma.

Well differentiated liposarcomas are for the most part non-metastasizing lesions that are of low grade histology, but their rate of local recurrence in the retroperitoneum approaches 100%. With local recurrence, cachexia and intestinal obstruction are common. Approximately 10% of well differentiated retroperitoneal liposarcomas can dedifferentiate, after an average of 7 – 8 years. CT and MRI may occasionally suggest a specific histologic diagnosis. For example, the presence of macroscopic fat within a large retroperitoneal mass favors the diagnosis of a well differentiated liposarcoma, whereas caval involvement favors a leiomyosarcoma, particularly if cystic or necrotic intratumoral components and/or metastases are present. Similarly, a large retroperitoneal mass that contains calcifications, extensive hemorrhage without fatty components, or central necrosis favors a diagnosis of MFH. Although cross-sectional imaging cannot accurately predict the grade of a retroperitoneal sarcoma, the visualization of tumor necrosis suggests the presence of a high grade tumor and a poorer prognosis. Regional lymphadenopathy is uncommon in soft tissue sarcomas, with a frequency of less than 4% at presentation, and less than one third of patients have metastases at presentation. Complete surgical resection is the treatment of choice for primary and recurrent retroperitoneal sarcoma, Concomitant resection of adjacent organs that are involved by tumor is performed to ensure clear surgical margins. Presence of satellite nodules around a primary retroperitoneal sarcoma seen on preoperative cross-sectional imaging is associated with an increased risk of local recurrence, and may alter the extent of resection to be performed. Chemotherapy for retroperitoneal soft tissue sarcoma is not effective, and adjuvant radiation therapy is limited by toxicity to adjacent intra-abdominal structures. The attenuation and SI features of recurrent sarcoma may differ from those of the original primary sarcoma.

Leiomyosarcoma is the second most common retroperitoneal sarcoma, accounting for approximately 30% of retroperitoneal sarcomas, and accounts for about 8% of soft tissue sarcomas overall. Most leiomyosarcomas present in the fifth or sixth decades of life, with two thirds of all retroperitoneal leiomyosarcomas occurring in women. Approximately one half of all soft tissue leiomyosarcomas develop in the retroperitoneum, making it the single most common soft tissue site. Retroperitoneal leiomyosarcomas are typically well circumscribed, have a mean diameter of 16 cm, and often contain intratumoral necrosis and hemorrhage.

Two thirds of retroperitoneal leiomyosarcomas are located external to the lumen of the inferior vena cava (IVC), whereas approximately one third have both intraluminal and extraluminal components. Leiomyosarcoma is the most common intraluminal venous neoplasm, and is the most common primary tumor of the IVC. The finding of a retroperitoneal mass which has both intraluminal and extraluminal components is very suggestive of a leiomyosarcoma. Initially, adjacent organs are displaced without direct invasion, but eventually do become involved by direct extension. Purely intraluminal caval leiomyosarcomas account for 5% of leiomyosarcomas, occurring primarily in women (80 – 90% of patients), and present at a younger age (mean age of 50 years). On imaging, the intracaval leiomyosarcomas are seen as polypoid or nodular masses that are firmly attached to the vessel wall. They are smaller than those that are entirely extravascular, are less likely to show intratumoral hemorrhage and necrosis, and are most frequently located between the diaphragm and the renal veins. Leiomyosarcomas with an intraluminal component are more likely to produce early symptoms than those that are completely extraluminal. On CT and MRI, leiomyosarcomas usually have attenuation similar to muscle, being low-intermediate SI on T1-WI, and heterogeneous intermediate-high SI on T2-WI (Figs. 42-17 and 42-18). Central liquefactive necrosis is more common and extensive than in other sarcomas, and is seen as foci with low attenuation, low T1-W SI, and high T2-W SI. Fat and calcification are not typically seen. Intratumoral hemorrhage typically appears as high attenuation and high T1-W SI relative to muscle. Smaller tumors may present as a solid non-necrotic mass, and uncommonly, the tumor may present as a predominantly cystic mass with extensive necrosis. The enhancement of leiomyosarcomas is variable and depends on their muscular and fibrous components; it is usually delayed compared to the enhancement of the surrounding skeletal muscles.
Malignant fibrous histiocytoma (MFH) is the most common soft tissue sarcoma in adults, with most patients presenting between the sixth and eighth decades of life. Two thirds of these tumors occur in men. MFH accounts for 25% of all soft tissue sarcomas, but only 16% arise in the retroperitoneum. Nevertheless, it is the third most common retroperitoneal sarcoma after liposarcoma and leiomyosarcoma. On CT and MRI, MFH appears as a large, relatively well circumscribed mass that spreads along fascial planes and between muscle fibers, with attenuation similar to muscle, low-intermediate SI on T1-WI, and heterogeneously increased SI on T2-WI relative to muscle (Fig. 42-19). Intratumoral fat is absent. Areas of low attenuation due to cystic degeneration or necrosis may be present.

Extensive intratumoral hemorrhage frequently occurs in MFH, but most masses of MFH have non-hemorrhagic solid components, and thus most tumors can be differentiated from a bland benign hematoma. Intratumoral calcifications may be seen in up to 20% on CT, often peripherally with a lumpy or ringlike configuration or sometimes more centrally with a speckled or amorphous configuration. Calcification is more difficult to detect prospectively on MRI.

Primary extragonadal germ cell tumors (EGCTs) represent between 1 – 3% of all germ cell tumors, occurring most commonly in the mediastinum and slightly less commonly in the retroperitoneum. Primary EGCTs are more common in men than women with a peak occurrence in the fourth and fifth decades of life, which is a slightly older age group compared to patients who develop primary testicular germ cell neoplasms. Primary retroperitoneal EGCTs are hypothesized to arise from primordial midline germ cell remnants of the genital ridge that fail to migrate properly. As the majority of retroperitoneal germ cell tumors are metastases from primary testicular germ cell tumors, careful clinical and imaging evaluation should be performed in affected men to exclude a coexistent primary testicular neoplasm.

On CT and MRI, primary retroperitoneal EGCTs are typically large, with mean size of 7 – 8 cm, midline enhancing retroperitoneal masses of soft tissue attenuation that are of low-intermediate SI on T1-WI and intermediate-high SI on T2-WI relative to skeletal muscle. Areas of cystic change or necrosis are seen as very high SI foci on T2-WI. Seminomatous EGCTs tend to be homogeneous in attenuation and SI, whereas mixed and non-seminomatous EGCTs tend to be heterogeneous in attenuation and SI, with areas of cystic necrosis or hemorrhage. A midline location of a retroperitoneal mass is probably the most helpful finding to suggest this diagnosis, whereas metastatic retroperitoneal lymphadenopathy from a primary testicular neoplasm tends not to be midline in location.

Retroperitoneal Neurogenic Tumors

Paraganglioma
Paragangliomas, sometimes called extraadrenal pheochromocytomas, are rare neurogenic tumors that arise from highly vascularized specialized neural crest cells called paraganglia, that are symmetrically distributed along the aortic axis in close association with the sympathetic chain in the neck, chest, abdomen, and pelvis. The largest collection of paraganglia includes the paired organs of Zuckerkandl that overlie the aorta at the level of the inferior mesenteric artery, and have an uncertain physiologic role. They are prominent during early infancy and regress after 12 – 18 months. 10 – 20% of pheochromocytomas are extraadrenal in location, and most often arise in the retroperitoneum from the organs of Zuckerkandl. Only a few tumors develop at other locations along the aorta or its branch vessels. Patients with paragangliomas present in the fourth and fifth decades of life, although malignant paragangliomas may sometimes arise in younger patients. Men and women are affected equally. Paragangliomas may be multicentric, particularly if there is a family history of paraganglioma, or may be associated with other tumors such as gastric malignant gastrointestinal stromal tumors (GIST) and pulmonary chondromas as a component of Carney’s triad. 10% of paragangliomas are familial, occurring in conditions such as multiple endocrine neoplasia (MEN) types II A and II B and neuroectodermal syndromes such as tuberous sclerosis (TS), neurofibromatosis type I (NF-1), and von Hippel-Lindau syndrome (VHL). Up to 40% of paragangliomas are malignant as compared to 10% of adrenal pheochromocytomas.

Ganglioneuroma
Ganglioneuromas are uncommon benign neurogenic tumors that arise from sympathetic ganglia and represent 1 – 2 % of all primary retroperitoneal tumors, outnumbering neuroblastomas by about 3 to 1. They occur slightly more commonly in women than in men at a ratio of 1.5 to 1, most commonly in the first through fifth decades of life, with a mean age at diagnosis of 7 years. They are most often located in the posterior mediastinum, followed by the retroperitoneum, and the neck and pelvis (8 – 9%). Although some ganglioneuromas result from maturation of neuroblastomas and ganglioneuroblastomas, the majority arise de novo. Most patients with ganglioneuromas are asymptomatic and have normal levels of urinary catecholamines. When symptomatic, abdominal pain and a palpable abdominal mass are the most frequent symptoms and signs. Patients with hormonally
active ganglioneuromas may clinically present with episodic hypertension, sweating, flushing, or diarrhea due to the excess catecholamine production.

**Schwannoma**

Schwannomas are benign tumors of nerve sheaths of peripheral nerves that account for up to 4% of all retroperitoneal tumors, and are most frequently found in the head and neck region and flexor surfaces of the extremities. Most patients are asymptomatic and present with a slowly growing painless soft tissue mass. Malignant transformation is rare. Retroperitoneal schwannomas are typically larger than 8 cm at the time of presentation. Schwannomas are solitary fusiform masses derived from Schwann cells. They are surrounded by a fibrous capsule and are eccentrically located in relation to the parent nerve.

On CT and MRI, schwannomas are sharply circumscribed fusiform, round, or oval masses, usually located in the paravertebral or presacral portions of the retroperitoneum. They are of low-intermediate SI on T1-WI, high SI on T2-WI, and have solid enhancing components. A low SI capsule may sometimes be seen on T1-WI and T2-WI (Fig. 42-22). Heterogeneous attenuation and SI are much more common in schwannomas than in neurofibromas.

**Retroperitoneal Fibrosis**

Two thirds of all cases of RPF are considered idiopathic (also called Ormond’s disease), and approximately one third of cases develop in response to various medications, malignancies, or other etiologies. The exact etiology of idiopathic RPF is unclear. In up to 15% of individuals with RPF, associated fibrotic processes outside the retroperitoneum may be present, including fibrosing mediastinitis, sclerosing mesenteritis, orbital pseudotumor, primary sclerosing cholangitis, and Reidel’s thyroiditis. Other autoimmune or inflammatory disease processes such as systemic lupus erythematosus, rheumatoid arthritis, ankylosing spondylitis, small and medium-sized vessel vasculitides, and ankylosing spondylitis, as well as asbestos exposure also have an association with RPF.

**Pelvic lipomatosis**

- Uncommon condition
- Overgrowth of histologically normal fat and fibrofatty tissue in the extraabdominal compartments of the pelvis
  - perirectal space
  - perivesicular space.
- African American males (67% of cases)
  - mean patient age of 48 years
  - male-to-female ratio of 18:1
  - smaller size of the male pelvis, particularly among black men, may predispose to condition

Associated with

- urinary obstruction
- DVT
- constipation
- proliferative cystitis (cystitis glandularis- premalignant condition)
- half of the patients complain of urinary tract symptoms (frequency, dysuria, hematuria, urgency, sensation of incomplete emptying),
- 1/5 th complain of GI symptoms (constipation, nausea, vomiting)
- May have generalized but nonspecific symptoms (lower abdominal pain, backache, and flank pain).
- May complicate pelvic surgery such as prostatectomy
LECTURES SESSION VII

TOPIC: RENAL COLIC AND HEMATURIA
Moderators: S Moussa (UK), M Scherr (DE)

“RENAL COLIC” WITH NEGATIVE (UNENHANCED) CT: LOOK AGAIN?
D Baumgarten
Emory University, Atlanta GA, United States

The purpose of this session is to highlight diagnoses other than ureteral stones as a cause of renal colic—that is, if the unenhanced (stone protocol) CT is “negative” for its primary diagnosis, what are common alternative diagnoses and when does the addition of intravenous contrast help? Alternative diagnoses to ureteral stones can be broadly divided into 2 categories: additional urinary tract causes and non-urinary tract causes. Urinary tract causes include (this is not an exhaustive list):
- Non-stone urinary tract obstruction
  - Ureteropelvic junction obstruction
  - Ureteral mass
  - Extra-ureteral mass
  - Retroperitoneal fibrosis
  - Surgical mishap
- Non-obstructing renal/collecting system stones
  - Pyelonephritis
  - Renal infarction
  - Renal vein thrombosis
  - Renal hemorrhage
    - Due to an underlying mass
    - Spontaneous
- Renal mass

Non-urinary tract causes include many additional categories (and again, this is not an exhaustive list):
- Gynecological
  - Ovarian cyst (functional, hemorrhagic, ruptured)
  - Ruptured ectopic pregnancy
- GI Tract
  - Diverticulitis
  - Appendicitis
  - Pancreatitis
  - Epiploic appendagitis
- Vascular
  - Ruptured abdominal aortic aneurysm
  - Aortic dissection

Several papers in recent years have evaluated the frequency with which alternative diagnoses are evident on unenhanced (stone protocol) CT. Katz, et al in 2000 in Urology [1] reported on 1000 consecutive examinations and found ureteral calculi in 557, 67 with findings of a recently passed stone and no explanation for pain in 275. Significant alternative or additional diagnoses were found in 101, 26 of whom also had urinary tract stones. These significant alternative or additional diagnoses were comprised of 62 related to the urinary tract and 39 unrelated for a 10% rate. Hoppe, et al in the Journal of Urology in 2006 [2] looked at 1500 patients who presented with flank pain and underwent unenhanced CT. 1035 (69%) had urinary tract calculi in any location. 1064 (71%) had findings unrelated to stone disease; only 105 (7%) had a normal CT. 207 (14%) had findings requiring immediate or deferred treatment unrelated to stone disease. Ather et al in Urology Journal [3] reported a series of 4000 CTs. Urinary calculi (collecting system, ureteral and bladder) were found in 3120 (78%) while 153 (3.8%) had an alternate cause of flank pain and 245 (6.1%) had an additional diagnosis of which 113 (2.8%) were considered significant. Of the alternative causes of pain, 37 (0.9%) were Urogenital and 108 (2.7%) gastrointestinal. 47 (1.2%) had an incidentally detected solid mass (12 within the kidney). So, it seems safe to state that based on these large series that the rate of significant additional findings is somewhere between 10 and 15%. Further, even if a urinary tract stone is found that would explain symptoms, additional important findings may be present.
What about stones that are not obstructing in a patient with no signs of recent stone passage? Furlan et al in AJR in 2008 [4] reported on 173 patients who underwent a stone protocol CT. 56 had an obstructing stone, 4 had signs of recent stone passage, 31 had other causes of pain, 51 had a no cause of pain and 31 had no obvious cause of pain but had non-obstructing stones. They concluded that in the absence of another source of pain, these non-obstructing stones “are likely to be the cause of a patient's acute pain.”

How often does the addition of IV contrast help with the diagnosis? Miller et al published data on 1204 patients in 2005 [5] addressing this question. Of the 1204 with a stone protocol CT, 708 had their study repeated with IV contrast. Of these, only 67 (9.4%) had an abnormality that could only be seen on the post-contrast CT; of these 32 were acute pyelonephritis. 3 had renal infarction only evident after contrast. In 376 (53.1%), no additional findings were evident. The authors concluded that “the most frequently undetected diagnosis on unenhanced CT is acute pyelonephritis, which can be diagnosed by other means. As a result, routine administration of contrast may not be helpful in patients without abnormalities on unenhanced CT.”

An approach to the stone protocol CT might go like this: 1) look for signs of urinary tract obstruction; 2) optimize window and level to detect any urinary tract calcifications; 3) record all (or all relevant) calculi; 4) if stones present with signs of obstruction, the cause of pain has been established (but the remainder of the exam must be analyzed anyway); 5) if obstruction but no stone, can one have recently passed? 6) evaluate for an alternate cause of obstruction; 7) if obstruction not present, evaluate renal contour and density for mass; 8) if inflammation present where is epicenter? Can an alternative diagnosis be established? 9) if nothing is seen, but the clinical picture points to renal infarction or aortic dissection and management will change, repeat with IV contrast; 10) or feel confident there is nothing wrong!

References

Additional reading

DIAGNOSTIC IMAGING FOR HAEMATURIA: HOW I DO IT
N Cowan
Oxford, United Kingdom

First Imaging Test for Investigating Haematuria
For the diagnostic imaging pathway for investigating haematuria to be efficient the first diagnostic imaging test should have high sensitivity for disease with high prevalence in the test population. So the selection of the first imaging test in the diagnostic pathway for investigating haematuria should be strongly influenced by the prevalence of disease in the test population.
Table 1 shows the prevalence of disease in patients evaluated for haematuria from three papers, Sutton 1990, Khadra et al 2000 and Edwards et al 2006 with the patient population divided into those with macroscopic and those with microscopic haematuria. The two most readily identifiable clinical parameters which reflect the prevalence of urological cancer and so may be used for risk stratification are the presence of macroscopic or microscopic haematuria and increasing patient age. With this knowledge it becomes possible to define risk groups for urological cancer.

### Table 1

**Findings in patients evaluated for haematuria**

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<tr>
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<th>MACH (n=1200)</th>
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<th>MICH (n=1689)</th>
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<tr>
<td><strong>Sutton 1990</strong></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Disease</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Urological Cancer:</td>
<td>270</td>
<td>22.5</td>
<td>86</td>
<td>5.1</td>
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<tr>
<td>Bladder</td>
<td>178</td>
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<td>63</td>
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<td>Renal</td>
<td>45</td>
<td>3.6</td>
<td>9</td>
<td>0.5</td>
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<tr>
<td>Prostate</td>
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<td>2.4</td>
<td>8</td>
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<td>Ureter</td>
<td>10</td>
<td>0.8</td>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>Other cancers:</td>
<td>8</td>
<td>0.6</td>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>Other disease:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stones</td>
<td>130</td>
<td>11.0</td>
<td>84</td>
<td>5.0</td>
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<tr>
<td>Renal disease</td>
<td>-</td>
<td>-</td>
<td>37</td>
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<tr>
<td>UTI</td>
<td>394</td>
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<td>73</td>
<td>4.3</td>
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<td>Prostatic hyperplasia</td>
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<td>217</td>
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<tr>
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<td>101</td>
<td>8.4</td>
<td>717</td>
<td>43.0</td>
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<tr>
<td><strong>Totals</strong></td>
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<td><strong>Khadra et al 2000</strong></td>
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<tr>
<td>Disease</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Urological Cancer:</td>
<td>183</td>
<td>19.3</td>
<td>47</td>
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<tr>
<td>Bladder</td>
<td>9</td>
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<td>3</td>
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<td>Renal Cell</td>
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<td>0.1</td>
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<tr>
<td>Disease</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
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<td>73</td>
<td>3.7</td>
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<tr>
<td>Bladder</td>
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<td>0.5</td>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>Other disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stones</td>
<td>183</td>
<td>8.83</td>
<td>153</td>
<td>7.8</td>
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<tr>
<td>No disease found</td>
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<td>1702</td>
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<tr>
<td><strong>Totals</strong></td>
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<td>100</td>
<td>1950</td>
<td>100</td>
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</table>

**Risk Groups for Urological Cancer**

Two risk groups, namely low risk and high risk, may be defined for urological cancer according to age and the presence of macroscopic or microscopic haematuria:
1. The **low risk group** comprises patients <40-years of age, with microscopic haematuria (subgroup 1.1), patients aged <40-years of age with macroscopic haematuria (subgroup 1.2) and patients >40-year of age, with microscopic haematuria (subgroup 1.3).

2. The **high risk group** consists of patients, aged >40-year, with macroscopic haematuria.

**Risk Subgroup 1.1 (<40-yr, with persistent microscopic haematuria and urinary tract infection excluded)**

In this subgroup, the disease with the greatest prevalence is medical renal disease and so renal tract ultrasonography (US) is recommended for the first imaging test. US may detect the presence and position and outline of the kidneys, cortical thickness, large stones, large renal masses, and hydronephrosis.

**Risk Subgroup 1.2. & 1.3. (<40-yr with macroscopic haematuria and urinary tract infection excluded and >40-yr with microscopic haematuria and urinary tract infection excluded)**

For the subgroups 1.2 and 1.3, stones are the most common cause of haematuria; and as the imaging modality with the highest sensitivity for upper urinary tract stones is unenhanced CT of kidneys, ureters and bladder (CT KUB), unenhanced CT KUB is recommended as the first imaging investigation. Unenhanced CT KUB may detect small stones, hydronephrosis, hydroureter, some renal masses, upper tract urothelial cancer and bladder cancer. If following US or unenhanced CT KUB there is an increased risk for urological cancer as defined by the clinical risk score ($\geq$ 3), then multidetector computed tomography urography (CTU) becomes justified. Imaging of the bladder allows those patients with a positive imaging test result to avoid flexible cystoscopy and proceed directly to rigid cystoscopy and biopsy or tumour resection.

2. **High Risk Group for Urological Cancer**

($>40$-yr, with macroscopic haematuria and urinary tract infection excluded)

This risk group constitutes a high risk for urothelial cancer, justifying first-line investigation with CTU. CTU is a term which is often loosely used, encompassing a number of CT series. By definition, a CTU examination must include at least one series in the excretory phase usually acquired 10-15 minutes following administration of intravenous contrast medium. Other series may be added according to the particular indication.

CTU is not sensitive enough to rule out but is specific enough to rule in bladder cancer, so if CTU is positive for bladder cancer then patients may go direct to rigid cystoscopy, biopsy and / or resection. When should CTU be performed for investigating haematuria?

Contrast enhanced CT is required to diagnose the solid renal mass, certain types of renal cyst, upper tract urothelial cancer (UTUC) and bladder cancer. It is only in the high risk group that the prevalence of these diseases is sufficient to justify investigation with contrast enhanced CT. A method incorporating a risk score is proposed; such that patients with a risk score of $\geq$3, contrast enhanced CTU is performed and for a risk score of < 3, unenhanced CT KUB is carried out.

<table>
<thead>
<tr>
<th>Table 2</th>
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</thead>
<tbody>
<tr>
<td>**Risk Scores for patients presenting with haematuria and UTI excluded. **&lt;br&gt;A <strong>Risk Score of $\geq$3</strong> is justification for <strong>CTU.</strong>&lt;br&gt;</td>
</tr>
<tr>
<td><strong>Risk Factor</strong></td>
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<tr>
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<tr>
<td><strong>Haematuria:</strong></td>
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<tr>
<td>microscopic</td>
</tr>
<tr>
<td>microscopic, persistent</td>
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<tr>
<td>microscopic, unspecified</td>
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<td><strong>Age:</strong></td>
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<td>$&gt;40$-yr</td>
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<tr>
<td><strong>CT KUB unenhanced or US KUB findings:</strong></td>
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<tr>
<td>UTUC</td>
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<tr>
<td>BCa</td>
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<td>renal mass</td>
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<tr>
<td>hydronephrosis, hydroureter</td>
</tr>
<tr>
<td>stone, large, for PCNL planning</td>
</tr>
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<td><strong>Urine cytology:</strong></td>
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<td>atypical / positive</td>
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<td><strong>Occupational exposure:</strong></td>
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<tr>
<td>aromatic amines, etc.</td>
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<tr>
<td><strong>Unable to perform cystoscopy:</strong></td>
</tr>
<tr>
<td>urethral stricture</td>
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SUMMARY OF IMAGING PATHWAY FOR HAEMATURIA

1.1 Under 40-yr with microscopic haematuria
Non-urgent US renal tract only.

1.2 Under 40-yr with macroscopic haematuria
Urgent US renal tract followed by unenhanced CT KUB. Radiologist cancels CT if US yields a diagnosis.

1.3 Over 40-yr with microscopic haematuria
Unenhanced CT KUB followed by US renal tract. Radiologist cancels US if CT yields a diagnosis. (Only those patients over 50-yr with microscopic haematuria and lower urinary tract symptoms constitute an urgent referral).

2 Over 40-yr with macroscopic haematuria
Urgent CTU within 2 weeks.

Non-urgent scans are performed within 6-weeks.
Urgent scans are performed within 2-weeks.

ADDENDUM
Microscopic haematuria must be persistent (i.e. at least two positive out of three urinary dipstick tests, one week apart), and urinary tract infection excluded.
The nature of haematuria must be specified as either macroscopic or microscopic to allow correct categorisation of patients. If this information is not provided on the request form, it will be returned to the requesting clinician.
Patients of any age with persistent microscopic haematuria and normal imaging investigations re-imaging is only justified if there is a significant change in the risk score e.g. they develop urinary tract symptoms or macroscopic haematuria.

MR UROGRAPHY: UPDATE ON CURRENT INDICATIONS
J Leyendecker
United States

Anatomic images of the renal collecting systems, ureters, and bladder are typically obtained with MRI in one of two ways. Static-fluid MR urography is based on heavily T2-weighted sequences that take advantage of the intrinsic contrast of urine. Exploiting urine’s long T2 relaxation time and imaging the urinary tract as a static fluid column, this technique does not require extrinsic contrast material. Static-fluid images can be acquired with a thick slab single shot fast spin-echo technique that takes only seconds to acquire. The acquisition of multiple thick slab images in succession allows visualization of the ureters along their entire length, helpful in confirming a site of stenosis or obstruction. Sufficient time must be allowed to elapse between views to allow for sufficient recovery of magnetization. Static-fluid MR urography cannot discriminate between urine within the urinary tract and other types of simple fluid. Static-fluid MR urography can also be performed using a thin section 3D respiratory-triggered T2-weighted sequence that facilitates detection of small filling defects and creation of multiplanar reconstructions. In either case, it is important to perform static-fluid MR urography sequences prior to the administration of gadolinium-based contrast agents (GBCA) because of the T2 shortening effect of gadolinium. MR urography based on T2-weighted sequences work best for distended collecting systems and can rapidly assess the presence and level of ureteral obstruction. Once the site of obstruction is identified with static-fluid techniques, additional sequences are often required to diagnose the cause. For nonobstructed patients imaged with a static-fluid technique, a full bladder has been shown to improve visualization of the upper collecting systems. Excretory MR urography depicts the urinary tract during the excretory phase after intravenous administration of a GBCA. For excretory MR urography, we perform a coronal breath hold, fat suppressed, three-dimensional (3D) gradient-echo sequence to image the renal collecting systems, ureters, and bladder during the excretory phase. The dose of GBCA administered for excretory MR urography ranges from 0.01 to 0.1 mmol/kg body weight in the literature, and we typically employ a dose of 0.05 or 0.1 mmol/kg body weight. Often, the use of a GBCA can help determine if a ureteral obstruction is partial or complete; however, this technique requires a minimum level of excretory
function to succeed. Given the rapidity with which anatomic imaging can be performed, we routinely apply both static-fluid and excretory techniques and often find them complimentary. The quality of both types of MR urography can be improved with the use of hydration and diuretics. Hydration and diuretic administration improve distention of the collecting systems and augment dilution and dispersion of GBCA throughout the urinary tract. Intravenous hydration is preferred over oral water administration for T2-weighted static-fluid techniques, as fluid-filled bowel loops can interfere with attempts to image a fluid-filled collecting system. The use of a diuretic also improves the temporal window for imaging after GBCA administration by limiting the impact of T2* effects caused by concentrated GBCA in the urine. A low dose of furosemide, typically 0.1 mg/kg or 5-10 mg for adults, usually yields high quality images while allowing the patient to complete the entire examination without needing to void. In our practice, we routinely administer 250 ml of normal saline intravenously and 5 mg of furosemide to patients for comprehensive MR urography, provided no contraindications to hydration and diuretics exist. We have found routine prone imaging and the use of compression unnecessary. A negative oral contrast agent can be used to reduce bowel signal, although this adjunct is optional.

A major advantage of MR urography over other methods of urography is the lack of dependence on ionizing radiation. While CT urography has become the dominant noninvasive technique for imaging the urinary tract, the effective dose for patients undergoing CT urography has been reported to be as high as 1.5 to 2.0 times that of traditional intravenous urography. Ferrandino et al. studied the radiation exposure in acute and short-term management of urolithiasis at two academic centers. During the short-term follow-up of an acute stone event, defined as one year, one fifth of the patients studied received potentially significant radiation doses, estimated at greater than 50mSv. The median total effective radiation dose per patient, considering all radiographic examinations one year following an acute stone event, totaled 29.7 mSv. The authors concluded that, while imaging remains integral in symptomatic urolithiasis for diagnosis and management, efforts must be made to track radiation exposure, minimize dose, and seek alternative imaging strategies, particularly for long-term management. While MR urography remains relatively insensitive for detecting intrarenal calcifications, it has potential to detect ureteral calculi in symptomatic patients and could eventually play a role in the management of urolithiasis in young patients.

Because MR urography is free of ionizing radiation, it has become an important tool in the field of pediatric urology. Given its ability to assess morphology, as well as physiology and function in a single study, it has the potential to replace more conventional imaging techniques, such as radionuclide scintigraphy. In children, the average dose estimate for 99Tcm dimercaptosuccinic acid (DMSA) scintigraphy, based on administered activity and body surface area, is approximately 1 mSv. Furthermore, intravenous urography (IVU) with an average of eight radiographs has a similar dose for infants, but may be twice as high for older children. MR urography has the potential to provide the same functional data as a radionuclide renal evaluation, while offering excellent anatomic visualization of typically complex anatomy. MR urography can also be offered as an alternative imaging strategy to reduce the risk of repetitive radiation exposure in children with symptomatic recurrent urolithiasis. There is growing consensus that MR urography should be the modality of choice for patients with complicated genitourinary anatomy. Payabvash et al. compared MR urography with other imaging modalities for the diagnosis of ureteropelvic junction (UPJ) obstruction, vesicoureteral junction obstruction, ureterocele, ectopic kidney, posterior urethral valves, and polycystic kidney disease. MR urography was the most sensitive modality for diagnosis of congenital urogenital anomalies (86%) compared to IV urography (63%), renal nuclide scan (50%), US (44%), and voiding cystourethrogram (VCUG) (41%). MR urography is helpful in identifying the ureter of a poorly functioning kidney and in detection of occult upper pole moieties and ureteral ectopia. Similarly, MR urography is being used to evaluate the cause and guide management of hydrourephrosis diagnosed prenatally. In the future, MR urography may replace the conventional multi-modality work-up for a variety of congenital urinary tract anomalies, including UPJ obstruction, horseshoe kidney, kidney duplication, kidney hypoplasia and hypertrophy, multicystic kidney, ureterocele, vesicoureteral stenosis, atrophy of the renal artery, and missing kidney. Pregnant patients represent the second major population in whom ionizing radiation exposure is to be avoided. Static-fluid MR urography techniques help differentiate physiologic hydrourephrosis, which occurs as the mid-ureter is compressed between the psoas muscle and the gravid uterus during the latter stages of pregnancy, from pathologic obstruction. Obstruction from stones can present throughout pregnancy and involve any portion of the ureter, most often at the ureteropelvic junction, vesicoureteral junction, or the compressed mid ureter. A transition in ureteral caliber in an unexpected location, periurethral edema, ureteral filling defect, or persistent ureteral dilatation below the normal site of compression during pregnancy suggests the obstruction is not physiologic.
MR urography techniques can be used to limit a patient’s exposure to iodinated contrast agents or to avoid intravenous contrast material altogether. In pregnancy, GBCAs are currently considered class C agents and are to be avoided unless their potential benefits are considered to outweigh their potential risks. The risk of nephrogenic systemic fibrosis (NFS) should be considered before administering GBCAs to patients with severe renal insufficiency. In both of these patient populations, static-fluid techniques may be sufficient to diagnose non-physiologic obstruction and guide management. In patients on dialysis with minimal residual renal function, intravenous hydration is inadvisable and excretory urography is unlikely to succeed.

In patients with mild to moderate renal insufficiency or in patients with recent renal transplant, MR urography techniques can be used to avoid exposure to iodinated contrast media. Blondin et al. compared the diagnostic accuracy of static-fluid MR urography to contrast-enhanced MR urography in patients with renal transplant failure. The subjective image quality of contrast-enhanced MR urography was significantly better than static-fluid sequences; however, there was no statistically significant difference in diagnostic sensitivity. When administration of a GBCA is deemed necessary in a patient with severe renal insufficiency, a low dose of contrast media can be considered. Doses as low as 0.01 mmol/kg of gadopentetate dimeglumine have been used for excretory MR urography.

Hematuria is a common symptom that frequently leads to imaging. The relative insensitivity of MR urography for the detection of calcification and concerns regarding its ability to detect small urothelial neoplasms have prevented MR urography from becoming a first line technique for the evaluation of hematuria. While urinary tract calculi do not typically produce an MR signal, secondary signs of renal and ureteral calculi, such as filling defects, perinephric or periureteral edema, and ureteral caliber transition are often detectable with MR imaging techniques. There is improved sensitivity of calci
detection with diuretic-augmented excretory MR urography when compared to static-fluid techniques, with sensitivity for the detection of ureteral calculi in excess of 90% in some reports.

The potential of MR urography for diagnosing urothelial carcinomas in high-risk patients with con	raindications to standard urologic evaluation has been demonstrated. However, there is a paucy of studies evaluating the sensitivity of MR urography for the detection of small urothelial neoplasms. Takahashi et al. retrospectively evaluated the detection of small urothelial tumors measuring less than 2 cm by MR urography. Gadolinium-enhanced MR urography detected 74% of small urothelial carcinomas studied. While some tumors were visible on T2-weighted sequences, most were seen on nephrographic or excretory phase images, which were deemed essential for evaluation of small urothelial carcinomas.

Because of the relative paucity of experimental data available at the present time, further research into the sensitivity of MR urography techniques for the detection of clinically significant calculi and small urothelial tumors is necessary before MR urography can be considered a first-line technique for the evaluation of hematuria.

At most centers, MR urography focuses on anatomic imaging of the urinary tract. It is likely that a number of recent advances in MR imaging will soon become integrated into standard MR urography protocols, serving to increase spatial resolution, improve lesion detection rates, and permit the routine acquisition of functional data.

If MR urography is to supplant CT urography for anatomic imaging of the urinary tract, there must first be a significant improvement in the SNR of current systems. The SNR places constraints upon the temporal and spatial resolution achievable at a given field strength. One of the simplest, albeit costly, ways to improve the SNR is to increase field strength. Moreover, there is evidence to suggest that at 3.0 Tesla the conspicuity of gadolinium enhancement increases relative to 1.5 Tesla, potentially augmenting the detection of enhancing lesions. Despite this theoretical potential, to date there has been only one study specifically comparing MR urography at 1.5 and 3.0 Tesla in an animal model. Regier et al. found that MR urography at 3.0 Tesla allowed for significantly improved SNR and image quality compared to 1.5 Tesla, especially helpful for delineating the pelvicicalceal system. Of course, there are also disadvantages in increasing field strength in the form of worsening susceptibility and chemical shift artifacts, greater signal intensity variation across large fields of view, and increased specific absorption rate. While adjustments in bandwidth and echo time, the use of parallel imaging, and application of novel pulse sequences designed to compensate for the increase in SAR and T1-relaxation times can improve image quality and shorten acquisition times, many adjustments come with the price of decreased SNR.

Diffusion-weighted imaging (DWI) has been applied to a variety of malignant neoplasms of the abdomen and pelvis, including those of the urinary tract. Takeuchi et al. looked at DWI and corresponding apparent diffusion coefficients (ADC) in twenty upper urinary tract cancers. They found high signal intensity on DWI in all studied urinary epithelial cancers. The corresponding ADC of urinary
cancer was significantly lower than the ADC measured in the lumen of the ureter or renal pelvis. They concluded that DWI is useful in both tumor detection and evaluation of tumor extent. Estimates of glomerular filtration rate can be obtained from dynamic contrast enhanced MR imaging and can be integrated into a standard MR urography protocol. However, such techniques remain largely investigational, awaiting dissemination of time-efficient co-registration and segmentation software and adoption of optimized kinetic models. Estimates of GFR can vary widely depending on the compartmental model used, the accuracy of the segmentation technique, image quality, and patient condition. In the future, it is possible that additional techniques such as blood oxygen level-dependent (BOLD) MR imaging, arterial spin labeling (ASL), and MR spectroscopy will allow routine noninvasive assessment of renal perfusion, oxygenation status, and metabolism.

In addition to providing functional information about the kidneys, MR has the potential to assess ureteral function. A recent study by Kim et al. demonstrated the use of a data-sharing 3D gradient echo sequence with spiral k-space filling to evaluate ureteral peristalsis. The ability to quantify peristaltic frequency of the ureter could offer a new noninvasive method of assessing acute or chronic obstruction, primary megaureter, vesicoureteral reflux, prior surgery, and abnormal ureteral implantation.

References
Towards Guidelines on Imaging of Hematuria

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Isolated hematuria depends on numerous nephrologic and urologic conditions. Diagnostic approach relies on preliminary clinical assessment, urine sediment, cytology, cystoscopy and/or imaging. As to imaging concerns, it is important to answer to the following questions:
- when to image?
- what to look for?
- what modalities to start with?
- how and when to investigate further?

Many multidisciplinary guidelines on this topic have been produced from different countries between 2001 and 2009 (1-8), trying to answer to these questions.

What to look for with imaging? Imaging can detect neoplasms (renal tumors, tumors of the collecting system and bladder, other neoplasms along the urinary tract), urolithiasis, inflammatory disease, and other pathologic conditions (vascular, obstructive, prostatic …).

When to image and what modality to start with? How and when investigate further? The recommendations of the various guidelines on this regard are in part discordant. Imaging is indicated in patients with gross hematuria, but there is no evidence as to the optimal approach. Considering patients with microscopic hematuria, there is no evidence to indicate which of them require urological and imaging evaluation, or which is the best approach. Moreover, there are different definitions of microscopic hematuria with different levels of risk for significant disease.

The available modalities to image patients with hematuria are ultrasound (US), CT urography, IV urography, MR urography. The current indications and limitations of the different imaging modalities will be presented and the recommendations of the latest international guidelines will be discussed, remembering that current guidelines are not-evidence based, and that they depend in part on local economic and cultural factors.

Considering the contribution of US, this technique can detect kidney cancer, cancers of the collecting system, ureters and bladder. It can also detect lesions in other organs and recognize kidneys stones. Moreover, US is able to direct diagnostic investigation towards nephrologic diseases and it can identify vascular disorders. The advantage of using US is the absence of ionizing radiation. However, this technique misses a significant proportion of clinically relevant lesions.

CT urography is an accurate test for the detection of renal, urothelial and vesical neoplasms. It is possibly superior to IV urography, although direct comparisons between the two techniques are lacking. However, the protocol is not yet standardized, as different examination and contrast medium administration protocols are used (9). It is an effective investigation, although the radiation dose is relatively high, and it is becoming the method of choice for hematuria, supplanting intravenous pyelography, even though their appropriateness ratings are the same (8).

MR urography is a useful tool for evaluating hematuria in children or during pregnancy, due to the lack of ionizing radiation. It is also of value in case of contraindication to CT urography, such as in patients
with allergy to iodinated contrast material, and it can be used in the serial follow-up in young subjects (9). However, it is inferior to CT urography in the depiction of stones and small urothelial tumors and it is more difficult to obtain diagnostic-quality images compared with CT urography. Moreover, there is a limited availability of MR equipment and this technique requires a longer examination time. Further clinical validation is required before MR urography can be proposed as the initial modality in hematuria.

Considering IV urography, this imaging modality has been virtually abandoned in favor of CT urography in Europe, while it is still widely used in the USA and other countries. The American College of Radiology considers it equivalent to CT urography for evaluating patients with hematuria. A survey sent to all 259 members of the Society of Uroradiology (USA) (10), with a response rate of 39% showed that 87% of the members perform CT urography, and that 69% of the members perform CT urography in more than 75% of cases in which urinary tract imaging is requested. 27% of the members have completely replaced IV urography with CT urography, while 13% of members do not use CT urography, but IV urography alone, for various reasons. Only 15% of radiologists who use CT urography know the estimated radiation dose delivered to patients at their institutions.

Guidelines from American Urologic Association say that in patients with gross hematuria IV urography is considered by many the best initial study (1). CT is the modality of choice for detection of stones, infections and solid renal lesions. US allows excellent characterization of renal cysts, while imaging has limited value in the detection of bladder cancer, where there is a need for cystoscopy. In patients with microscopic hematuria, IV urography is again considered by many the best initial study. If CT is chosen, in low-risk patients is enough to obtain unenhanced scan alone if urolithiasis is demonstrated, while it is necessary to obtain enhanced images in all other cases.

British guidelines report that there are insufficient data to draw reliable conclusion supported by evidence of diagnostic accuracy among the different imaging modalities in determining the cause of hematuria (2). Economic considerations suggest that an approach with US, followed by CT urography in patients with negative US and persistent hematuria, may have a good cost-effectiveness ratio. Japanese guidelines suggest that in cases of gross hematuria abdominal US is indicated as the initial imaging test (3). In cases of microscopic hematuria abdominal US is indicated as the initial imaging test as well. Other imaging tests, such as IV urography and CT are suggested if US findings are abnormal.

Finnish guidelines suggest an initial assessment with US and, if necessary, IV urography (4). However, the use of IV urography in children requires careful consideration. Kidney US is safe and, especially in pregnancy, the only recommended investigation. Sometimes additional tests are required such as IV urography, CT urography, angiography and retrograde pielography.

Canadian guidelines report that IV urography and US are the most commonly used modalities (5). However, there are no comparative studies that can help to determine an evidence-based diagnostic strategy. There is limited evidence to strongly recommend one modality. Thus, although US, CT or IV urography are acceptable, taking patient safety (ionizing radiation and exposure to iodinated contrast media), availability and cost into consideration, it is recommended that US be used as the imaging test of first choice.

Kaiser Permanente guidelines (USA) suggest an initial assessment with non contrast renal CT and IV urography, or IV urography and renal US to reduce radiation dose (6). High radiation dose is the major problem that limits the use of CT urography: it is therefore necessary to develop examination protocols that minimize the dose. In terms of costs, the cost of CT urography and of IV urography plus US is similar. There is no consensus that CT urography is superior to IV urography for evaluating hematuria. There is however increasing scientific evidence that this may be the case. CT urography may therefore be used to evaluate patients with hematuria, but special care must be taken to optimize the dose.

Guidelines from British Columbia state that most adults with persistent microscopic hematuria require imaging evaluation (7). Imaging evaluation is not necessary in young women with a clinical picture of cystitis and hematuria that resolves after therapy. For the initial assessment renal US should be preferred to IV urography. Cystoscopy is recommended for all patients with risk factors for bladder cancer and for patients more than 40 years with negative US and persistent hematuria.

Guidelines from American College of Radiology state that hematuria always requires imaging evaluation, with the exception of young women with a clinical evidence of cystitis which resolved after therapy (8). US and chest X-ray are indicated in patients with glomerular disease, to evaluate the kidneys prior to biopsy and to assess associated cardiopulmonary diseases. Some advocate the use of US in selected patients, such as in patients with severe allergy to iodinated contrast media, in children and during pregnancy. Intravenous urography and CT urography represent the leading techniques, with an increasing trend for the latter. US and MRI have secondary roles in selected
populations. With the currently available evidence, in patients less than 50 years upper tract imaging could be performed by US to detect renal cell carcinoma and could be supplemented by ultralow-dose CT to detect urinary tract calculi (11).

In our current practice, in patients less than 40 years with very low risk for transitional cell carcinoma (TCC) the initial assessment is performed with US, followed by a wait and watch approach if US is negative. In patients less than 40 years with low risk and in patients more than 40 years with a medium risk the first approach is US, followed by CT urography if US is negative and symptoms persist. In patients more than 40 years with high risk for TCC the initial assessment is performed with CT urography, followed by specialist referral.

Considering the patients with hematuria, the question to be answered is if whether the use of US as initial approach is justified, or if should CT urography be used as the initial study. The answer cannot currently be based on evidence. There is the need to search for the most cost-effective strategy, both biological and economic, in patients with different risk levels for urothelial cancer. Based on current scientific evidence abdominal and bladder US is justified as the initial study in patients with low and medium risk of urothelial cancer because it can avoid radiation exposure to young patients when it detect stones or other benign conditions, and it can identify a renal cancer and direct the choice of technique to be used in the subsequent CT study. KP study group is planning to collect sufficient data on the outcomes of patients with hematuria and different risk levels for urothelial cancer to evaluate the clinical impact of imaging and the diagnostic yield of the different modalities.

References
Primary urothelial carcinoma of the upper tract accounts for approximately 5% of all urothelial tumors. It has a propensity for multifocality, which can be synchronous or metachronous, local recurrence and development of metastatic disease, especially with high-grade lesions.

The sensitivity of urinary cytology for detecting upper tract urothelial cancer may be as low as 29% (1). Thus, confirmation of the diagnosis of upper tract lesions is performed either by endoscopic inspection of the upper urinary tract and biopsy of suspicious lesions, or by fluoroscopically directed retrograde pyelography and brush biopsy; visual assessment alone at ureteroscopy was inaccurate in 30% of the cases in one reported series and biopsies remain essential for accurate grading of upper tract TCC (2).

Flexible ureteroscopes allow reliable assessment of the entire collecting system, but ureteroscopy of the proximal collecting system is associated with more complications such as perforation and strictures, than is endoscopy of the more distal urinary tract.

Treatment of upper tract TCC is primarily guided by the stage and grade of tumor. As ureteral stump recurrence can be as high as 30-75% for patients with renal urothelial cancer, the standard of care in patients with a normal contralateral kidney and normal renal function is nephroureterectomy with bladder cuff excision. Endoscopic treatment of upper urinary tract tumors is considered for patients with single kidneys, bilateral tumors, or those with preexisting renal insufficiency.

Endoscopic treatment can be performed by retrograde transurethral ureteroscopy or through a percutaneous track (3-5). Electrocautery fulguration or laser resection are used to resect the tumor, and patients may also receive local BCG therapy after the resection. Ureteroscopic treatment of upper tract tumors is not considered adequate therapy for patients with high-grade or invasive lesions. Larger tumors are also better managed by a percutaneous approach (6). Ureteroscopic approach is best considered in patients with smaller tumors (<1.5 cm) which are unifocal, of low grade and superficial (7).

Patients with tumors larger than 1.5 cm have only a 36% likelihood of being rendered tumor-free compared to 91% for tumors smaller than 1.5 cm. Patients with multifocal disease are also more likely (50%) to have incomplete resections (6). Grade 2 tumors are more likely (44%) to recur than Grade 1 tumors (26%). Recurrence of transitional cell cancer following electrocautery fulguration, resection or laser ablation may occur in the renal pelvis (37%), ureter (43%) or bladder (41%) at three-year follow-up (8). The rate of ureteral perforation and stricture has been reported to be 10% and 9% respectively (8).

Percutaneous treatment of upper tract urothelial cancer requires access into an appropriate calyx, followed by biopsy and cautery of the tumor (5). Adjuvant topical therapy can be given after the resection through the nephrostomy track, and some authorities recommend radiation therapy of the nephrostomy track to prevent recurrence due to seeding of the track. Recurrence rates after percutaneous therapy are reported to be 25-30% for low grade tumors, with disease specific survival of 96-100% (70). With higher grade tumors, recurrence rates may be seen in 44% of patients. (9) Following endoscopic management of upper tract urothelial cancer, regular and periodic surveillance is essential. Recurrence is common and nearly one-third of these patients may eventually require nephroureterectomy (10).

In a selected group of patients, minimally invasive strategies for managing upper tract urothelial cancers are an useful alternative to radical surgery.

References
WORKSHOPS

WORKSHOP I

TOPIC: PROSTATE IMAGING: RECENT IMPROVEMENTS
Moderators: R Clements (UK), P De Visschere (BE)

MR OF THE PROSTATE: 3T OR NOT? ENDORECTAL OR NOT?
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3T or not?
Imaging prostate at 3T has been introduced in clinical practice a few years ago, with the expectation that most of the sequences used for prostate at 1.5T would benefit from imaging with higher signal level, higher spatial or temporal resolution. Generally, higher magnetic field strength increases the signal-to-noise-ratio (SNR), which potentially can be used to increase the spatial or temporal resolution of the MR measurements. From a theoretical point of view, working at 3T increases the SNR by a factor of approximately 2. MR has demonstrated itself to be an accurate and useful imaging technique. With 3T, the further clinical gains are expected. However, there are currently a limited number of prospective studies comparing prostate MR imaging at 1.5T and 3T.

Some authors believe that the increased SNR at 3T can obviate the need for the endorectal coil (ERc) and that using only external multi-channel coils would result in better patient acceptance, lower costs, more uniform signal and less compression and deformation of the gland. There are only two studies, published in 2005 and 2007, which directly compared 3T and 1.5T prostate cancer staging. Even this comparison was suboptimal, as use of a phased array coil at 3T was compared to use of a phased-array coil and/or an endorectal coil at 1.5T.

Inferring conclusions on effects of higher field strengths on MR prostate cancer staging remains difficult, as research on this topic is still very premature, as interobserver variability remains high.

Endorectal coil or not?
Currently, most research groups combine an ERc and external pelvic phased-array coils (PPAc) for prostate MR imaging (ERc-PPAc imaging) because this combination provides excellent SNR. However, the use of the ERc has several drawbacks. First, it induces gland distortion and artefacts due to rectal motion and near field flare [1,2]. The air-filled endorectal balloon can also create susceptibility artefacts especially at diffusion-weighted imaging and MR spectroscopy (MRS) [2-4]. Spasmolytic medications have been proposed to decrease rectal movements, signal intensity postprocessing algorithms partially correct near field flare, and the field homogeneity is improved by replacing the air in the endorectal balloon with demineralised water, liquid perfluorocarbon or barium sulphate suspension [3,4]. Nevertheless, none of these solutions is perfect and ERc-related artefacts can be the cause of low image quality in up to 14% of cases [5]. Second, the placement of the ERc is time consuming and a source of discomfort for the patients. Third, the ERc is expensive and its use substantially increases the cost of the examination.

Because of these difficulties, some investigators have used only external surface coils for prostate imaging (PPAc imaging). This solution has rapidly become a common clinical practice both in academic and non academic centres. However, whether it provides similar results as the ERc-PPAc combination for prostate cancer detection/localization and for local staging has not been fully investigated.

References


THE ROLE OF MRI IN PROSTATE CANCER IN FOCAL- AND RADIOTHERAPY AND RECURRENT DISEASE
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The objectives of this lecture are to show the potential role of MR imaging in prostate cancer in minimal invasive focal therapy, in radiotherapy and finally in recurrent disease.

Minimal invasive focal therapy
Since recently therapy of prostate cancer focused on entire gland removal, either with surgery or with radiotherapy, irrespective of the fact if there was, or was not a dominant lesion in only one part of the prostate. Focal therapy like HiFu, cryotherapy, focal thermo-ablation have been there quite some time, but did not really break through. This was due to the fact, that these techniques were guided with imprecise trans rectal ultrasound (TRUS). Thanks to more accurate (MR) imaging and improved focal therapy techniques, more and more urologists and radiation oncologists consider treating only the dominant intraprostatic lesion only. Thus reducing side effects like erectile dysfunction and incontinence. Focal removal of the dominant intraprostatic lesion requires imaging, which accurately localizes the tumor, and reliably determines its aggression and volume.

Localization
Multimodality MR imaging, using a combination of anatomic T2-weighted- and functional techniques like diffusion weighted imaging (DWI), dynamic contrast enhanced (DCE) imaging, and MR-spectroscopy (MRS) are highly accurate in localizing prostate cancer (Fig. 1). Reported localization accuracies for T2-weighted MRI, DWI, DCE and MRS are respectively 67-72, 82-89, 80-90 and 79-84%. The AUC of combined DCE and MRI was 0.90 (Futterer, Radiology 2006). MR imaging is superior compared to TRUS. Therefore, it is recommended to perform a multimodality MRI -which consists at least of T2-weighted MRI, DWI and DCE-MRI in patients with a prior negative TRUS biopsy and a persisting suspicion of prostate cancer. Beside localizing the tumor, multimodality MRI more precisely can obtain information. This information can be used to guide another biopsy to the most aggressive part of the tumor. This can be done by either performing a new TRUS biopsy with knowledge of the multimodality MR images, a biopsy using TRUS-MRI merged images, or a MR-guided biopsy. Multimodality MR-guided biopsy after at least 2 negative prior TRUS biopsies, detected and accurately localized cancer in 59% of cases, with 93% of these tumors being significant (Hambrock J Urol 2010). This MR-biopsy procedure was performed in 30 minutes and the average number of cores was 4. Not surprisingly 57% of the tumors was anteriorly located.

Figure 1: 67 Male with 3 x previous negative prostate biopsies. PSA 33 ng/ml. Normal DRE. Patient received an ERC 3T multi-modal MRI with a subsequent 3T MR guided biopsy of the tumor suspicious lesion. Histological analysis of biopsy showed prostatic adenocarcinoma with Gleason score 4+4 = 8. Endorectal Coil 3T multi modality MRI. On axial T2-weighted (a), ADC maps from diffusion weighted (b), dynamic contrast enhanced (c) as well as hydrogen spectroscopic (d) MR imaging, a tumor suspicious region is seen in the ventral aspect of the prostate. Using a 32 channel coil 3T MRI, MR guided biopsies of this region was performed as seen on axial T2-weighted TRUFISP imaging (e), confirming adenocarcinoma of the prostate.
Aggression
In order to allow focal therapy of the dominant aggressive lesion, a reliable modality should be used to determine if a tumor is significant or insignificant. Beside PSA (<10), PSA velocity (< 0.15), and size
(<0.5cc) aggression is the most important parameter. Any tumor with a primary Gleason 4 component is considered aggressive and should be treated. Thus far for this assessment TRUS-biospy has been performed. Unfortunately this technique yields an underestimation of the Gleason score in 45% of patients. In this respect more and more papers demonstrate the value of DWI. There is a significant correlation between ADC value and Gleason grade. With this technique especially tumors with Gleason 4 component or higher are visualized (Hambrock, Radiology in Press, Mazahari Radiology 2009) (Fig. 2). Also, MRS allows discrimination of high Gleason grade tumors (Zakian Radiology 2005), and to some extent DCE can be helpful. Best is to perform more than one technique: multimodality MRI.

Figure 2: Correlation between DWI and tumors with various Gleason grades

Volume
Thus far MR imaging showed only a limited correlation with tumor volume with prostatectomy specimen. There was over- and underestimation, due to BPH, prostatitis and post-biopsy hemorrhages. Recently, however, promising results have been obtained in using DWI. With this technique a correlation coefficient of 0.60 was found between DWI and tumor volume (Mazahari, Radiology 2009). Especially the higher grade (grade 4) components are accurately determined with DWI.

Staging
When a local therapy is considered, it is important to rule out advanced local disease, such as extra prostatic extension (EPE), and to exclude nodal or bone metastases. Best technique to exclude EPE is endorectal coil MRI either at 1.5 or 3T. Reported sensitivity and specificity for local staging with 3T ERC MRI are respectively 87 and 96% (Futterer, Invest Radiology 2006, Heijmink, Radiology 2007) (Fig. 3).

Figure 3: 60 yr patient with a PSA of 18 ng/ml. He had 4 x previous negative prostate biopsies. The patient received an endorectal coil 3T multi-modal MRI which showed a tumor suspicious lesion in the very apex of the prostate. Additionally atypically positioned and pathologically enlarged lymph nodes were found ventral to the prostate. A 3T MR guided biopsy of the apical lesion confirmed an adenocarcinoma of the prostate with Gleason score 4 + 3 = 7. The lymph nodes found on MRI were subsequently biopsied with transabdominal ultrasound guidance. These were confirmed to contain metastatic adenocarcinoma.

Detection of prostate cancer using multi-modal endorectal coil 3T MRI. On axial (a) and coronal (b) T2-weighted images as well as ADC maps (c) and DCE-MR parametric maps (d), a tumor suspicious region is seen in the apex. Additionally atypically positioned and pathologically enlarged lymph nodes were seen ventral to the prostate on axial (e) and sagital (f) T2-weighted images. MR guided biopsies of the prostate (g) and transabdominal ultrasound guided biopsy of the lymph nodes (h) confirmed prostatic carcinoma.
In nodal staging, unfortunately conventional CT and MRI rely on size criteria. As 70% of metastases in prostate cancer occur in normal—i.e., < 8 mm—nodes, these techniques have a low (30%) sensitivity (Hoevels, Clinical radiol 2008). Thus still pelvic nodal dissection is the mainstay of diagnosis. New promising MR contrast agents like iron oxide nanoparticles (USPIO) have shown to improve sensitivity significantly from 34 to 93%, while specificity remained high 93% (Heesakkers Lancet Oncol 2008). Unfortunately, due to regulatory issues these contrast agents are commercially not available. Diffusion weighted techniques with background suppression (DWIBS) are promising. Especially the combination of DWI and USPIO may be a powerful one. Further investigation in this area is needed (Fig. 4).

Figure 4: 59 yr patient with a PSA of 20 ng/ml, Gleason 4=4 prostate cancer and nodal metastases. (a) Coronal T1-weighted GRE shows 2 normal size nodes (arrows). Right common iliac node is gray, left is black suggesting presence of USPIO-loaded macrophages in left, thus indicating that this node is normal. (b) Merge of T1-GRE image and DWI (b=600, orange) In right node there is diffusion signal, indicating absence of USPIO contrast, thus indicating metastasis. In the left node the DW signal is absent, indicating presence of USPIO.

For bone marrow staging routinely bone scanning is routinely used. However, reported sensitivity and specificity are low: respectively 46 and 32% without, and 63% and 64% with the additional use of conventional plain films. For MRI of pelvis and spine these are 100 and 88% (Lecouvet JCO 2007). Furthermore, if the spine and pelvis do not contain metastases, the chance in prostate cancer that there are isolated metastases outside these areas is almost zero. This imaging of spine and pelvis is sufficient, and time consuming whole body MRI is not needed. Also, here the combination of anatomic and diffusion weighted imaging is promising.
Radiotherapy
Although radiotherapy planning needs to be performed on CT-scan images, MRI offers the advantage, that due to its superior soft tissue contrast, both cancer as well as the prostate can be delineated much better on MRI. The clinical target volume on MRI is >6% smaller, compared to CT. Also, inter-observer variability in delineating the prostate is better with MRI, especially at the apex of the prostate (Roach, IJROBP 1996). Using MRI results in less radiation to the bulb of the penis, thus allowing a higher chance for preserved erectile function.
One of the challenges is to merge MR- with CT-images. For this purpose TRUS implanted gold fiducial markers can be used. Special software programs can merge the MR and CT images, based in three or more fiducials. The fusion inaccuracy at the border of the prostate is less than 1 mm (Huisman, Radiology 2005). Multimodality MR images thus can be merged with CT, enabling IMRT of the on the multimodality MR images functional dominant intraprostatic lesion.
Selective IMRT to lymph nodes still is limited by the lack of adequate methods to reliably detect them. Also here, the most promising technique is USPIO enhanced MRI, merged with CT. For this fusion vessels or bone can be used (Fig. 5).

Figure 5: 55 yr patient with Gleason 4=4, stage T3B N2, M0 prostate cancer. 3D fused USPIO MR and CTA image shows abnormal (red) nodes, and normal (green). Nodes. Based on this image selective IMRT (dose painting) may be given.

Conclusion
With multimodality MRI unique functional information of prostate and its cancer can be acquired, accurately showing where the tumor is located, showing its aggression and where the most aggressive par is located. Also extra prostatic tumor extension or recurrence can be reliably shown. Finally, MRI has a potential value in assessing the lymph node and bone marrow status. This will enable the increased use of limited invasive focal therapy, with less side effects, equal or better therapy results, and less costs.
Challenges are, how to implement these techniques in the routine practice, and how to merge the multimodality MRI information with TRUS, thus bringing the MRI in the urologist office. Also, there is a need for bringing the multimodality MR information to the radiation oncologist and merge the information with CT images.

Appendix: suggested MRI-protocols
A. For detection, localization and recurrence detection: a 30 minute MRI -preferably but not necessarily at 3T- can be performed without ERC, including:
- T2-weighted images in at least 2 directions (including axial)
- axial DWI preferably with addition of high b-value (that is 1500)
- axial DCE with a time resolution of 5 seconds
- post-processing of the data above.

B. For **staging of local extra prostatic disease**: a 45minute MRI -preferably but not necessarily at 3T- can be performed with ERC, including:
- T2-weighted images in at least 3 directions (including axial)
- axial DWI preferably with addition of high b-value (that is 1500)
- axial DCE with a time resolution of 5 seconds
- optional: MRSI (extra 15 minutes)
- post-processing of the data above.

C. For **lymph node and bone staging**: a 30 minute MRI without ERC, including:
- T1-weighted images of pelvis (3D) and spine (sagittal): for bone
- DWI or STIR images of pelvis (3D) and spine (sagittal): for bone
- T2-3D through pelvis: for nodes

D. **Combidx** MRI: 60 minute MRI, through abdomen and pelvis, including:
- T1-tSE or GRE (3D Pelvis, 2D upper abdomen
- T2*-GRE (3D pelvis breath-hold upper abdomen axial and coronal)
- optional DWI 3D through pelvis.

**LOCAL RECURRENTENCE IN PROSTATE CANCER: MRI, PET-CT, TRUS**

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Germany

There are many different treatment options in localized prostate cancer (PCA) today. Radical prostatectomy, radiotherapy, brachytherapy, cryotherapy and highly focussed ultrasound (HIFU) ablation strive for curative treatment and therefore reaching a post-treatment nadir of prostate specific antigen (PSA) level. Depending on the initial tumor stage (TNM), pre-treatment PSA and histolopathologic tumor grading in a subset of patients a post-therapeutic PSA relapse will occur requiring further diagnostic procedures to distinguish between solely local recurrent prostate carcinoma (lrPCA) and/or metastatic spread. PSA relapse is also known as biochemical failure (BC).

After ruling out distant metastases it still is a diagnostic dilemma to achieve a reliable diagnosis and exact position of a local recurrence. Dedicated pelvic magnetic resonance imaging (MRI) can be performed with or without endorectal coil @1.5T or @3T. Additional contrast enhanced or perfusion based sequences, diffusion weighted imaging (DWI) or morphologic imaging complemented by magnetic resonance spectroscopy (MRS) show very promising results. The various MRI based imaging techniques of the pelvis are currently in competition to positron emission tomography combined with computed tomography (PET-CT) using the most recent tracers predominantly based on choline. Providing good results in detecting PCA metastases, PET-CT is still limited in the depiction of early lrPCA. Endorectal ultrasound, in Germany predominantly in the hand of urologists, seems to be less accurate. It may improve with state of the art equipment, using doppler information and especially when ultrasonic contrast media is used.

Before using all these imaging strategies we have to choose the appropriate one and be prepared where and how changes in lrPCA present, depending on the prior therapy and the used imaging modality. It remains unclear whether a histopathologic proof is necessary before starting a focal salvage treatment, e.g. by targeted biopsy, which could be guided by ultrasound or MRI.

The main goal remains the early detection of a local recurrence at a low PSA level providing the best options in further focal treatment and the best outcome.

**Learning objectives:**
1. Definition of PSA relapse and biochemical failure
2. Distinguish patients with high suspicion of lrPCA
3. Choosing the best imaging modality at one’s diposal after ruling out distance spread
4. Comparison and value of latest imaging procedures suitable for detection of lrPCA
4. Findings in local recurrence and resulting treatment options.
Literature
Vees H, Buchegger F, Albrecht S, Khan H, Husarik D, Zaidi H, Soloviev D, Hany TF, Miralbell R (2007) 18F- choline and/or 11C-acetate positron emission tomography: detection of residual or progressive subclinical disease at very low prostate-specific antigen values (<1 ng/mL) after radical prostatectomy. BJU Int 99:1415–1420

MR MORPHO-FUNCTIONAL PATTERNS OF PROSTATE CANCER IN RESPONSE TO THERAPY
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One of the goal of imaging is define and to re-define the response to therapy. MR (morpho and fMRI) is now the most accurate and complete examination in the follow up of the prostate cancer. The multiple parameters obtained from MRS, DWI, DEC-MR can be correlated to biological carcinogenesis process: from apoptosis disregulation to neoangiogenesis. The treatment options actually are represented by standard (RP, EBRT, HT, Brachy,) and ablative approach (Cryo, HIFU, RITA). The common and final effects on neoplastic tissue are represented by atrophy and fibrosis. We can observe diffuse low signal intensity on T2, metabolities decrease on MRS, decrease in blood flow and ADC map modifications. Knowledge of final pattern after RT allow to differentizate between recurrence and response to therapy. Concerning HT it is possible to determine the time- dependent metabolic and angiogenic changes that occur in PC during neoadjuvant approach, defining the optimal time to start the definitive therapy (RT) in each patient.

The therapeutical effect can be observed on Neurovascular Bundle (NVB) using MR Diffusion Tensor Imaging with Fiber Tracking Reconstruction.

In clinical practice monitoring changes during therapy with multifunctional imaging can provide valid information on the in vivo mechanism of action to define the optimal time to start the definitive therapy (RT) in each patient. The clinical implication can improve therapeutical planning and to better select the appropriate second-line treatment.
SKELETAL METASTASES IN PROSTATE CANCER: CURRENT ROLE OF MRI

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Background
Metastases are present in up to 10% of patients at diagnosis of prostate cancer (PCa). Lymph nodes and bones are the initial metastatic sites. Patients with bone metastases are not eligible for local treatment (i.e. surgery or radiation therapy) but for hormono or chemo-therapy, and/or bisphosphonates. Hence, early detection of bone metastases is critical for treatment planning. In most institutions, bone scintigraphy (BS) with 99mTechnetium methylene-bisphosphonate (99mTc-MDP), completed by targeted X-rays (TXR) and/or targeted Magnetic Resonance Imaging (MRI) in inconclusive cases, has been and remains the standard algorithm for skeletal metastases survey in patients with PCa. Albeit more expensive and not as widely available as BS, MRI has been proved more sensitive and specific than BS in detecting bone metastases in PCa and in other malignancies. In addition, MRI appears promising for a quantitative evaluation of a significant proportion of bone metastases, which are currently considered as non-measurable with BS and TXR, owing to their poor spatial resolution.

Approaches: MRI protocols
In early studies, MRI surveys for bone metastases have been limited to a “bone marrow screen” including the spine and the pelvi-femoral area, often called “axial skeleton” (AS-MRI). Despite this limited approach, this survey appears superior to BS and appears reproducible and easy to obtain on most MR magnets, based on T1-weighted sequences. More recently, advances in MRI equipment have allowed the acquisition of whole-body MRI (WB-MRI) images with the same field of view as the BS, without spatial resolution compromises and with a reasonable acquisition time - approximately 30 minutes. Thus, MRI now enables a bone metastases survey of the entire skeleton, including the appendicular skeleton, without irradiation or need for contrast injection. Most teams acquire WB-MRI studies in the coronal plane using T1-weighted images- which remain the cornerstone of bone marrow evaluation – and a T2 sequence (or equivalent, most often a STIR sequence). The development of diffusion-weighted imaging contributes to establish WB-MRI as one of the leading imaging approaches of cancer, challenging other techniques and current multimodality diagnostic algorithms used to stage cancer.

Impact on therapy
Early and more reliable identification of bone metastases has major impact on treatment decisions, thanks to a better definition of the true disease stage by the time of therapeutic decisions. Moreover, AS-MRI and WB-MRI appear promising not only for assessing the presence/absence of bone metastases, but also for quantifying the bone metastatic burden, for example using to the Response evaluation criteria in solid tumours (RECIST) transposed to bone metastases. This possibility is very promising and could drastically impact the therapeutic approach of bone metastases which have been considered as “non measurable” in daily practice of oncology and in clinical trials.

WORKSHOP II

TOPIC: PERCUTANEOUS BIOPSY AND ABLATION OF RENAL MASSES
Moderator: O Hélénon (FR)

THE INCIDENTAL RENAL MASS
C Triantopoulou
Greece

Incidental findings are those unexpected imaging findings that cannot be related to the patient’s presenting symptoms or past medical history. Incidental findings in the kidneys are common and most of them are renal masses. It has been estimated that over half of patients over the age of 50 years harbor at least one renal mass, and often several are found during one radiologic examination such as ultrasonography (US), computed tomography (CT), or magnetic resonance (MR) imaging. The vast majority of incidental renal masses
are benign simple cysts and most can be confidently diagnosed on the basis of cross sectional imaging alone.

Upon the detection of an incidental renal mass, there are many questions that arise and the radiologist has to answer as a member of a decision-making group. At first, conditions that mimic a renal mass (sometimes known as pseudotumors), including hypertrophied parenchyma adjacent to scarred parenchyma and congenital anomalies such as a prominent column of Bertin or lobar dysmorphism, should be excluded. Mass like enlargement of the kidney may also be attributed to trauma, infarction, hemorrhage, infection or even vascular aneurysms.

Once an incidental mass is determined to be a neoplastic process, management depends first on the probability that the renal mass is malignant, and second, on factors related to the patient, such as age, life expectancy, co-morbidity disease, and patient preference. It has to be emphasized that most patients with renal cell carcinoma are asymptomatic and the tumor is diagnosed as a result of an incidental finding on imaging examination performed for non renal origin symptoms.

Concerning cystic masses size is not an important feature of the Bosniak classification; small cystic masses may be malignant and large ones may be benign. Today, particularly with the use of multidetector CT and thin collimation protocols, cysts as small as 5 mm can be characterized with more confidence than in the past as simple cysts by using 3-mm sections with a 50% overlap.

Bosniak has recommended that in otherwise healthy individuals all lesions (cystic and solid) 1.0 cm or larger should be evaluated, but lesions under 1 cm that appear to be simple cysts, that is, a low-attenuation (0–20 HU) mass containing no septations, nodularity, calcifications, or enhancement, can be presumed to be benign and need not be pursued further.

If a solid renal mass is detected in a patient with a known primary malignancy (eg, lung cancer, lymphoma), a metastasis should be considered in the differential diagnosis as well as either a second primary (renal cell carcinoma) or a benign neoplasm. If multiple renal masses are discovered lymphoma, metastatic disease, multifocal renal cell carcinoma and multiple oncocytomas are the main differential diagnoses. Percutaneous biopsy has been shown to be helpful in these patients.

In adults most solitary solid renal neoplasms found incidentally that do not contain fat are renal cell carcinoma. Most angiomyolipomas can be diagnosed by identifying regions of fat within a noncalcified renal mass at unenhanced CT. However, calcified and noncalcified fat-containing renal masses have been reported to be renal cell carcinoma. Chemical shift MR imaging may be used also to diagnose an angiomyolipoma that contains fat cells. Approximately 5% of angiomyolipomas contain little or no fat and appear as small, hyperattenuating (at unenhanced CT), and homogeneously enhancing masses. As a result, they are indistinguishable from a small renal cell carcinoma at CT. However, the MR imaging appearance of clear cell renal cell carcinoma is typically different from that of angiomyolipoma with minimal fat. But, it should be kept in mind that angiomyolipoma with minimal fat and papillary renal cell carcinomas are indistinguishable even on MRI.

Most incidentally discovered renal cell carcinomas are low stage. In addition, it appears that the smaller the cancer, the less aggressive the clinical behavior. However, some investigators have debated this point and have claimed that small cancers may be aggressive. Hyperattenuating, enhancing renal masses may represent other benign tumors that include metanephric adenoma, oncocytoma, and leiomyoma. Although there are some image based features that can be used to raise the possibility of oncocytoma (eg, homogeneous enhancement, central scar at CT or MR), none is sufficiently diagnostic and a tissue diagnosis is needed. However, biopsy results may not be definitive since some renal cell carcinomas have oncocytic features.

Many incidental renal masses are detected during a radiologic examination designed to detect extrarenal disease. Therefore, CT or an MR examination using protocols designed to evaluate renal masses may be needed to characterize the mass fully. MR imaging and biopsy have been found to be particularly useful in preventing benign masses from being inadvertently ablated. DW imaging can be also used to characterize renal lesions; however, compared with CE MR imaging, it is less accurate. DW imaging can be used to differentiate solid RCCs from oncocytomas and characterize the histologic subtypes of RCC and could be a reasonable - albeit less accurate - alternative to contrast-enhanced MR imaging for renal mass characterization in patients with contraindications to gadolinium-based contrast material.

The role of percutaneous biopsy has increased, due in large part to the increasing incidental discovery of small renal masses that can be confidently characterized as enhancing, and therefore solid, neoplasms by using advanced CT and MR imaging techniques. Advances in cytologic techniques, particularly immunocytochemistry, have contributed to the increasing ability to diagnose both benign and malignant incidental tumors percutaneously.
References

BIOPSY OF RENAL MASS LESIONS: WHEN AND HOW?
P Hallscheidt
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With the increasing number of incidentally detected renal lesions the number of small renal masses as diagnostic dilemmas are increasing.

The CT guided percutaneous biopsy is safe and minimally invasive method to sample renal parenchyma. The risks are minimal.

The accepted indications are biopsies of solid lesions or suspicious cystic lesions or the non focal biopsies of renal parenchyma to establish the diagnosis of a nephropathy or transplant rejection.

The pre-procedure workup should include the medical history of the patient, the coagulation and the creatinin level.

The complications of this procedure are rare. The overall mortality rate is about 0.0031% (Smith).

The risk of a perinephric hemorrhage is quite high in hypervascular RCCs with about 90% (Ralls).

The risk of infection is very rare. The procedure is performed under sterile conditions.

Seeding of tumor cells in the biopsy tract is extremely rare with only 7 reported cases.

The reported risk of seeding has decreased with the introduction of coaxial biopsy systems.

The sensitivity of 70% -100% and the specificity of 100% of all renal biospsies is reported (Dechet, Eshed).

References

RENAI M MASS BIOPSY: TECHNIQUE, CHALLENGES, NEW DEVELOPMENTS
VA Sahni
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Learning Objectives
1. To understand the varied techniques available for performing successful renal mass biopsy.
2. To appreciate the challenges associated with renal mass biopsy and solutions for overcoming these.
3. To be aware of new developments available to aid renal mass biopsy.

Abstract
Percutaneous biopsy has long been used to diagnose renal masses. It is a safe and accurate procedure that has an expanding role with multiple established and emerging indications. Successful
renal mass biopsy is contingent upon a detailed understanding of the indications, technique and limitations. This workshop aims to review the techniques available. In particular, the relative strengths and weaknesses of different imaging modalities and the diagnostic effectiveness of renal mass biopsy will be discussed. Topics for consideration will include the relative merits of fine and large needle biopsies in differentiating benign from malignant disease and their ability to subtype and grade renal tumors.

The approach to difficult cases will be reviewed. These will include upper pole, central, anterior and cystic lesions. Cases will be shown that demonstrate the techniques available for obtaining successful biopsy of these challenging lesions and for minimizing complications. Finally a review of technological advances available will be presented. These will comprise the use of MRI, commercially available guidance systems, and advanced cytological techniques.

**RADIOFREQUENCY ABLATION (RFA) AND CRYOTHERAPY**

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Belgium

**Background and Purpose:** The introduction of radiofrequency ablation (RFA) into other fields of surgery has fueled the interest to study its application in small renal masses (SRM). Some controversies remain, however, regarding its oncologic efficacy. We review technical factors and tissue characteristics that influence treatment success, discuss the evaluation of treatment success by post-treatment imaging and histopathology, and highlight intermediate-term oncologic outcomes of recent, larger RFA series.

**Materials and Methods:** A search of the MEDLINE database regarding the treatment of SRM by RFA was performed from 2003 through August 2009. For the purpose of describing technical factors and tissue characteristics that influence treatment success and the evaluation of treatment success by imaging and histopathology, articles were selected when they provided detailed descriptions of one or more of these items. For the analysis of oncologic outcomes, the selection was limited to series in which a minimum of 20 patients were treated and that provided effectiveness based on follow-up imaging.

**Results:** Technical evolutions and correct patient=tumor selection have led to increasingly higher success rates being achieved by RFA. Even though tumor skipping has been described in preclinical studies and early clinical studies, this does not seem to influence final success. Indeed, a 8.6% re-treatment rate has to be taken into account. Accepting this, the final ablative success rate is 93.8% at intermediate-term follow-up. Complications after RFA are less frequent and more often minor compared with surgical series.

**Conclusions:** The present analysis reveals that RFA achieves a high intermediate-term ablative success rate when accepting a 8.6% reablation rate. Complication rates are low and mostly minor. Those facts render RFA an attractive minimally invasive treatment for SRM, especially in the growing elderly patient population with multiple comorbidities. Long-term follow-up data are expected to confirm the role of RFA in the management of SRM.

**WORKSHOP III**

**Topic:** Kidney, Testis, Prostate and Penis: Miscellaneous  
Moderator: P Pavlica (IT)

**ACUTE RENAL COLIC: RADIOLOGY IN PRACTICE**

T Bretlau  
Denmark

Abstract of colleague:  
Unenhanced computed tomography in acute renal colic reduces cost outside radiology department. Lauritsen J, Andersen JR, Nordling J, Thomsen HS  
Departments of Diagnostic Radiology and Urology, Copenhagen University Hospital, Herlev, Denmark (Acta Radiol 2008;49:1182-1186)  
**Background:** Unenhanced multidetector computed tomography (UMDCT) is well established as the procedure of choice for radiologic evaluation of patients with renal colic. The procedure has both
clinical and financial consequences for departments of surgery and radiology. However, the financial
effect outside the radiology department is poorly elucidated.

**Purpose:** To evaluate the financial consequences outside of the radiology department, a retrospective
study comparing the ward occupation of patients examined with UMDCT to that of intravenous
goography (IVU) was performed.

**Material and Methods:** A total of 594 consecutive patients were admitted for renal colic during two 6-
month periods. One hundred seventy-three consecutive patients were examined with IVU in 2000 and
421 with UMDCT in 2005. The only difference between the two groups was the imaging procedure.
The duration of hospital stay and pathology findings were registered.

**Results:** In 50% of the patients undergoing UMDCT, a stone was found; a stone was found or
suspected in 40% of patients undergoing IVU. Patients undergoing IVU stayed significantly longer in
the ward than patients examined by UMDCT (P<0.0001). The new procedure (UMDCT) saved the
hospital USD 265,000 every 6 months compared to the use of IVU.

**Conclusion:** Use of UMDCT compared to IVU in patients with renal colic leads to cost savings outside
the radiology department.

**Key words:** Bladder; calcifications/calculi; CT; spiral; kidney; urinary

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**THE ‘INCIDENTAL’ TESTICULAR MASS: IMAGING, BIOPSY AND TESTIS-SPARING SURGERY**

**V Dogra**

**United States**

Benign lesions of the testes constitute about 2% of all the scrotal lesions detected. High frequency
ultrasound examination can help in characterization and appropriate categorization of these lesions.
Appropriate diagnosis of benign testicular lesions facilitates testes sparing surgery. After attending this
presentation attendee will be:

1. Describe the features of common benign lesions of testes such as tunica albuginea cysts,
   epidermoid cysts, tubular ectasia and cystic dysplasia.
2. Discuss the role of Testicular biopsy.
3. Understand the mimics of testicular benign lesions.

**TRUS AND MRI OF NON-NEOPLASTIC LESIONS OF THE PROSTATE**

**AT Turgut**

**Turkey**

**Benign Prostate Hyperplasia**

Benign prostate hyperplasia (BPH) involves microscopically nodular hyperplasia of the transition zone
(TZ) and the periurethral glandular zone (PGZ) of the prostate. In cases with BPH, an enlarged inner
gland (IG) is visualized as low-echo areas on TRUS. Based on this information, it is easy to distinguish
the hyperplasia of the prostate from the peripheral zone (PZ) of the prostate gland with higher
echogenecity. On US, the capsule located between the enlarged TZ from the PZ is demonstrated as a
rim with its different echogenecity surrounding the TZ. With the use of ellipsoid formula and
multiplication factor as 0.5, the prostate volume may be calculated with a high accuracy from the
values of the largest diameters of width, height and length on TRUS. Then, the weight of the gland can
be estimated, using the fact that 1 ml of prostate tissue is equivalent to 1 g. In clinical practice, a
prostate gland weighing more than 40 g is accepted to be enlarged in men older than 50 years of age.
In patients with BPH, an evaluation of the upper urinary tract using transabdominal US study is a
routine procedure for the exclusion of the possible diagnoses of hydrourereteronephrosis, bladder
trabeculation or diverticulation, elevation of the bladder base and increased PVR.

On the other hand, magnetic resonance imaging (MRI) can demonstrate the stromal type BPH without
any prominent nodular appearance or non-stromal BPH with heterogeneous nodular enlargement of
the TZ. The signal intensity of hyperplastic adenomas on MRI is of low to high signal intensity
depending on the stromal versus glandular tissue content. MRS, on the other hand, has been reported
to be more accurate for the differentiation between BPH and prostate cancer compared with T2
weighted images or DWI.

**Cystic Lesions of the Prostate**
A) Intraprostatic Cystic Lesions

**Prostatic Utricle Cysts;** On TRUS, they are seen as an anechoic midline cystic cavity posterior to the urethra.

**Müllerian Duct Cysts;** These lesions are seen as an anechoic midline cystic cavity posterior to the urethra on TRUS and may extend above the prostate gland. On MRI, the cysts may be hypo-, iso- or hyperintense on T1- and hyperintense on T2-weighted MRI scans.

**Ejaculatory Duct Cysts;** they are secondary to the congenital or acquired obstruction distal ejaculatory duct. Anatomically, they are seen in paramedian location within the prostate on TRUS and MRI. Characteristically, these cystic lesions are round or oval in shape, thin-walled, and unicocular. On MRI, a low signal on T1-weighted and a high signal intensity on T2-weighted images can be detected implying the fluid content of the cysts.

**Retention Cysts;** Retention cysts are true acquired lesions secondary to the obstruction of prostatic glandular ductules. On TRUS, a peripheral, smooth-walled unicocular cyst is frequently observed.

**Cystic degeneration of Benign Prostatic Hyperplasia;** Typically, these lesions are located in the hyperplastic TZ within the hyperplastic nodules of the prostate.

B) Extraprostatic Cystic Lesions

**Seminal Vesicle Cysts;** Seminal vesicle cysts are rare lesions and TRUS and MRI reveal an intraseminal round or oval anechoic lesion adjacent to the prostate gland.

**Cowper’s Duct Cysts;** Typically, a unilocular cyst is located at the posterior or posterolateral of the posterior urethra on TRUS and MRI.

**Vas Deferens Cysts;** Cysts of vas deferens are situated in the caudal direction of the prostate gland.

**Prostatitis**

**Acute Prostatitis;** Classical findings of acute prostatitis on TRUS are the presence of enlarged and round prostate in shape, heterogenous prostate in echogenicity, and prostate with loss of the echogenicity difference between the IG and the PZ. Nevertheless, the main role of US in cases with acute prostatitis is the exclusion of the diagnosis of abscess formation. On MRI, a diffuse decrease of signal intensity or curvilinear lesions with low to intermediate signal intensity can be detected in the PZ.

**Chronic Prostatitis;** On US, stromal fibrosis with a spared area of the inflammatory cell infiltration is seen as a thin and hypoechoic rim at the outer periphery of the prostate. In addition, CDUS can reveal an increased vascularity, possibly due to concomitant inflammatory process in cases with chronic prostatitis. On MRI, a diffuse or patchy decrease of signal intensity can be detected on T2-weighted images.

**Granulomatous Prostatitis;** Granulomatous prostatitis is a rare benign inflammatory process of the prostate presenting as prostatic enlargement and focal or multifocal hypoechoic lesions on TRUS. On MRI, non-specific signal intensity changes can be detected.

**Abscess of the Prostate;** In cases with prostate abscess, the clinical picture involving the symptoms of fever, chills, urgency, perineal pain, dysuria and hematuria is similar to that of prostatitis. Radiologically, TRUS is the best choice for the diagnosis of the prostate abscess, characterized by a focal enlargement of the prostate gland and unilocular fluid collections with septae. If there is an abscess formation larger than 1.5 cm, an urgent surgical drainage is recommended, but smaller ones can be treated with medical therapy. Aspiration of the lesion under TRUS guidance provides both a definitive diagnosis and a correct treatment. MRI usually shows uni- or multiloculated fluid collections with low signal intensity on T1-weighted high signal intensity on T2-weighted images and enhancing rim can be detected on post-contrast images.

**Congenital and Acquired Lesions of the Seminal Tracts**

**Congenital Anomalies of the Seminal Tracts;** Congenital anomalies of the seminal tracts including hypoplasia or absence of the structures may cause infertility in males.

**Ejaculatory Duct Obstruction;** Ejaculatory duct obstruction, a rare cause of male infertility, may be either congenital or acquired. In these cases, the most common causes of the ejaculatory duct obstruction are calcifications or stones along the ejaculatory duct, intraprostatic cysts, and blockage due to scar tissue of various etiology, such as inflammation or trauma. Distal obstruction of the seminal tract may cause the appearances of dilated ejaculatory ducts, and seminal vesicles or vas deferens on TRUS. Seminal vesicle dilatation should be considered in the presence of a seminal vesicle with an anteroposterior dimension exceeding 15 mm.

**Solid Non-Neoplastic Seminal Vesicle Masses;** Solid non-neoplastic seminal vesicle masses are unusual lesions, but unilateral or bilateral involvement of the seminal vesicles by schistosomiasis is possible in some geographic regions of the world. MRI is helpful for the evaluation of complicated cases by means of its multiplanar imaging capability and enhanced soft tissue contrast.
Introduction

Only a relatively limited number of dedicated operators routinely perform penile imaging in the clinical practice, and therefore this field is often considered of limited interest for most radiologists. This consideration could be true for some pathological conditions, but not for all. In fact, patients with traumas, ischemic priapism, inflammation, and other pathologies presenting with penile pain may present at a first aid station, and imaging may be required in emergency. A basic knowledge of the different penile pathologies that might be encountered in emergency is therefore useful for the general radiologist as well.

Penile traumas

The penis can be wounded as a result of various accidents, and in the erect state it is more prone to trauma in the form of penile fracture. Diagnosis of penetrating traumas is usually straightforward and imaging is rarely required, but in the more complex situations which need careful preoperative assessment. In particular, grey-scale and color Doppler US can be useful to identify cavernosal or albugineal hematoma, to assess integrity of the tunica albuginea and of the cavernosal arteries. A variety of lesions may result from injury to the penis including extra-albugineal and intracavernosal hematoma, acute intracavernosal hemorrhage, rupture of the dorsal penile vessels with intact albuginea, isolated injury to the urethra and to the corpus spongiosum, and rupture of the tunica albuginea and of the cavernosal bodies which may be associated to urethral and vascular injury. The most challenging differential diagnosis is differentiating injuries with rupture of the tunica albuginea, that require surgery, from injuries in which the tunica albuginea is intact, that may be treated conservatively. US is able to assess whether the tunica albuginea is intact or not. In case of rupture US is able to detect the exact site of the tear as an interruption of the echogenic line of the tunica albuginea, to determine whether cavernosal tissue protrudes through the defect, and examine for associated hematoma. Recently it has been reported that injury to the erect penis may produce isolated disruption of the penile septum. US evaluation allows early identification of the resulting hematoma, which can be recognized as a well-defined cystic-like area in the septal region. Hematoma aspiration under US guidance is recommended in these patients to prevent circumscribed septal fibrosis. Due to its limited availability, in patients with penile traumas MRI is often not performed in the acute setting, but may be useful to confirm integrity of the tunica albuginea in non-operated patients.

Ischemic priapism

Low-flow, ischemic priapism presents with complete, painful erection lasting several hours associated with increasing anoxia, a rising pCO2 and acidosis. Prolonged ischemia is associated with tissue oedema, necrosis of cavernosal smooth muscle cells and fibroblast proliferation resulting in cavernosal tissue fibrosis and irreversible erectile dysfunction.

At US the corpora cavernosa initially present with the same echogenicity and echotexture observed in patients with normal erection. When the patient is left supine for few minutes without manipulating the
penis, the corpuscule component of the blood into the corpora cavernosa tends to sediment downwards forming a fluid-fluid level. In more advanced situations the corpora cavernosa present with increased echogenicity, probably associated with tissue oedema. Occasionally echogenic material obliterates the cavernosal arteries. Initially glans is turgid, while it is usually flaccid later. In longstanding ischemic priapism wide echotexture alterations of the corpora cavernosa are recognized, consistent with fibrotic changes.

Ischemic priapism is an urological emergency. Prompt treatment is mandatory because recovery of function becomes increasingly unlikely over time. Therapy is based on the underlying cause and will typically follow a pattern of least invasive to more invasive procedures. Penile aspiration and irrigation with saline remains the standard first line management strategy, followed by cavernosal injections of alpha adrenergic receptor agonists. Methylene blue has been shown to be useful as an alternative to alpha agonists. Pain and anxiety also require therapy. If these relatively simple measures fail, surgical intervention is required. A variety of techniques has been described to create a shunt between the glans and corpora cavernosa. Proximal cavernosal-spongiosal shunts are considered only after failure of distal shunting procedures. CEUS may have a role in evaluating shunt patency.

Calciphylaxis
This rare life-threatening disorder is characterized by progressive vascular calcification and ischemic tissue loss in patients with end-stage renal disease. Histological characteristics include small-vessel calcifications of skin, subcutaneous tissue, and visceral organs. These vascular changes promote tissue ischemia that often results in tissue necrosis. Penile involvement has rarely been reported. Clinically the patients present with penile induration and severe pain that are unresponsive to narcotic. US shows widespread calcification of the tunica albuginea, of the cavernosal arteries, and obliteration of the penile vessels. Small calcifications can be identified also within the cavernosal tissue. Angiography and contrast enhanced CT confirm occlusion of the vascular supply to the penis, but are usually not indicated in these severely ill patients with end-stage renal disease. Plain film radiographs and non-contrast CT demonstrate severe calcification of the tunica albuginea and penile arteries.

Thrombosis of the dorsal vein
Dorsal vein thrombosis can be associated with thrombophilia, may result from reduced penile blood outflow in patients with pelvic malignancies, or may follow inflammation, trauma, and intercourse. This condition may also present spontaneously in patients without known risk factors. Patients often present to first aid station complaining of a rod-like painful induration in the dorsal aspect of the shaft. US shows echogenic material within the dorsal and circumflex veins which does not change in shape following compression with the transducer. Dorsal vein thrombosis is usually treated with fibrinolytics, anticoagulation, and discontinuance of sexual activity. Spontaneous resolution usually occurs within 6-8 weeks.

Corporal thrombosis
This uncommon clinical situation is characterized by thrombosis of an isolated portion of a corpus cavernosum, either idiopathic, or associated to a traumatic event. Clinically the patients present with persistent painful swelling of the involved cavernosal portion. Physical examination reveals a firm mass. Complete resolution of symptoms and resumption of normal erectile function is reported in most of cases; conservative management is therefore advocated. Imaging allows differential diagnosis with other penile masses. At US a heterogeneously echogenic mass is identified replacing the affected portion of the corpus cavernosum. At MRI the appearance of the thrombus characteristically varies with time on both T1- and T2-weighted images depending on oxygenation and degradation of its contained hemoglobin.

Inflammation
Penile inflammation caused by infections of glans and foreskin are common pathological entities. Diagnosis is based on clinics, laboratory and microbiological findings. Usually imaging is not required except in cases of severe inflammation with involvement of the corpora cavernosa or abscess formation. Penile abscesses and infection of the corpora cavernosa can be a serious life-threatening complication of intracavernosal drug injection. Other causes include spreading of perineal inflammatory processes, and complicated penile cellulitis or balanitis. cavernous tissue ischemia represents a predisposing factor, in particular, in diabetic patients who may develop severe penile infections after surgical manoeuvres or prosthesis implantation. Cellulitis presents with superficial tissue thickening, inhomogeneous echotexture, and hypervascularization at color Doppler interrogation. Cavernositis presents with markedly increased vascularity of the cavernosal bodies.
Echotexture of the corpora cavernosa may be altered; oedema produces increased echogenicity, while microabscesses present as hypoechoic areas. Penile abscesses present as hypoechoic collections with corpusculated content and internal debris. US is able to define abscess location, evaluate the relationships with the adjacent structures, and guide drainage. The mainstay of therapy of penile inflammation is treatment with appropriate antibiotics. In patients with cavernositis and/or abscess formation treatment includes antibiotics, bilateral corporotomy, debridement, and placement of intracorporeal irrigation and suction drains. Early management of post-injection cavernositis can result in preservation of erectile function with no angulation. Acute purulent cavernositis often fails to respond to conservative therapy, and requires penile amputation. In case of recovery severe fibrotic cavernosal changes usually develop producing irreversible erectile dysfunction.

Primary tumors
The clinical presentation of penile cancer varies from an area of induration or erythema to a non-healing ulcer or a warty exophytic growth. Pain can be present, especially in tumors complicated with inflammation, and patients can therefore present at a first aid station. Diagnosis of primary penile cancer, however, is based on clinical investigation and biopsy. Imaging is indicated for staging only, and it is usually not performed in emergency. US is more accurate than clinical examination to evaluate the local extent of the tumor and presence of pathological nodes. MRI is the gold standard imaging modality for staging primary penile malignancies. Since it provides better contrast resolution than US, the margins between the mass and the erectile bodies are more clearly visualized and better tumor staging is obtained.

Secondary tumors
Invasion of the corpora cavernosa by a malignant neoplasm can present with penile stiffness and severe pain. In these patients US can show circumscribed tumor nodules within the corpora cavernosa or diffuse infiltration of the shaft. Venous stasis can be associated, resulting from infiltration of the normal venous leakage pathways. Direct infiltration of the tunica albuginea can be identified as a tunical interruption at the base of the penis, or in other portions of the shaft. MRI allows an excellent depiction of penile tumor invasion. However, it is not usually required in emergency, since diagnosis is straightforward and only palliative treatment is possible.

Conclusion
A variety of penile emergencies may be encountered in the clinical practice. Although diagnosis is usually based on history and clinics, imaging is confirmatory and often provides clinically useful information which helps in planning patient management. Ultrasound is the imaging modality of choice in evaluating these patients since it is widely available, not invasive, and highly effective. Other techniques such as MRI and CT are indicated in selected cases only.

References
INTRODUCTION

Urolithiasis is a universal problem. The prevalence of urinary stones has progressively increased in the last decades. It is estimated that up to 14% of males and 6% of women will develop stone disease during their lifetime with a recurrence rate of 50% within 5-10 years and 75% within 20 years. Unenhanced computed tomography (CT) has become the gold standard for the evaluation of stone disease in many centers and represents 22% of all CT examinations for the evaluation of acute abdominal pain.

Unenhanced multidetector CT (MDCT) provides information of location and size of calculi and can support treatment decisions. However, it cannot reproducibly predict stone composition, so after treatment of the acute episode detailed metabolic evaluation is indicated. Characterization of renal stones is important for treatment decisions. Uric acid calculi can be treated with oral medication and certain types of stones like cystine and calcium oxalate monohydrate are resistant to extracorporeal shock wave lithotripsy.

Differences in X-Ray attenuation of different materials are well known and the possibility of material characterization applying different X-ray spectra can be achieved and have been studied since late 70s. Technical limitations of the CT at that time prevented the development of routine clinical applications. The biggest constraint was that the dose in the low voltage data was much less than in the high voltage data since only the tube voltage was switched without adapting the tube current. Therefore, the noise level in the low voltage data was significantly higher, which finally hampered and limited the use of dual energy applications at that time.

With the introduction of dual source CT systems, which allows simultaneous DE acquisitions with similar radiation doses to MDCT, the problems have been overcome.

OBJECTIVE

The aim of this workshop is to explain how dual energy works, possibilities and limitations in renal calculi composition determination and to summarize other applications in urogenital radiology.

DUAL ENERGY FOR MATERIAL DIFFERENTIATION: A LITTLE BIT OF PHYSICS

Dual energy CT refers to the use of CT data representing 2 different spectra to display anatomy and pathology in addition to differentiating and classifying tissue composition. Data can be obtained using various hardware and software applications.

Types of dual energy hardware:

1. Sequential acquisition: at 80 kV and 140 kV with single source CT.
2. Rapid kV switching: the X-ray tube is capable of rapid kV and mA modulation, switching from low to high energy at adjacent projections.
3. Sandwich detector: Low energy photons are absorbed in the top layers while higher energy photons are absorbed in the lower layers of detector.
4. Dual source scanner: MDCT with 2 X-ray tubes separated by 90° each one operating at a different energy. This is the most diffused option.

Dual Source CT: The 2 tubes of these new MDCT can be used in different modes:

1. High pitch, cardiac mode or FLASH ® acquisition: both tubes operating at same energy to improve temporal resolution.
2. Obese mode or sometimes called dual source CT mode: both x-ray sources may be simultaneously energized using the same x-ray tube potential, and the resultant data may be appropriately summed prior to image reconstruction.
3. Dual energy mode: Each tube operating using different energy to obtain material differentiation.

How can we get material differentiation with Dual Energy?
The differentiation of material in computed tomography is based on their X-ray attenuation which is caused by absorption and scattering of radiation by the material. Each material has an “optimum” level of energy in which the attenuation is maximum. This level, known as the k edge, increases as the atomic number increases. Most of organic tissues compounds have a low atomic number, with similar k edges, which are far below the energy used in commercial CTs (most use 80 and 140 kVp). But
there are some materials such as Iodine or Calcium with higher atomic numbers with K edges sufficiently high and different from soft tissues that allow differentiation (fig 1).

Fig 1. Graph shows linear attenuation coefficients of iodine and calcium at 56 and 76 kV (the mean photon energy generated from a commercial X-ray tube operating at 80 and 140 kV). There is a large difference in attenuation of iodine but much smaller in calcium. These absorption properties permit material classification.

So these materials with higher K edges will have different attenuation values depending on the energy used and it is this property the one that allows characterization. So there are some substances that have higher attenuation at 80 kV (iodine, bone, metal…), some others have higher UH at 140 kV (fat, plastic, uric acid…) and there is a last group with similar values at both energies (water, soft tissues, blood…) Placing the ct values of the ideal materials in an axis system we can calculate the composition of an “unknown” substances with different amounts of each reference substance depending on its response to each tube energy.

How does it affect to lithiasis characterization?

While calcium oxalate, calcium phosphate and cystine contain elements with high atomic numbers; uric acid and struvite are composed of elements with lower atomic numbers. Therefore, each of the above is expected to have its own attenuation profile. Available software uses the information from both tubes to generate a color-coded image. This image is based on a three material decomposition algorithm. In this algorithm the ideal response of pure calcium, pure uric acid and pure urine (water) is used as the base of the process. The algorithm assumes a mixture of water, calcium and uric acid for each voxel and colors those voxels that show dual energy behavior similar to calcium in blue and those similar to uric acid in red (Fig 2). The rest of the voxels with behaviors different to those 2 remain in gray. In each algorithm only 2 substances can be separated, that is why when using kidney stones algorithm iodine cannot be detected.
DUAL ENREGY CT AND KIDNEY STONES (fig 3)
Differences in X-ray attenuation properties at high and low kVs allow accurate renal stone differentiation between uric acid and non uric acid urinary calculi. In vitro studies showed a sensitivity of 88-100% and accuracy of 93-100%. In vivo studies showed similar values (S: 74-100% and A: 89-100%).

Some articles have been published with in vitro studies with renal phantoms in which further material characterization could be achieved. As far as I know no in vivo studies have been published and differentiation of other compounds apart from uric acid, non uric acid and mixed calculi is not possible with commercial software.

OTHER APPLICATIONS OF DUAL ENERGY IN GU IMAGING:
Detection of urinary stones at pyelographic-phase: the sensitivity varies from 29% for 1-2 mm stones to 100 in 7 mm or larger.
Renal mass evaluation: DECT allows the differentiation between hypeattenuating hemorrhagic cysts and renal cell carcinoma.
Characterization of adrenal masses directly on a contrast CT.
Urothelial tumor detection.

RECOMMENDED LECTURES
ACUTE RENAL COLIC: PRACTICAL STRATEGIES

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I. Overview
A. Helical CT is accepted in the USA as the imaging technique of choice for evaluating patients with acute flank pain in whom renal or ureteral calculi are suspected [1,2].

B. Advantages of CT over excretory urography:
1. No need for intravenous contrast material
2. Prompt diagnosis of urolithiasis, greatly reducing patient time in the emergency room [3]
3. Improved diagnostic confidence [4]
4. Ability to detect non-urologic causes of abdominal pain (e.g., appendicitis, aortic disease) and asymptomatic important findings (e.g., renal cell carcinoma); occur in 10% [5]

C. Disadvantages of CT compared to excretory urography:
1. Generally CT is substantially more expensive than IVP
2. CT may be less accurate in guiding treatment decisions as the degree of obstruction is less clear by CT. However, in a study of 100 patients with urolithiasis, only a few follow-up excretory urograms were deemed necessary, and none of these altered subsequent treatment [6]

D. Stone CT has led to new thoughts on hematuria
1. Prior assumptions on the high sensitivity and specificity of hematuria in identifying patients with ureteral calculi have been overstated. In one study, about 20% of patients with ureterolithiasis did not have any hematuria, while nearly half of all patients without ureterolithiasis had hematuria [7]

II. Technique
A. No oral or intravenous contrast material (interferes with stone conspicuity)

B. Contiguous or overlapping images with slice thickness of 5 mm or less
In a cadaver kidney study as slice collimation was reduced from 5 mm to 1.25 mm, sensitivity increased from 81 to 92% (while specificity remained unchanged) and the accuracy of stone size measurement improved [8]. Thin sections helped distinguish phleboliths from ureteral stones using criteria of roundness and central lucency [9].

III. Diagnosis of urolithiasis
A. Identification of the ureteral calculus
1. CT sensitivity, specificity, and accuracy of 96-100%, 96-100%, and 96-98% [10].
2. Only a few rare types of calculi, such as indinavir stones [11] cannot be reliably detected
3. Diagnosis of renal stones is rarely a problem; ureteral stones can be problematic secondary to confusing calcifications adjacent to the ureter (e.g., arterial calcifications, phleboliths)
4. Definite diagnosis of a ureteral calculus when high density focus (not “calcification”, e.g., a uric acid stone) is clearly identified within the ureter, even if the ureter is not dilated

B. Secondary signs of urinary tract obstruction
1. Strongly suggestive CT findings (the so-called secondary signs of urinary tract obstruction) [12]:
Pelvocaliectasis (67% of adult patients with symptomatic ureteral calculi)

Ureterectasis (67%)

Perinephric or periureteric soft tissue stranding (65%)

2. At least one secondary finding present in over 95% of adults with obstructing calculi [12]

3. Decreased attenuation of the affected kidney (likely due to edema)
   a. In one series [13], in 25 of 26 patients with CT findings positive for ureterolithiasis, the
      obstructed kidney had lower attenuation; in 16 patients, this difference was visibly detectable

4. Secondary signs of urinary tract obstruction may be less frequently present in children
   a. No secondary signs were present in six (40%) of 20 children with urolithiasis [14]

5. Secondary signs of urinary tract obstruction are more likely to be present as duration of patient
   symptoms increases [15]; may explain why secondary signs are absent in some instances
   a. Some signs, such as perinephric or periureteral stranding (commonly seen after 7-8 hours of
      symptoms), only rarely seen within the first two hours

IV. Problems with renal stone CT

A. Problematic pelvic calcifications and their analysis

1. Most frequently encountered dilemma: a pelvic high density focus is detected near but not
   clearly within a ureter and no definite secondary signs are seen
   a. Many of these are vascular calcifications, usually phleboliths, rarely arterial calcifications
   b. Sometimes these represent nonobstructing or minimally obstructing ureteral calculi

2. Imaging signs that attempt to distinguish ureteral calculi from phleboliths:
   1. The rim sign:
      A circumferential relatively uniform rim of soft tissue attenuation around a pelvic calcification
      strongly suggests that the involved pelvic calcification is a ureteral calculus. This rim sign has
      been identified around 50-75% of detected distal ureteral stones, but around fewer than 10% of
      pelvic phleboliths [16,17]. The rim sign is much more commonly encountered around smaller
      calculi (measuring < 4 mm in greatest diameter), possibly because larger calculi may stretch the
      edematous ureteral wall, thereby making it undetectable.

2. The comet-tail sign:
   The presence of linear or curvilinear soft tissue attenuation leading to a pelvic calcification
   suggests that the involved calcification represents a phlebolith. In two published studies, this
   comet-tail sign was observed adjacent to 30-65% of phleboliths, but not adjacent to any ureteral
   calculi [18,19].

3. Geometric shape of calcification:
   While both ureteral calculi and phleboliths can have round/oval shapes, calculi may have
   geometric shapes. In one series, eight (21%) of 38 calculi and none of 146 phleboliths had
   geometric shapes [18]. With 1 mm collimation, geometric shape can be detected in 92% of calculi
   [9].

4. Central lucency:
   Although pelvic phleboliths often have radiolucent centers on abdominal radiographs, central
   lucency has not been typically helpful on renal stone CT. In one study, visible central lucency was
   seen on CT in only 13 (9%) of 146 pelvic phleboliths [18]. However, using 1 mm collimation,
   central lucency was identified in 60% of phleboliths with 100% specificity [9].

5. Attenuation measurements:
   Ureteral calculi tend to have higher attenuation values than phleboliths. Although there is wide
   overlap, only calculi have attenuation measurements exceeding 300 HU [18].

   3. While the above features can be used in an attempt to distinguish between ureteral calculi and
      phleboliths, we have found that they are almost never useful [20]
      a. Why? Because when any of these features is present, the diagnosis of ureterolithiasis or
      phlebolith (based on location of the pelvic calcification and the presence or absence of urinary
      tract dilatation and adjacent stranding) is almost always otherwise obvious. In 0 of 23 patients did
      identification of a rim sign alter the diagnosis [20].

B. “False positive” secondary signs

1. Occasionally, collecting system dilatation and/or perinephric and periureteric soft tissue
   stranding may be present in some patients who do not have obstructing ureteral calculi
   a. In such patients, pelvic phleboliths may lead to a false positive diagnosis of urolithiasis
   b. Other causes of false positive (for stone) secondary signs:
      Non-stone obstruction (e.g., ureteropelvic junction obstructions, ureteral strictures). Acute
      pyelonephritis. Renal vein thrombosis. Residual changes following passage of a ureteral calculus.
   c. Clinical details may help:

V. Using helical CT to predict stone passage
   A. With CT, as with IVP, larger and more proximal calculi are less likely to pass spontaneously [21].
   B. Coronal reconstructions allow CT measurement of the longitudinal stone dimension, which is often larger than the transverse dimension [22], but whether this measurement is helpful in predicting stone passage has been challenged [23].
   C. Using secondary signs to predict the likelihood of stone passage is probably unhelpful
      1. Collecting system dilatation and perinephric soft tissue stranding or fluid did not predict failure of spontaneous calculus passage in one study [3]. In two other reviews [24, 25], severity of some secondary signs (when present) was somewhat predictive.

VI. Following ureteral calculi detected on CT
   A. Sometimes additional imaging may be needed to determine if a CT-detected calculus has passed
   B. Subsequent plain radiographs are frequently unsuccessful
      1. Follow-up radiographs are helpful if the calculus can be visualized on an abdominal radiography obtained at the time that the diagnostic CT is performed, but this is not always needed: Stones visualized on CT scout radiographs are visible on plain radiography [26, 27].
      a. Features of stones on the axial CT slices may predict which stones will be visible on abdominal radiographs [26, 28]: Most calculi measured at 5 mm or larger in maximal diameter on CT and the vast majority of calculi measured at more than 300 HU on CT were visible on plain radiographs. In comparison, the majority of calculi smaller than 5 mm or measuring less than 200 HU could not be identified on plain radiographs. 75% of mid-ureteral stones are not visible on plain radiography.

VII. Risks of renal stone CT
   A. Due to its easy availability and rapid diagnosis, some young patients are being referred for multiple stone CT examinations in short time intervals resulting in high radiation doses [29].
   B. Ongoing efforts encourage reducing the radiation dose of renal stone CT by decreasing exposure factors [30, 31]. While a variety of radiation dose estimates exist, in the United States, the radiation exposure from a renal stone CT, especially at a reduced dose, is likely equal to or slightly less than that of a dedicated excretory urogram [32]. An ultra-low dose CT with exposure similar to a plain abdomen radiograph has been reported to have overall similar diagnostic yield to historical CT in an uncontrolled study [33], and to higher dose CT in a cadaver kidney study [34]. However, stratifying by stone size shows reduced sensitivity for smaller 2-3 mm stones with reduced dose [35].
   C. Although no studies are available to confirm, we strongly believe that patients are receiving more stone CTs than the number of IVPs they received prior to the availability of stone CT. Thus the overall radiation dose to patients appears to be greater, even if the dose per exam is the same or slightly less. However, even among known stone patients, repeat CT will find a non-stone alternative diagnosis in 18% (one-third of these requiring urgent intervention) [36].

VIII. Alternatives to stone CT: Sonography
   A. Advantages: availability, inexpensive, noninvasive, no ionizing radiation, no contrast media required. Disadvantages: less sensitive, operator dependent, patient habitus can interfere.
   B. Sensitivity in detecting calculi is 37-64% and acute obstruction is 74-85% [37]. Detection decreases for stones smaller than 5 mm (where acoustic shadowing may not occur); as low as 13% for stones of 3 mm or less. (Optimize focal zone at depth of suspected stone or slightly deeper.) Contributing is the difficulty in detecting ureteral stones when entire ureter cannot be imaged.
      Park [10] reported 98% detection of ureteral stones, but using a specialized protocol of 8 hours fasting and IV saline; plus selected population: 93% of imaged patients had stones!
   C. A full bladder aids in detecting stones at the ureterovesical junction (UVJ) using the transabdominal approach. Transvaginal, transrectal, and transperineal sonography (including 3D endosonography) can improve the detection of stones at the UVJ [10,37].
   D. Color Doppler Twinkling Artifact: rapidly alternating artifactual red and blue Doppler signals in and behind certain stationary objects with the proper composition. Increases sensitivity in detecting small stones that lack acoustic shadows [10]. False positives include calcifications in vessels, papillae (papillary necrosis, medullary sponge kidney, nephrocalcinosis), or tumors [37].
E. Color Doppler Ureteral Jets: normally 1-12 jets per minute per side. Presence excludes complete obstruction but absence occasionally in nonobstructed patients; continuous low-level flow suggests partial UVJ obstruction; insensitive for low-grade obstruction or nonobstructing calculi [37,38].

F. Resistive index may be helpful in assessing the obstructive nature of a ureteral stone [38,39].

IX. Alternatives to stone CT: MR Urography (MRU)
A. Advantages: noninvasive, no ionizing radiation, can be done without contrast media. Disadvantages: expensive, reduced availability, poor direct visualization of stones though can be seen as filling defects (must distinguish from clots or tumors), patient contraindications to MR such as pacemakers.
B. High accuracy in assessing level of obstruction. Good sensitivity for ureteral stones (90%) when T2-weighted static MRU and gadolinium-enhanced 3D gradient echo MRU are combined [37].
C. Useful when special concern for radiation dose (children, pregnancy) and sonography inconclusive.

References
CT UROGRAPHY FOR PLANNING STONE MANAGEMENT AND FOLLOW-UP

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CT urography is a relatively new diagnostic imaging technique providing comprehensive evaluation of the upper and lower urinary tract. On the basis of promising data, the indications for CT urography have been expanded to include evaluation of patients with hematuria and now there are only few, if any, conditions of the urinary tract for which CT urography is not a highly effective tool. It is now progressively replacing other imaging techniques, especially intravenous urography, which was traditionally used in the pretherapeutic assessment of stone disease. The management of urinary calculi is mainly determined by presenting symptoms, calculus location, stone burden, calculus composition, and spatial relationships with the collecting system. Urinary tract stone disease generally presents with a classic scenario of acute flank pain, for which the appropriate initial imaging evaluation required is unenhanced CT; CT urography is useful in the evaluation of chronic stone disease.
Techniques of CTU
CT urography is defined as a CT examination of the urinary tract obtained before and after administration of iodinated contrast medium (that contains 30-42 g of iodine) and includes excretory-phase images. Unenhanced scans are mainly obtained to detect calculi, but also to provide a baseline attenuation value of any abnormality. Excretory-phase scans are obtained to evaluate the lumen and the wall of the urinary tract and to determine the presence or absence of urothelial abnormalities. In patients with chronic stone disease, unenhanced scans and excretory-phase are essential, whereas vascular-phase scans and nephrographic-phase scans (to optimize evaluation of the renal parenchyma) are optional. Evaluation of the CT excretory-phase images depends on opacification and distension of the urinary tract. Until now, there is no universally accepted technique for performing CT urography. Oral hydration is often inadequate and administration of intravenous furosemide (10 mg 2-3 minutes prior the administration of contrast material) has proved useful to improve middle and distal ureteral opacification and distension compared with intravenous saline alone. Two main techniques of CT urography are available. The three-scan CT protocol includes unenhanced images, nephrographic phase images obtained 100 seconds after administration of contrast material and excretory phase images obtained 10-15 minutes after contrast medium injection. The split-bolus protocol reduces the total number of scans from 3 to 2 and decreases radiation exposure. After the unenhanced images, a 30-50 mL dose of contrast material is administered followed by a delay of 8-10 minutes before 80-100 mL of contrast material is given. A CT scan is obtained 100 seconds after the second dose of contrast material, containing excretory information from the first dose and nephrographic information from the second dose. Slice thickness, reconstruction parameters are not standardized. Various 3D reconstruction techniques can be used for CT urography, including MIP, curved multiplanar reformation, volume rendering, and virtual endoscopy. On CT urographic images, the opacified urine is less dense than stones, and stones are visible within the opacified collecting system.

Imaging information essential in choosing appropriate treatment
In patients with stones, the main therapeutic options include medical treatment, extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), ureteroscopic removal, and open surgery, which was the method of choice for treating these patients in the past. The information most useful for planning treatment is the location of the stone and the stone burden, the composition of the stone, and its spatial relationships with the collecting system.

Stone location. The major predictors for spontaneous stone passage of a ureteric stone are size and position. Unenhanced CT and CT urography both reliably determine the precise location of stones: in the kidney, in the renal pelvis or at the pyeloureteral junction, in the lumbar or pelvic ureter, at the vesicoureteral junction or in the bladder. Stone burden. Measurement of stone burden at CT is used to predict the rate of spontaneous passage of ureteral stones, to plan treatment and to predict treatment success, particularly for ESWL. The most common method of assessing stone burden is measurement of stone size (greatest dimension, or more precisely stone surface and volume). It is more precise with CT than with conventional radiography, as shown by Narepalam et al. (9). The most accurate way to measure urinary stones is to use bone windows settings with magnification. The volume of stones can be given on 3D images with a precision exceeding 4.8%, according to Olcott et al. (10).

Stone fragility. The fragility of stones at ESWL seems to be correlated with their internal morphologic features. Heterogeneity in stone composition renders a stone susceptible to fragmentation with treatment while homogeneous stones tend to be more rigid and therefore harder to break with ESWL, often requiring more treatment sessions. The internal structure of stones is best appreciated when viewed with bone window settings and when imaged at high resolution with thin sections.

Stone composition. The choice of effective clinical management of urinary tract calculi can be facilitated by knowing the precise chemical composition of the stones and their corresponding fragility. Typically, pure stones composed of calcium oxalate monohydrate and brushite or cystine are relatively refractory to shock wave lithotripsy and percutaneous ultrasonic lithotripsy, and are more likely to be treated endoscopically whereas uric acid stones are usually treated with oral alkalization. Calcium oxalate dihydrate and struvite stones usually fragment easily with both shock wave lithotripsy and ultrasonic lithotripsy. Bellin et al. (1) have shown in vitro that single-energy multidetector CT can be used to characterize and stratify calculi of various chemical composition with 64%-81% accuracy. Differentiation among stones is less reliable in vivo, because it is dependent on the size, accurate placement of the region of interest, slice thickness, and whether stones are of pure or mixed composition. In vivo, CT attenuation measurements have been shown to be most valuable in allowing differentiation of 100% uric acid.
stones from other stones. Dual-energy CT shows great promise in the determination of stone composition.

**Predisposing conditions and anatomic variants.** Congenital anomalies of renal position, number, and form of the urinary tract can predispose to stone formation and are easily appreciated with CT urography. CT urography may be useful to delineate a calyceal diverticulum and show its communication with the collecting system; it may also demonstrate renal tubular ectasia. Duplications of the collecting system are more obvious on a single coronal image that depicts the collecting system in its entirety than on conventional axial CT images. Horseshoe kidneys are also nicely depicted with CT urography. Furthermore, CT urography can identify other entities frequently associated with stones, including UPJ syndrome, congenital megaureter, ureterocele, stenosis or extrinsic compression of the urinary collecting system, and some diversions.

**Complications of stones.** They include urinary tract obstruction proximal to stones, chronic calculous pyelonephritis, and xanthogranulomatous pyelonephritis. CT urography can reliably detect signs of obstruction: early fornical blunting, dilatation of the renal collecting system, renal parenchymal atrophy. It may also show infectious complications of stones, including pyelonephritis, renal abscess and pyonephrosis. Information about urinary obstruction and infection has a major influence over whether and how to treat stones.

**Treatment planning.** CT can be useful in the presurgical planning of interventional procedures such as PCNL. It may assist in the selection of an appropriate calyx for percutaneous access and of a safe path for puncture by depicting the relationships of the kidney to various surrounding organs such as the spleen, liver, and colon. Knowledge of pelvicalyceal anatomy is critical for renal stones of >1 cm in diameter, as the infundibulopelvic angle, infundibular length and width are all important determinants of outcome. When PCNL is planned, these variables are essential in deciding the most appropriate angle and calyx for percutaneous puncture. Several authors have highlighted the value of the SSD (as measured from the center of a stone to the skin surface on axial CT) as a reliable predictor of stone-free status following ESWL for lower pole renal stones, but this remains controversial.

**Follow up**

The main objectives of imaging are threefold: to confirm stone-free status, to identify the presence of residual stones, and to rule out urinary obstruction. Most series on ureteroscopy or percutaneous nephrolithotomy use postoperative plain radiography of the kidneys, ureters and bladder (KUB) or ultrasound (for renal stones) to determine outcomes. However, in a recent series of 92 patients who underwent 113 ureteroscopic procedures for either renal or ureteral stones, Macejko et al. (8) reported that the overall stone-free rates by CT were lower than stone-free rates reported by KUB or IVU criteria. These authors concluded that the significance and natural history of residual stones fragments on CT scan after ureteroscopy needed to be addressed in further studies.

**Conclusions**

CT urography with high quality multiplanar reconstructions and advances in three-dimensional reformatting is able to provide accurate information about the presence, size, and precise location of a urinary stone. It may also accurately map the pelvicalyceal system and complex renal calculi. Since urinary stone disease is often a recurrent disease, the radiation risk should be minimized by taking appropriate measures, especially in young patients. CT urography currently plays a major role in the management of patients with urolithiasis, from the initial diagnosis to treatment planning and posttreatment evaluation.

**References**


STONE-RELATED RENAL INFLAMMATORY DISEASE: DIAGNOSIS AND PERCUTANEOUS TREATMENT
P Nikolaidis
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Xanthogranulomatous Pyelonephritis (XGP)
- Rare chronic destructive granulomatous process
  - Thought to result from an atypical, incomplete immune response to subacute bacterial infection
  - In a collecting system with longstanding partial obstruction (stones, stricture rarely, uroepithelial tumor)
  - Proteus mirabilis, E coli, Klebsiella, Pseudomonas
- Progresses to replacement of kidney parenchyma by xanthoma cells
  - Lipid-laden histiocytes
- Typically middle-aged women
  - Recurrent UTIs, diabetes, kidney stones
- Classic triad: staghorn calculus, decreased or absent renal enhancement and poorly defined mass or renal enlargement
- Inflammatory process usually diffuse, can extend beyond the kidney
  - Diffuse form common (85%)
  - Focal (solid mass) form is difficult to differentiate from neoplasms on imaging

XGP – CT Findings
- Hydronephrosis/renal enlargement
- Renal calculus
- Pyonephrosis / inflammatory collections
  - Ovoid hypodense cavities in the parenchyma and collecting system
- Renal cortical atrophy
- Decreased/absent contrast excretion
- Abscess (perirenal/psoas)
- Perinephric fat accumulation
- Cutaneous fistula

XGP – Treatment
- Definitive diagnosis → histologic confirmation
- Definitive treatment → open radical nephrectomy
- Before surgery can be attempted, obstruction should be relieved fluid collections / pus should be drained through percutaneous nephrostomy

Staghorn Calculi and Struvite Stones
Staghorn calculi
75% “Struvite stones”
- Named by Georg Ulix after Baron von Struve
  - Also known as:
    - Triple-phosphate stones (3 cations - Ca\textsuperscript{2+} Mg\textsuperscript{2+} NH\textsubscript{4}\textsuperscript{+} associated w. 1 anion - PO\textsubscript{4}\textsuperscript{3-})
    - Infection stones
    - Urease stones
  - Less commonly composed of uric acid or cystine
Only rarely calcium oxalate or phosphate stones

Composition
- Struvite (magnesium ammonium phosphate)
  - Precipitates at urine pH>7.2
- Carbonate apatite
  - Crystallizes at urine pH>6.8

Pathophysiology
- UTI infection by urease-producing bacteria a prerequisite
  - Proteus sp., Ureaplasma urealyticum most common
  - Staphylococcus, Klebsiella and Pseudomonas species
  - Escherichia coli do not produce urease; not associated with struvite stone formation
  - Several other common bacteria do not produce urea including Citrobacter freundii, enterococci, and streptococci

Pathogens: Urease Producing Organisms

<table>
<thead>
<tr>
<th>Organisms</th>
<th>Frequently (&gt;90% of Isolates)</th>
<th>Occasionally (5%-30% of Isolates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram negative</td>
<td></td>
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<tr>
<td>Proteus rettgeri</td>
<td>Klebsiella pneumoniae</td>
<td></td>
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<tr>
<td>Proteus vulgaris</td>
<td>Klebsiella oxytoca</td>
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<tr>
<td>Proteus mirabilis</td>
<td>Serratia marcescens</td>
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<tr>
<td>Proteus morganii</td>
<td>Haemophilus parainfluenzae</td>
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<tr>
<td>Providencia stuartii</td>
<td>Bordetella bronchiseptica</td>
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<tr>
<td>Haemophilus influenzae</td>
<td>Aeromonas hydrophila</td>
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<tr>
<td>Bordetella pertussis</td>
<td>Pseudomonas aeruginosa</td>
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<tr>
<td>Bacteroides correndens</td>
<td>Pasteurella species</td>
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<tr>
<td>Yersinia enterocolitica</td>
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<tr>
<td>Brucella species</td>
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<tr>
<td>Gram positive</td>
<td>Staphylococcus epidermidis</td>
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<tr>
<td>Staphylococcus aureus</td>
<td>Bacillus species</td>
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<tr>
<td>Micrococcus</td>
<td>Corynebacterium murium</td>
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<tr>
<td>Corynebacterium ulcerans</td>
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<td>Corynebacterium equi</td>
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<tr>
<td>Corynebacterium renale</td>
<td>Peptococcus asaccharolyticus</td>
<td></td>
</tr>
</tbody>
</table>
Mycoplasma T-strain Mycoplasma
Ureaplasma urealyticum

Yeasts
Cryptococcus
Rhodotorula
Sporobolomyces
Candida humicola
Trichosporon cutaneum

Pathogenesis
• Struvite stones are comprised of magnesium ammonium phosphate
• Are caused by urea-splitting bacteria
• Urea splitting produces ammonia and carbon dioxide and makes the urine alkaline
• The highly alkaline state results in the precipitation of apatite and hydroxyapatite

Risk Factors
• Patients with recurrent/persistent UTIs and urinary retention
  – Obstruction
  – Chronic indwelling catheters
  – Neurogenic bladder, voiding disorders
  – Urinary diversions
  – Distal Renal Tubular Acidosis (RTA Type I)
  – Medullary Sponge Kidney

Clinical Manifestations
• Often insidious onset
• Many patients asymptomatic
  – May present for evaluation of:
    • Recurrent UTIs / hematuria, abnormal urinary sediment
    • Vague abdominal symptoms
    • Fever & urosepsis
• UA: Alkaline urine with struvite or apatite crystals, +/- active UTI
• Natural Hx: Progressive morbidity and mortality
• Without definitive treatment 30-40% progress to renal failure

Treatment Goals
• Complete removal of stone fragments
  – Stones harboring bacteria cannot be penetrated by systemic antibiotics
• Eradication of infection
• Once stone-free: prevention of future recurrence important

Pathogenesis diagram:
- UTI with urea-splitting organism
- Urease synthesis
- Urea to H₂O, N₂, NH₃, CO₂
- Ammonium NH₄⁺ in alkaline urine
- Precipitation of apatite/hydroxyapatite
- Crystals grow in bacteria, microlith formation
- Bacteriolyis
- Nidus for stone formation
- Struvite-apatite dust crystallized in/around bacteria

Antibiotic therapy: maintenance of sterile urine

**Medical Therapy: Urease Inhibitors**
- Aceto-hydroxamic Acid (AHA or Lithostat)
  - Complete non-reversible, non-competitive inhibition of urease → preventing supersaturation of struvite
  - High rate of severe neurologic, dermatologic, and hemologic side effects

**Medical Therapy: Dissolution therapy**
- Dissolve via ureteral catheter or PCN tube
- Hemiacidrin (Renacidin) = citric acid, magnesium oxide and sodium carbonate with d-gluconic acid
  - Enhanced stone dissolution by ion exchange with Ca²⁺
  - Urine pH <5.5 allows increased struvite solubility
    - Don’t use in active UTI or flank pain or renal colic
    - Monitor serum magnesium levels to avoid hypermagnesemia
    - Maintain low intra-renal pressure<25 cm H₂O

**Medical Therapy**
- Tiselius et al. 1999
  - 118 patients → combined Shockwave Lithotripsy (SWL) and percutaneous dissolution
  - Overall stone free rate 60%
  - Mean 3.4 SWL treatments
  - Mean hospital stay 32 days
  - Low complication rate
- Conclusion: Feasible alternative in high risk patients when invasive/definitive procedures are not possible

**Shockwave Lithotripsy**
- Stone free rates vary widely—23-86%
  - If stone surface area <500 mm² approaches efficacy PCNL
  - If surface area>2.5 cm² not effective
- Need for second procedure 42%
- Significant morbidities
  - Complication rate: 31%
  - Steinstrasse obstruction, renal colic, sepsis, perinephric hematoma
- Should not constitute monotherapy
- Best suited for pediatric patients

**Ureteroscopy**
- Stone free rates lower than PCNL
- May be adjunctive treatment in conjunction with PCNL
- Can be used in combination with PCNL to avoid multiple percutaneous tracts
- May be used as monotherapy in pts. with modest stone burden who are not suitable candidates for PCNL

**Anatrophic Nephrolithotomy (AN)**
- Open surgical removal of staghorn
  - Requires clamping of renal artery, incision and reconstruction of collecting system
  - Only used in cases where multiple PCNL +/- ESWL required
  - Anatomic abnormalities
    - Infundibular stenosis
    - Poor compliance
    - Morbid obesity

**Percutaneous Nephrolithotomy**
- Treatment of choice
- Overall complete clearance rate up to 93%
  - 98.5% partial
  - 71% complete staghorns

**PCNL vs. Open Surgery (AN)**
- Prospective trial by Al-Kohlany et. al. 2005
  - 88 complete staghorns randomized to PCNL/AN
  - Similar stone free rates: 49-66% @ discharge, 74-82% @ 3 mos.
  - PCNL: ↓ transfusion rate, ↓ intraop complications, ↓operative time, ↓hospital stay, earlier return to work

**PCNL vs. SWL**
• PCNL vs. SWL: Meretyk et. Al. 1997
  – Patients radomized: 27 SWL vs. 23 PCNL
  – Stone free rates 3x greater in PCNL group: 74% vs. 22% (p=0.0005)
  – More complications and ancillary procedures in SWL group

Treatment Recommendations
• American Urologic Assoc. Guidelines
  – PCNL= 1st line Tx for most patients
  – Stone free rate = 78% for complete staghorns vs.
    • 71% Open Surgery, 54% SWL monotherapy
  – Patients will require avg. 1.3 PCNL procedures
  – Obtain f/u imaging to ensure patient is stone free
  – Postop Abx to treat any UTI source
  – Monthly serial cultures to ensure sterile urine for 1 year postop
  – Best defense against recurrence: treat chronically infected urine and eliminate any stone fragments

Summary
• Staghorn calculi=large stones that fill renal pelvis and majority of calices
  – Composition: pure struvite or struvite+carbonate apatite
  – Strongly associated with urease+ bacteria
  – Left untreated → damage renal function
• AUA Guidelines: Eradicate causative organisms, relieve obstruction, prevent stone growth & associated infection, preserve kidney function
• PCNL = First line Tx
• Following treatment → periodic surveillance with imaging and UA to rule out recurrence

References
Xanthogranulomatous pyelonephritis
Struvite/Infectious stones
LECTURES SESSION VIII

**TOPIC: FUNCTIONAL MRI**

Moderators: P Choyke (US), BK Hamm (DE)

**FUNCTIONAL MRI OF THE KIDNEY**

N Grenier  
France

The management of acute and chronic renal diseases requires having an access to several physiological parameters using simple and reliable tools. Unfortunately, renal physiology is complex and measurements of these parameters are either impossible or often too complex to implement on a regular basis, or not reliable enough. Renal perfusion and glomerular filtration rate (GFR) are major functional parameters which are involved in many parenchymal diseases and used to monitor the renal function. Getting an easy, reliable and reproducible access to these data, in conjunction with precise morphological information, would significantly improve the patient care in nephrology. For example, actually, measurement of perfusion in clinics is not reliable and no reference method is available for patients. Noninvasive and accurate measurement of renal perfusion could have a major impact in understanding physiopathology of renovascular diseases and for their follow-up. Similarly, GFR is used as an index of functioning renal mass, representing the sum of filtration rates in each functioning nephron. Fall of GFR may be the earliest and only clinical sign of renal disease and its serial monitoring allows estimating the severity and following the course of kidney diseases. Its evaluation is most of the time only estimated, because accurate measurement requires implementing complex methods of plasma or urinary clearance. Approaches provided by imaging are promising because simple to implement and flexible but many technical and theoretical limitations still precludes their diffusion in clinics.

1. **Contrast agents and technical issues**

Depending on the chosen method, intrinsic (as moving protons or deoxyhemoglobin) or extrinsic contrast agents are used. The former are devoted to study renal blood flow, renal perfusion, renal diffusion and renal oxygenation. The later are devoted to study renal perfusion and renal filtration [Grenier, et al.2003].

Regular low-molecular-weight gadolinium (Gd) chelates are still the only extrinsic agents used in clinical imaging. As iodine contrast agents they can also be considered as glomerular tracers. However, their role in evaluation of renal function shows some limitations: first, as the other mentioned agents, they are also freely diffusing into the interstitium, compartment which is usually neglected in most pharmacokinetic models; second, the relationship between signal intensity (SI) and concentration is highly complex, inducing concomitant reduction of T1 and T2 (or T2*), which is not the case for radioactive agents or iodine compounds.

Concentration of agent can be calculated by the linear relationship to the R1 relaxation rate and the specific relaxivity of the agent (r):

\[ C = \frac{(R1- R10)}{r}, \]

where R10 is the bulk R1 in the tissue without contrast agent. In principle, this means that a precontrast measurement of R1 should be performed before injection of the contrast agent. To convert changes in SI into changes in R1, different approaches can be used. A commonly used method is based on a phantom of tubes filled with Gd solutions at various concentrations imaged with the same sequence. The acquired SI values are plotted against measured R1 values, and a polynomial fit is made to obtain a calibration curve. However, the relaxivity is not equivalent in solution and in tissues. Another method uses the relationship between SI and R1 given by the equation driven by the sequence used [Pedersen, et al.2004], which unfortunately is not straightforward.

Other types of contrast agents have appeared in the research field with different pharmacokinetic and magnetic properties: either larger Gd-chelates or iron oxide particles [Choyke, et al.2006]. The first
ones do not diffuse in the interstitium but are still filtered by the glomeruli; the second are strictly confined to the vascular space but can be captured by activated cells with a phagocytic phenotype. If their applications remain limited today, these large molecules could be useful either for functional purposes (quantification of perfusion, quantification of glomerular filtration rate, estimation of tubular function) or for cellular purposes (intrarenal phagocytosis in inflammatory renal diseases).

2. Measurement of glomerular filtration

Whereas the level of GFR is the best index for monitoring chronic kidney diseases (CKD), measurement of glomerular filtration is difficult to obtain accurately in routine. Therefore, the kidney Disease Quality Outcome Initiative (K/DOQI) of the National kidney Foundation recommend GFR estimates for the definition, classification and monitoring of CKD [Prigent.2008]. Based on serum creatinine values, these prediction equations have limitations, especially in the normal and near-normal range of GFR, in kidney transplant recipients and in the pediatric population. The Cockcroft and Gault formula estimates a global creatinine clearance, and the MDRD (Modification of Diet in Renal Disese study) formula estimates a GFR. Stratification of kidney diseases is based on one of these formulas in clinical practice. However, they have several limitations [Prigent.2008]: variations of plasma creatinine level are around 10%; some tubular secretion may lead to overestimation of GFR, particularly in advanced renal failure; there is a reduction of creatinine excretion with age related to a decrease in skeletal muscle mass; finally, in acute or rapidly progressing renal failure, this technique provides inaccurate information when GFR is rapidly changing.

Indications of true GFR measurements in nephrology actually include: systematic follow-up of renal transplants, evaluation of living donors, when measurement of creatinine clearance is not reliable (low muscle mass, obese) and during all protocols requiring a reliable and reproducible renal function estimation.

The commonest method used clinically for accurate GFR measurement is assessment of the plasma disappearance of a substance that is excreted from the body exclusively by glomerular filtration with no tubular reabsorption nor tubular excretion e.g. ethylenediamine tetraacetic acid (EDTA), or iothalamate [Prigent.2008]. Most of the time, these standard methods are underused because quite time consuming and requiring several blood/urinary samplings. Therefore, a quantitative method based on a tracer intrarenal kinetics, obtained rapidly, without blood and/or urine samplings, coupled with a morphological evaluation of the kidneys and the entire excretory system would be extremely useful in clinical management of patients with renal disease.

Besides nuclear medicine, evaluation of the filtration function is devoted to MR imaging only [Grenier, et al.2008] because US contrast agents are not filtered by the kidneys, and because dynamic studies require long acquisition times, making CT not acceptable in patients yet.

2.1. Measurement of split renal function

Semi-quantitative evaluation of renal function, as split (or differential) renal function is sufficient in urological management of most uropathies, mainly obstructive. However, it is usually not useful in daily assessment and follow-up of renal diseases. In the nephrologic field, it can be required when a reduced renal function is associated with renal asymmetry, in renovascular diseases, before renal surgery if renal function is altered or before renal biopsy. The split renal function (given in percentage) corresponds, for each kidney, to the product:

\[ RF(\%) = \frac{RF}{RF\ total} \times 100 \]

where RF total is the sum of RFs of both kidneys. In clinical routine, the split renal function is still measured using nuclear medicine with glomerular (99mTc-DTPA) or tubular (99mTc-MAG3) agents. Two methods are promoted for that purpose: either the calculation of areas under the filtration curves or Rutland-Patlak plots.

Using dynamic contrast-enhanced MR imaging, Rohrschneider et al [Rohrschneider, et al.2000] obtained calculations of the percentage of the single-kidney “activity” comparable to those derived with gamma camera scintigraphy. These studies were based on a dynamic RF-spoiled gradient-echo sequence and half of a standard clinical accepted dose of Gd-DTPA. A region of interest (ROI) was positioned around the renal parenchyma (omitting the pelvis), and calculation of the relative renal function was then based on the equation:

\[ RF = \frac{AUC\ (mm^2)}{S\ (mm^2)} \]

where AUC corresponds to the area under the glomerulotubular segment of the time-intensity curve and S is the ROI area (Fig 1). In both an experimental study of ureteral obstruction [Rohrschneider, et al.2000] and in patients [Rohrschneider, et al.2002], a high correlation between MR and renal scintigraphy was found. In addition, conversion from SI to concentration of contrast agent is not necessary as recently demonstrated in rats with acute and chronic ureteral obstruction [Pedersen, Shi,
Anderson, Stodkilde-Jorgensen, Djurhuus, Gordon and Frokiaer.2004]. A large multicentric trial comparing renal scintigraphy and dynamic MR imaging in adults and children presenting with unilateral obstruction is actually on-going in France (unpublished data). The early results of this study show better concordance of MR estimation with renal scintigraphy using Rutland-Patlak plots than using Rorschneider approach.

2.2. MR quantification of global GFR
Two methods are proposed for measurement of global GFR using MRI and freely filtered Gd-chelates. The first one is based on the measurement of the clearance of a MR agent using blood samplings [Choyke, et al.1992]. This method presents little advantage compared to other methods, because it is time-consuming and requires several blood samples. The second method is based on measurement of the slope clearance of a freely filtered Gd-chelate from the extracellular fluid volume (ECFV) using SI changes within abdominal organs [Boss, et al.2007]. GFR is calculated as the product of the ECFV (ECFV = 0.02154.weight0.6469.height0.3964) and the time constant of the second exponential phase (α2). The best concordance between gadobutrol clearance and iopromide clearance was observed within the liver, the exponential fit being performed between 40 and 55 minutes after injection (with a mean paired difference of -5.9 mL/min/1.73m2±14.6) (Fig 2). All measurement points were within ± 2 standard deviation values but the maximum deviation form the reference GFR was 29%. With such a wide deviation, this technique can hardly be applied to an individual patient. Main drawbacks of this method are the length of MR acquisition, the sensitivity to body movements and to the selected time intervals when the analysis is performed. More experience is required with this technique.

2.3. MR quantification of single kidney GFR (SKGFR)
Two methods are available for measurement of global GFR using MRI and freely filtered Gd-chelates: 1) monitoring of tracer intrarenal kinetics; 2) measurement of the extraction fraction of the agent.

2.3.1. Monitoring of tracer intrarenal kinetics
A great heterogeneity for parameters of pulse-sequences, doses of injected Gd contrast, methods for conversion of signal intensity into concentration, post-processing methods and compartment models is still noted in the literature between the different groups and no consensus exists [Mendichovszky, et al.2008].

* MR technical requirements
- This quantification requires an accurate sampling of the vascular phase of the enhancement with a high temporal resolution in order to measure the AIF, which is characterized by the SI changes within the suprarenal abdominal aorta. It is used for the different kinetic models in order to compensate for the non-instantaneous bolus injected into the blood (Fig 3). Without taking this into account will produce an overestimation of GFR due to recirculation of the agent within the vascular space.
- All pulse-sequences must have a heavy T1-weighting and be fast enough to characterize the vascular phase of the tracer kinetic which is necessary for assessment of the arterial input function (AIF). Therefore, sequences with a nonselective magnetization preparation are often preferred, combining with very short TR/TE and low flip angles.
- Concentration of Gd within the kidney can be very high, due to water reabsorption in the proximal convoluted tubule and within the medulla. Therefore, to avoid T2* contribution to the signal, the injected dose must be lowered and the patient well hydrated [Rusinek, et al.2001]. The choice between 0.025 mmol/kg and 0.05 mmol/kg depends on the level of signal-to-noise ratio obtained with the sequence and the system used.
- An oblique-coronal plane, passing through the long axis of the kidneys, has to be preferred to an axial plane because with the later, movement correction is impossible and the AIF can be severely impaired by inflow effects within the aorta.
- About renal coverage, some cover the entire parenchyma with several slices using a multislice or a 3D acquisition and calculate GFR by summing the GFR values of each voxel in each slice. Others acquire only one median slice, calculate a mean GFR value and extrapolate this value to the entire renal volume to get a total GFR.

* Post-processing
- Because dynamic MR imaging of the kidneys is performed during free breathing, the main problem is correction of respiratory movements. Absence of correction produces artefacts in time-intensity evolution which can lead to incorrect quantification. Gated sequences would lead to severe penalties in temporal resolution. A movement correction method developed in our group [de Senneville, et
al.2008] based on the estimation of a rigid transformation and correction allowed to estimate successfully small motion and provided more than 20% of reduction on GFR uncertainty on transplanted kidneys and up to 60% on native kidneys (Fig 4).

- Extraction of dynamic should be ideally limited to the cortex, which requires an accurate segmentation method. In the published clinical studies, it was generally done manually. A recent review has developed and discussed extensively the principles and the difficulties on segmentation and on renal ROI generation [Michoux, et al.2006].

* Compartment models

The ideal model reflecting filtration physiology remains to be worked out. Most of the reviewed MRI methods used a two-compartment model although Lee et al [Lee, et al.2007] proposed a more complex compartment model.

The Rutland-Patlak plot technique is a graphical method based on a two-compartmental model with the assumptions that the rate of change of concentration in the kidney during the clearance phase is constant if the amount of contrast agent is taken into account during this period [Patlak, et al.1983]. This method has been applied to MRI by several groups [Annet, et al.2004, Hackstein, et al.2002, Hackstein, et al.2003, Hermoye, et al.2004, Pedersen, et al.2005]. The assumption that no contrast agent leaves the ROI during the sampling period may justify theoretically the use of ROIs encompassing both cortex and medulla. The model is realized as a x-y plot using the ratio of the renal concentration/aortic concentration plotted against the ratio of the integral of aortic concentration/aortic concentration. When applied to the second phase of the signal intensity-time curve (glomerulo-tubular uptake), this plot leads to a straight line, with a slope proportional to the renal clearance, and an intercept with the Y-axis proportional to the cortical blood volume (Fig 5). The cortical compartment model [Annet, Hermoye, Peeters, Jamar, Dehoux and Van Beers.2004, Hermoye, Annert, Lemmerling, Peeters, Jamar, Gianello, Van Huffel and Van Beers.2004] is a two compartments model confined to the cortex, taking into account the outflow from the tubules, during the sampling period, making it possible to draw ROIs strictly limited to the cortex. Calculation of the residue function, (i.e. the deconvolution of C(t) with AIF(t)) then exhibits 3 sequential peaks (successively glomerular, proximal tubule, distal tubule) and two rate constants, kin and kout that describe the flow into and out of the proximal tubule, meaning that kin represents SKGFR which can be calculated according to the following equation:

$$SKGFR = \frac{\text{maximal slope of proximal tubule peak}}{C(\text{vasc})_{\text{max}}}$$

To calculate C(\text{vasc})_{\text{max}}, the maximum of the vascular peak was divided by the RBV to take into account that the contrast agent remains in the extravascular space. This method has provided more accurate results than Rutland-Patlak model in an experimental study in rabbits, using $51\text{Cr}$-EDTA as a goldstandard [Annet, Hermoye, Peeters, Jamar, Dehoux and Van Beers.2004]. It is providing GFR, blood flow and vascular volume (Fig 6).

The multicompartimental model [Lee, Rusinek, Bokacheva, Huang, Oesingmann, Chen, Kaur, Prince, Song, Kramer and Leonard.2007] is including three cortical compartments (glomerular, capillary and proximal convoluted tubules, as in previous model), three medullary compartments (loops of Henle, distal convoluted tubules, collecting ducts) and the collecting system. Despite being complex, this model has the advantage of assessing some important tubular physiological parameters. Applied to the passage of Gd into the first two compartments, the model allows calculation of GFR.

* Accuracy and reproducibility

Such studies should be accurate and reproducible when compared to a gold standard technique. But only one clinical study undertook the 99mTc-DTPA clearance during the Gd-MRI [Lee, Rusinek, Bokacheva, Huang, Oesingmann, Chen, Kaur, Prince, Song, Kramer and Leonard.2007]. A recent analysis of the literature emphasized the great heterogeneity of protocols (in acquisition mode, dose of contrast, post-processing techniques…) and regression coefficient values which are generally considered inadequate for replacing an accepted reference method [Mendichovszky, Pedersen, Frokaer, Dissing, Grenier, Anderson, McHugh, Yang and Gordon.2008]. Whereas several published papers conclude that Gd-enhanced MRI provides a reliable estimate of GFR and is suitable for use in both clinical and experimental settings [Hackstein, Cengiz and Rau.2002, Hackstein, Heckrodt and Rau.2003, Laurent, et al.2002, Lee, et al.2003], evaluation seems still necessary at a larger scale.

2.3.2. Single kidney extraction fraction

This method allows a quantification of a single kidney (SK) extraction fraction (EF), based on the measurement of T1 within flowing arterial and venous blood (Look and Locker method) during a

$$EF = \frac{Ca \cdot Cv}{Ca}$$

where Ca and Cv are the arterial and venous Gd concentration respectively. Because of the linear relationship between relaxation rates and concentration of Gd, EF can be expressed alternatively as:

$$EF = \frac{\left(\frac{1}{T1a} - \frac{1}{T1v}\right)}{\left(\frac{1}{T1a} - \frac{1}{T10}\right)}$$

where T1a is T1 in the renal artery, T1v in the vein and T10 in the blood without Gd. Once EF is calculated for each kidney, values of SKGFR can be calculated if RBF is known:

$$SKGFR = EF \times RBF \times (1-Hct)$$

where RBF is the renal blood flow, usually measured with the cine-phase contrast method on the renal artery, and Hct is the level of hematocrit in the blood. Preliminary animal studies have shown concordant results with inulin clearance, but the correlation was 0.77 which is inadequate for clinical use at this stage [Coulam, et al.2002]. No clinical application of this method has been published to now.

3. Renal flow rate and renal perfusion

Renal blood flow (RBF), or flow rate, refers to the global amount of blood reaching the kidney per unit of time normally expressed in ml/min. This parameter is usually measured on a renal artery or a renal vein. Renal perfusion refers to the blood flow that passes through a unit mass of renal tissue (ml/min/g) in order to vascularize it and exchange with the extravascular space. The degree of perfusion depends on both the arterial flow rate and local factors such as regional blood volume and vasoreactivity. In clinical practice, measurement of renal blood flow or perfusion may become important for the evaluation of renal artery stenosis or nephropathies with microvascular involvement and help in monitoring intravascular interventions.

3.1. Renal flow rate

Measurement of renal flow rate is based on the product of mean velocities in the renal artery and its section area. The cine-phase-contrast MR method is able to sample intra-arterial velocity profile and to quantify the renal blood flow in each renal vessel without injection of contrast agent. This technique is well described in the literature [Debatin, et al.1994] : it is based on the encoding of phase shifts of flowing spins along either one direction, perpendicular to the vessel of interest, or in all 3 directions. For accurate measurements in the human arteries the imaging plane is usually positioned 10 to 15mm downstream from the ostium, where respiratory movements are minimal, and perpendicularly to the renal artery (Fig 7). Addition of this method to MR-angiography improved interobserver and intermodality agreement as sensitivity and specificity for detection of significant renal artery stenosis [Schoenberg, et al.1997, Schoenberg, et al.1997, Schoenberg, et al.2002]. It was also demonstrated, in vitro, that the degree of spin dephasing was directly correlated with the trans-stenotic pressure gradient [Mustert, et al.1998].

3.2. Renal perfusion

3.2.1. MRI

Renal perfusion parameters, as renal blood volume (RBV) and renal blood flow (RBF), can be assessed with MRI either by dynamic contrast-enhanced methods, using Gd-chelates or iron oxide particles, or by water spin labeling techniques.

3.2.1.1. Dynamic MR imaging

Technical constraints are the same than for GFR measurement. However, acquisition time is shorter, only the first pass being necessary, and breath holding is usually efficient. If the AIF is not taken into account, semi-quantitative parameters as maximal signal change (MSC), time to MSC (TMSC) or wash-in and wash-out slopes can be measured for comparison from right to left kidney (Fig 8), from cortex to medulla or from one territory to another, or for follow-up of patients [Michaely, et al.2007, Michaely, et al.2007, Michaely, et al.2006].

As for GFR, absolute quantification requires to take into account the AIF. Then, the calculated concentration-time curves must then be processed using specific mathematical models (Fig 9). The most widely used perfusion model is derived from Peters’s model [Vallee, et al.2000], developed for nuclear medicine [Peters, et al.1987]. Peters et al [Peters, Brown, Hartnell, Myers, Haskell and Lavender.1987] hypothesized that before leaving the kidney, the contrast agent behaves like microspheres that are trapped in the capillary system during a short time interval, inferior to the
minimal vascular transit time. Calculation of renal perfusion per unit of volume can be extracted from the mathematical expression:

\[ \text{RBF/vol} = \frac{\text{max slope renal}}{\text{max (R1)art}} \]

where (R1)art is calculated from the changes in aortic SI using a priori knowledge of the signal-vs-R1 relationship that can be elucidated in vitro using a Gd-filled phantom. With a small bolus of contrast (0.025 mmol/kg) and a T1-weighted gradient-echo sequence, Vallée et al [Vallee, Lazeyras, Khan and Terrier.2000] were able to measure cortical BF in 16 normal kidneys patients (254±116 ml/min/100g), decreasing to 109±75 ml/min/100g in case of RAS and to 51±34 ml/min/100g in case of renal failure. In animals, values of cortical RBF correlated linearly with reference values, but were nonetheless systematically underestimated [Montet, et al.2003].

Dujardin et al. [Dujardin, et al.2009, Dujardin, et al.2005] generalized the tracer kinetic theory from intravascular to diffusible tracers using deconvolution, which is a model-free approach. From ROI drawn on the aorta and on the renal cortex, tissue concentration–time course has to be deconvolved pixel by pixel with the flow corrected aortic time course, resulting in an impulse response function (IRF). This method allows getting intrarenal maps of RBF, as maximum of IRF, RBV, as the time integral of the IRF over the available time interval, and MTT as the ratio RVD/RBF. They showed a significant negative correlation of RBF and RVD with patient age [Dujardin, et al.2009].

The same approach can be applied to measurement of perfusion using iron oxide particles which have a unicompartimental distribution within the kidney. Once injected intravenously as a bolus, they produce dynamic signal intensity changes based on a T2* effect caused by alterations in the local magnetic susceptibility (Fig 10). Experimental applications in rabbits subjected to hydronephrosis [Trillaud, et al.1993] or renal artery stenosis [Trillaud, et al.1995], showed that the concentration-time curves of the ischemic kidneys had a lower slope and a higher area under the curve than the normal contralateral kidney. In an experimental model of RAS in dogs with four degrees of stenosis [Schoenberg, et al.2003], an increase of MTT and a decreased rRBF occurred only for severe stenosis above 90%. In patients, a decreased rRBF was noted only for severe stenosis (Fig 3) or in kidney suffering from chronic damage related to other renal diseases.

3.2.1.2. Renal perfusion using spin-labeling

Renal perfusion can alternatively be measured using pulsed arterial spin labeling (or spin-tagging) using endogenous water as a diffusible tracer. With this technique, a perfusion-weighted image can be generated by the subtraction of an image in which inflowing spins have been labeled from an image in which spin labeling has not been performed. Quantitative perfusion maps can then be calculated (in ml/min/100g of tissue) when T1 of the tissue and efficiency of labeling are known. Several pulse sequence strategies have been described to tag arterial flowing spins, which can be divided into two groups (continuous or pulsed labeling) with different advantages and drawbacks as described in detail by Calamante et al [Calamante, et al.1999].

Methods based on pulsed labeling are not compromised by the two major sources of errors seen with continuous labeling techniques (transit time and magnetization transfer). Pulsed labeling can be realized as an echo planar imaging sequence with signal targeting with alternating radiofrequency (EPISTAR) [Edelman, et al.1994]. Using this sequence in an experimental model of renal artery stenosis in pigs, Prasad et al. [Prasad, et al.1997] showed that a decrease of blood flow was 100% sensitive and specific for detection of 70% renal artery stenoses.

The flow-sensitive alternative inversion recovery (FAIR) [Martirosian, et al.2004] is based on two inversion-recovery images, one with a slice-selective inversion (will contain flow information: T1 apparent) and one with a nonselective inversion (assuming that blood and kidney relax at the same rate, it will contain no flow information: T1). Subtraction of both images generates a value directly related to the perfusion. Recently, a technique associating a FAIR preparation and True-FISP data acquisition provided very encouraging results within the kidneys because of shorter echo time, fewer saturation effects [Fenchel, et al.2006] (Fig 11). On perfusion images, severe RAS (>70% luminal narrowing) could be clearly distinguished from no or mild RAS and moderate RAS (< or =70% luminal narrowing) (p < .005), with significant correlations between FAIR perfusion data and grade of stenosis (r = -0.76).

References


DIFFUSION-WEIGHTED MRI OF THE UROGENITAL TRACT
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Diffusion-weighted MR imaging (DW-MRI) appears to hold promise as noninvasive imaging modality in the detection of early microstructural and functional changes of different organs preceding morphological alterations observed on conventional cross-sectional imaging (1). DW-MRI is an imaging technique that has been applied for the work-up of a large variety of diseases in the urogenital tract. In kidneys, DW-MRI has shown promising results in the evaluation of diffuse renal disease in native and transplanted kidneys with decreased ADC values reported in pyelonephritis, renal artery stenosis, acute ureteral obstruction and acute and chronic renal insufficiency (2-8). The clinical challenge of differentiating between cysts and cystic renal cell carcinomas or between different malignant and benign solid renal lesions has also been addressed by DW-MRI and initial results have shown its potential benefit to answer unresolved questions encountered in daily routine (9).

The benefit of DW-MRI for the detection of prostate cancer has already been shown in several published articles allowing correct tumour localisation in the peripheral zone in the vast majority of patients with significantly lower ADC values reported in the tumoral tissue compared to the adjacent healthy tissue (10-22). However, in the central gland there is still a big overlap between benign prostatic hyperplasia (BPH) and prostate cancer. Diffusion tensor imaging (DTI) has shown promising results to overcome this particular problem with reduced fractional anisotropy (FA) in the prostate tumour compared to BPH (23). The combined approach of T2w and DW-MRI showed also promising results for the detection of recurrent tumour in patients after radiation therapy (24). DW-MRI may improve the performance of conventional T2-weighted and contrast-enhanced MRI in the preoperative workup of bladder cancer, as it may help in distinguishing superficial from muscle invasive bladder cancer, which is critical for patient management (25, 26). Another challenging application of DW-MRI in the urogenital tract is the detection of pelvic lymph node metastases. As the ADC is generally reduced in malignant tumours and increased under inflammatory conditions, reduced ADC values were expected in patients with lymph node metastases.

DW-MRI seems to be a promising and accurate diagnostic tool to noninvasively detect pelvic lymph node metastases even in normal sized nodes of patients with bladder and prostate cancer with a high negative predictive value (27, 28).

Further studies have to be performed to define optimal threshold ADC values to avoid the high number of false positive nodes.

References
CT UROGRAPHY VERSUS MR UROGRAHPY: CURRENT OPINION
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To date, a good uroradiologist is a radiologist who can produce good CT and MR urograms. Indeed, a groundbreaking progress in urographic imaging during the past decade was substantiated by the clinical introduction of multidetector CT urography (CTU) and high-field MR urography (MRU). In a growing number of indications, both CTU and MRU are going to replace conventional urography and invasive endourologic diagnostics. On the other hand, it becomes clear that CTU and MRU compete for the best clinical acceptance within the community of uroradiologists and urologists. What we can do at present is to oppose the pros and cons of both techniques, which may help us define the role of CTU and MRU today and in the near future.

Both contrast-enhanced CTU and gadolinium-enhanced T1-weighted MRU reflect the renal excretory function and the urine flow through the upper urinary tract. Like conventional urography, contrast-enhanced CTU and T1-weighted MRU are infeasible in patients suffering from renal insufficiency. Obstructive uropathy with renal malfunction, however, is not a contraindication for MR imaging in general, because unenhanced static-fluid T2-weighted MRU generates typical urographic views of uretrohydronephrosis even in quiescent urinary systems. In renal insufficiency, unenhanced CT is markedly inferior to static-fluid MR urography.

For both gadolinium excretory T1-weighted MRU and static-fluid T2-weighted MRU, we mostly find clear and uniform examination protocols in the current literature. However, for contrast-enhanced CTU, a great variability of examination protocols has been promoted, including intravenous single-bolus and split-bolus techniques, different contrast delay-times, single-phase and multiphase data acquisition protocols, and different ways of supplementary hydration of the urinary tract. As a matter of fact, there is still a controversy about the optimal CTU technique and whatever variant of CT urographic technique we prefer, it is clear that we always have to strive for a compromise between the best possible urinary tract opacification and the lowest acceptable radiation exposure. Radiation exposure will never be an issue when talking about MRU.

On reviewing the current opinion in the literature, a number of characteristic pros and cons of CTU and MRU can be summarized as follows:

CTU pros:
- good clinical availability
- excellent spatial resolution
- detailed urinary tract morphology
- excellent detection of calculi (even inside opacified urine)
- high sensitivity for small intrinsic tumor lesions
- simultaneous assessment of the whole abdomen
- moderate cost

CTU cons:
- radiation exposure
- no standard imaging protocol (controversial variability)
- limited number of acquisition phases
- difficult opacification of markedly obstructed urinary tracts
- inapplicable in renal insufficiency and intolerance of iodine contrast agents
MRU pros:
• no radiation exposure
• detailed urinary tract morphology
• excellent soft tissue contrast
• well established imaging protocols for T1- and T2-weighted MRU
• T2-weighted MRU is independent of renal excretory function
• T2-weighted MRU easily visualizes markedly obstructed urinary tracts
• unlimited number of acquisition phases in T1-weighted MRU
• quantitative calculation of bilateral gadolinium excretion curves possible
• one-stop-shop imaging, eg. combination of MRU with MR angiography, diffusion-weighted MR imaging, MR spectroscopy, etc.

MRU cons:
• limited availability of in-bore times
• high cost
• poor identification of soft tissue calcifications
• unclear sensitivity for intrinsic tumor lesions
• T1-weighted MRU inapplicable in glomerular filtration rates < 30 ml/min

Both CTU and MRU have proved to be of diagnostic value in numerous urinary tract disorders. In the absence of randomized controlled study data, MR radiologists currently rather prefer MRU and, vice versa, CT specialists favour the use of CTU. Apart from such empiric practices, we especially know that unenhanced CT is regarded the diagnostic gold standard in imaging of urolithiasis providing a sensitivity and specificity of near 100%. Moreover, the CT urography working group of the ESUR recommends multidetector CTU to be integral part of the diagnostic algorithm for the noninvasive detection of urothelial cancer in patients older than 40 years, presenting with painless hematuria. For this reason and together with the superior clinical availability of CT scanners, we understand that, to date, CTU has outperformed MRU in the diagnostic management of adult patients. Also because of cost restraints in our health care systems, it is obvious that MRU will mainly be regarded as a diagnostic tool of secondary preference following ultrasonography, conventional urography and CTU. Nevertheless, MRU offers a number of first-choice applications and should not be limited to patients who do not tolerate iodinated contrast agents in CT. In a growing number of radiology departments, MRU has already replaced conventional urography for imaging urinary tract disorders in children. Especially MR imaging, rather than CT, suggests a great potential for combining morphologic plus functional imaging performed as a single-session “all-in-one” examination. Such an integrative diagnostic approach, including MRU, favours the preference of MR imaging for uroradiologic patient care in the long term.

Literature
DIFFUSION TENSOR IMAGING AND TRACTOGRAPHY OF TRANSPLANTED KIDNEYS
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INTRODUCTION: Normal kidneys have a well defined structure, so that a directed diffusion along the radially orientated tubules is expected. In this study we investigated the feasibility of Diffusion Tensor Imaging (DTI) and tractography to demonstrate these microstructures and to detect changes in transplanted kidneys compared to normal kidneys.

MATERIAL AND METHODS: 8 kidney transplanted patients with impaired allograft function (GFR = 15-49 ml/min) and 11 healthy volunteers underwent coronal fat-saturated echo-planar DTI (1.5 T MAGNETOM Avanto, 6 diffusion directions, b-values 0 and 600 s/mm², slice thickness 3 mm) of the allograft or the right kidney respectively. Using the Syngo DTI software ROIs were placed in the cortex and the medulla of the superior, middle and inferior part of the kidney and ADC and fractional anisotropy (FA) were determined. Diffusion directions were visualized by tractography.

RESULTS: ADC values in normal kidneys were significantly higher (p<0.05) than in transplanted kidneys and a corticomedullar difference was only observed in normal kidneys. FA was significantly higher (p<0.0001) in the medulla than in the cortex in all subjects. FA of the renal cortex was significantly higher (p<0.0001) in healthy volunteers (0.171 ± 0.005) than in transplanted patients (0.122 ± 0.007). In the medulla differences were even more pronounced with an FA of 0.403 ± 0.011 in normal kidneys and 0.254 ± 0.012 in transplanted kidneys respectively. Tractography demonstrated the preferred direction of diffusion along the tubules. In contrast, in transplanted kidneys a preferred diffusion direction was only visible in small parts of the organ reflecting the reduced anisotropy.

CONCLUSION: The preliminary results indicate the potential of DTI and tractography to detect and visualize changes of allograft function and microstructure. Further investigations are intended to evaluate whether DTI allows for assessment of chronic and acute rejection and for quantification of allograft fibrosis.

THE ROLE OF COMBINED STATIC-EXCRETORY MR UROGRAPHY IN THE EVALUATION OF UPPER URINARY TRACT DISORDERS IN CHILDREN
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INTRODUCTION: The aim of our study was to evaluate the feasibility, accuracy and diagnostic potential of combined static-excretory MR urography in paediatric patients with US detected abnormalities of the upper urinary tract (UT).

MATERIALS AND METHODS: The study included 59 children (42 boys and 17 girls) with US detected upper UT abnormalities. Their mean age was 9.4 years. All children have been examined by US, MRU and renal scan. VCUG was performed in 37 patients, while excretory urography was performed in 12 patients. 53 children have been examined by combined static-excretory MRU. We used Fr+ protocol with low dose Furosemide (0.5 to1 mg/kg). This was followed by IV application of a bolus of 0.1 mmol/kg of Gd-DTPA. In 6 patients, static MRU was only done due to high creatinine level.

RESULTS: In 59 children 106 renal units were evaluated by MRU (as 2 patients had solitary kidney and 10 patients had transplanted kidney). The final diagnoses included: Normal kidney (n= 42); duplex systems (n=8); Megaureter (n=13); UPJ obstruction (n=20); Ectopic kidney (n= 5); Small scarred kidney (n= 2), Dysplastic kidney (n=8); Post ESWEL non obstructive dilation (n= 2) and post transplant complications (n=6). Complex pathology was found in 10 patients. The MRI diagnosis correlated with the final diagnosis in 98 units, with diagnostic accuracy (92.4 %). MRU provided additional information to other imaging modalities in 22 patients. The confirmatory results of MRU helped to establish the final diagnosis in 32 patients. The findings of MRU were insufficient in 5 children.
CONCLUSION: MRU is feasible with high diagnostic accuracy, in pediatric patients with upper urinary tract abnormalities. Combined static-excretory MRU has to be indicated particularly in patients with severe and/or complex pathology, ectopic urethral insertion and duplex pelvicalyceal systems.

DOES IV IOPROMIDE DURING PREGNANCY AFFECT THYROID FUNCTION IN NEWBORN?

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PURPOSE: To determine the incidence of thyroid function abnormalities in the newborn whose mother underwent contrast enhanced CT for suspected pulmonary embolism during her pregnancy.

MATERIAL AND METHODS: In the 5-year period from 2005 until 2009, the radiology database was searched for female patients between 15-45 years with the specific CT pulmonary embolism code. Radiology reports and letters to referring physicians from the Pulmonary, Internal Medicine and Gynecology departments were read for proof of pregnancy. If there had not been any contact with the gynecologist, the specific birth date was obtained by searching the mother’s and the father’s surname, and address, in the hospital electronic patient database (Horizon®, McKesson). This search strategy was successful in all cases. In our country all newborns undergo a Neonatal Screening Test (Heel Prick Method), for treatable endocrinological, metabolic and genetic diseases. When this test is abnormal, a paediatric consultation is requested and further follow-up is done in hospital. Therefore, all abnormal Heel Prick Test results of the newborn would be recorded in the hospital electronic patient database of our hospital. If there was no prior history found of the newborn in the hospital electronic patient database, then we concluded that there were no thyroid function abnormalities as all abnormal test results lead to hospital referral in the Dutch Health system.

All patients received 85 ml Iopromide, followed by a saline flush of 50ml.

RESULTS: A total of 388 female patients 15-45 years underwent CECT for suspected pulmonary embolism in the period 2005 – 2009. Twenty of the patients were pregnant, mean age was 29 years. One woman delivered a stillborn due. The study group thus consists of 19 newborns. No thyroid function abnormalities were present in these babies.

CONCLUSION: Intravenous administration of iodinated contrast during pregnancy does not affect the thyroid function in the newborn.

AUDIT OF COMPLICATIONS FOLLOWING TRANSRECTAL ULTRASOUND GUIDED PROSTATE BIOPSY

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BACKGROUND: Transrectal ultrasound (TRUS) guided biopsy of the prostate is used to diagnose and stage prostate cancer. It is a safe procedure; however studies have demonstrated a high incidence of minor complications. The technique employed for TRUS guided biopsy of the prostate is similar across the two constituent hospitals of our UK National Health Service trust. The only difference between the protocols employed is the prophylactic antibiotic regime.

METHOD: We performed a retrospective questionnaire based cross-sectional audit of complications occurring after TRUS guided biopsy of the prostate at two hospitals.

RESULTS: Approximately 60 subjects were selected at random from each who had undergone TRUS guided biopsy in the previous eighteen months were sent a questionnaire. The anonymised questionnaire asked patients if they had suffered any of a list of complications following the procedure. The questionnaire also asked if the patient sought any medical advice following the procedure, and if the patient required additional antibiotics or hospital admission subsequent to the procedure. Overall the rate of complications reported compared favourably with the incidence of complications reported in the literature. The only significant difference in results between the groups of respondents from each hospital was the incidence of patients reporting infection-like symptoms. One group reported a rate of 2.3%, in comparison to 19.2% from the other group. The antibiotic regime of the second hospital (reporting the rate of 19.2%) was changed so that it was identical to that of the first hospital (i.e. prophylactic metronidazole suppositories were administered in both hospitals).

A prospective re-audit is underway. Provisional results from a total of 46 responses indicate that the infection-like symptoms in the second hospital fell from 19.2% to 4.2%.

CONCLUSIONS: Use of metronidazole suppositories was associated with a reduction is self-reported infection following TRUS prostate biopsy from 19.2% to 4.2%.
INTERNAL ILIAC ARTERY EMBOLIZATION FOR THE CONTROL OF SEVERE BLADDER HEMORRHAGE SECONDARY TO CARCINOMA: LONG-TERM FOLLOW-UP
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PURPOSE: The purpose of this study was to evaluate the efficacy and long-term complications of internal iliac artery embolization as a palliative measure in the control of intractable hemorrhage from advanced bladder malignancy.

MATERIALS AND METHODS: From January 1998 through December 2005, seven patients underwent transcatheter arterial embolization (TAE) of anterior division of internal iliac artery bilaterally for intractable bladder hemorrhage. After embolization, patients were followed for the efficacy of the procedure in controlling hematuria and complications.

RESULTS: TAE was successful in immediate control of severe hemorrhage in all seven patients after a mean period of 4 days. At a mean (range) followup of 10 (6–12) months, the hemorrhage was permanently controlled in four (57%) patients. Three patients developed hematuria and required emergency admissions; two had mild hematuria and were managed conservatively, and the remaining one required a second attempt of embolization after 2 months from the first one. During the whole period of follow-up, there were no significant complications related to embolization.

CONCLUSION: Internal iliac artery embolization is an effective and minimally invasive option when managing advanced bladder malignancies presenting with intractable bleeding. The long-term follow-up showed control of bleeding in the majority of such patients with no serious complications.

IMAGING FINDINGS OF FEMALE URETHRAL DIVERTICULUM ON MAGNETIC RESONANCE IMAGING (MRI)
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INTRODUCTION: Female urethral diverticulum is an uncommon pathological entity which is being diagnosed with greater frequency owing to increased awareness of this condition and better imaging techniques. Female urethral diverticulum can manifest with lower urinary tract symptoms and recurrent urinary tract infections. Clinical diagnosis can be difficult due to the non specific presenting symptoms which can mimic other genitourinary pathology. As a result, the patient may undergo a number of investigations before the diagnosis is made. Conventional imaging studies include cystoscopy, retrograde urethrogramy, voiding cystourethrogram, double balloon catheter urethrogramy and ultrasonography. Owing to the multiplanar capability and excellent tissue contrast, MRI consistently and clearly demonstrates the urethral and periurethral morphology, and is an excellent tool for evaluating urethral diverticulum. It allows assessment of the size, configuration and location of the diverticulum in relation to the urethra and its adjacent anatomical structures, which is useful for surgical and non surgical management. Herein, we describe the imaging findings of female urethral diverticulum on MRI and the techniques involved and report on potential pitfalls of diagnosing urethral diverticulum on MRI.

RESULTS: We report on a cohort of contemporary cases of urethral diverticulum in a number of females with histopathological confirmation from a single institution. We demonstrate a range of different diverticulum including “horse shoe” and “saddle bag” types. Our cases also highlight the variety of MR sequences which can be used in aiding diagnosis. We provide examples of potential pitfalls in diagnosing urethral diverticulum on MRI, such as collagen injection sites and other types of periurethral cysts which may be confused for urethral diverticulum.

CONCLUSION: As female urethral diverticulum are becoming more prevalent in clinical practice, radiologists and other clinicians should be familiar with its imaging appearances on MRI as well as some of the potential pitfalls to their diagnosis.

CIN INCIDENCE IN CECT AFTER IMPLEMENTATION OF A PREVENTION PROTOCOL
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INTRODUCTION: To determine the CIN incidence in outpatients undergoing CECT after implementation of a prevention protocol.

MATERIAL AND METHODS: From February until November 2009, a prospective observational study, approved by the institutional review board, in outpatients undergoing CECT was performed. Exclusion criteria included inpatient status and peritoneal or hemodialysis. Also a minimum of 7 days between scheduling and performing CECT was required, in order to receive informed consent and allow for a Nephrology consult. All patients not matching these exclusion criteria were invited to participate. All patients received Iopromide 300mg/ml (Ultravist®, Bayer Schering Pharma). SC was analyzed within 7 days before and 2-4 days after CECT. eGFR was calculated using the 4-point MDRD formula. Patients were identified at high risk when eGFR<45ml/min/1.73m² or eGFR 45-60ml/min/1.73m² and additional risk factors were present. These patients consulted a Nephrologist for termination of nephrotoxic drugs and a sodium bicarbonate 1.4% pre- and post hydration schedule. CIN was diagnosed when a rise in SC>44µmol/L or >25% occurred, in absence of an alternative etiology. All data were compiled into a spreadsheet format and analyzed using SPSS 14.0.

RESULTS: 583 consecutive patients were invited to participate. 207 patients gave informed consent and 59 had to be excluded due to incomplete data on SC. The study group thus consisted of 148 patients, 88 males and 60 females, mean age 65 years (21-83). The mean volume of contrast administered was 120ml (85-160) at a mean rate of 3ml/s (2-6). Fifteen patients were high-risk patients and consulted a Nephrologist for preventive measures. None of these met the CIN criteria. In the other 133 low risk patients, 2 met the CIN criteria.

CONCLUSION: CIN incidence in outpatients undergoing CECT after implementation of a prevention protocol is 1.4% (2/148). None of the high-risk patients developed CIN after taking preventive measures.

LONG-TERM FUNCTIONAL AND MORPHOLOGICAL EFFECTS OF TRANSCATHETER ARTERIAL EMBOLIZATION OF TRAUMATIC RENAL VASCULAR INJURY
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OBJECTIVE: To assess the long-term morphological and functional outcome of superselective transarterial embolization (TAE) for treating traumatic renal vascular injury.

PATIENTS AND METHODS: The surgical records of 124 patients with traumatic renal vascular injury managed by TAE between 1990 and 2004 were reviewed, of whom 81 completed a long-term follow-up and were included in the final analysis. Patients were followed using serum creatinine levels, grey-scale ultrasonography, intravenous urography (IVU) and radioisotopic renography using 99mTc-mercapto-acetyl triglycine (MAG3) and 99mTc-dimercaptosuccinic acid (DMSA).

RESULTS: Embolization resulted in the cessation of haematuria in all patients but two (97.5%). At 3 months, serum creatinine levels increased in four of nine patients with a solitary kidney, but only one of them required haemodialysis. After a mean follow-up of 4.6 years, IVU showed a normal calyceal configuration in 70% of renal units, pyelonephritic changes in 26% and no dye excretion in 4%. DMSA scans showed no evidence of photopenic areas in 17 renal units (21%). The mean (SD) percentage of DMSA uptake by the corresponding kidney improved from 24 (9)% at the 3-month scans to 32 (10)% at the last follow-up scan(P<0.001). Using MAG3, the mean (SD) glomerular filtration rate improved significantly from 26 (11) mL/min at the 3-month scan to 32 (9) mL/min at the last follow-up (P<0.05).

CONCLUSION: Superselective TAE is safe and effective for traumatic renal vascular injury. The short term deleterious effects were more pronounced in patients with a solitary kidney. The long-term follow-up showed functional and morphological improvements in the embolized renal units.

NEUROANATOMICAL EVALUATION OF PERIPROSTATIC NERVE IN PATIENTS SUBMITTED TO NERVE-SPARING PROSTATECTOMY: DTI FIBER TRACKING AND 3D FAST-RECOVERY FAST SPIN-ECHO (FRFSE) CUBE OVERLAPPING AT 3T
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PURPOSE
Aim of this study is to depict neuroanatomical distribution and relationship with capsular profile of periprostatic nerve in patients submitted to a bilateral nerve-sparing prostatectomy using DTI Fiber Tracking and 3D fast-recovery fast spin-echo (FRFSE) cube at 3T magnet.

MATERIALS AND METHODS
The study is performed on patients candidate to nerve-sparing prostatectomy (33 pts) at 3T Magnet ((Discovery M750, GE Healthcare) equipped with surface phased array and endorectal coil. Scan protocol includes morphologic imaging with TSE T2-weighted sequences on the axial, sagittal and coronal planes, DWI sequences at different b value (500, 1000, 3000) and 3D fast-recovery fast spin-echo (FRFSE) cube sequence; in addition DTI fiber tracking with b value 1000 and 16 directions (funtool protocol, version 7.4) is done.

RESULTS
Overlapping 3D cube sequence and fiber tracking we can obtained a precise view of the NVB in terms of: thickening of nerve fibers, distance from nerve fiber to prostate capsule, integrity and course on each part of the prostate. Periprostatic nerve fibers reveal a relatively even distribution in both lateral and dorsal parts of the prostate.

CONCLUSIONS
DTI fiber tracking and 3D FRFS Cube overlapping proposed in this study, would provide an additional diagnostic tool in decision making process in the patient nerve-sparing prostatectomy management.

MAGNETIC RESONANCE VOIDING CYSTOURETHROGRAPHY FOR EVALUATION OF VESICOURETERAL REFLUX
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PURPOSE: To assess the feasibility of magnetic resonance voiding cystourethrogram (MRVCUG) using dynamic magnetic resonance (MR) sequence for evaluation of vesicoureteral reflux (VUR), and its use as a noninvasive alternative to standard VCUG.

MATERIALS AND METHODS: A total of 33 MR studies of 33 patients (2 years to 15 years old) with a suspicion of primary VUR or with documented VUR diagnosed by standard VCUG were evaluated. MRVCUG was executed with a non-enhanced heavily T2-weighted HASTE sequence with fat saturation (TR/TE= 3500/667 msec; flip angle=90°; slab thickness=50–100 mm; matrix=256x224, nes= 1; bandwidth=149). During MRVCUG imaging sedation and catheterisation were not used whereas during standard VCUG catheterization was used. The MR findings were correlated with those obtained by the gold standard, standard VCUG. ICSR VUR grading system was used for standard VCUG and a similar 5 graded system was used for MRVCUG

RESULTS: The sensitivity, specificity, negative predictive value, positive predictive value and accuracy rate were 79%, 94%, 82%, 93%, 86% respectively. Kappa and gamma agreement regarding the grading of VUR between MRVCUG and VCUG was 0.68 and 0.879 respectively

CONCLUSION: When compared with standard VCUG, MRVCUG is more advantageous imaging method because there is no need for ionizing radiation or catheterization. To us, because of high specificity and acceptable sensitivity values, MRVCUG could be used as a first screening imaging modality in patients having suspicion of VUR or in the follow-up of documented VUR patients.

SENSITIVITY OF SCOUT RADIOGRAPH IN CTKUB: SHOULD RADIOLOGISTS REPORT SCOUT FILMS IN CTKUB?
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INTRODUCTION AND OBJECTIVES: Un-enhanced Computed Tomography of Kidney, Ureter and Bladder (CTKUB) has become the standard investigation for renal colic. Digital CT scout films are produced to assist in positioning patients before axial images are acquired. This study aims to determine the sensitivity of CTKUB scout films in detecting renal calculi using CTKUB as a standard reference.

MATERIALS AND METHODS: Patients who underwent CTKUB for acute flank pain between May 2006 and March 2007 were identified. CT reports were reviewed and 201 consecutive patients with positive ureteric calculi were included in the study. All scout films were reviewed by 2 Radiologists independently with access to CTKUB images. Each observer recorded the presence or absence of the
calculus on the scout view of each patient; location, size and mean Hounsfield unit of each calculus were assessed from CTKUB images.

RESULTS: 203 ureteric calculi were analysed from 201 patients. 153/201 (76%) patients were male and 48/201 (24%) female. Mean age was 44.7 years with a range of 17-84. Mean Hounsfield Unit of stone visible on scout view was 650 (observer A) and 642 (Observer B) with stone not visible on scout 406(Observer A) and 383 (Observer B). Significance of mean Hounsfield Unit and mean size between 2 groups of patients with visible stones on scout view and those not visible were tested. P value for both variables were <0.0001, which is significant. Overall sensitivity of scout films for observer A 86/203 (42.3%) and observer B 106/203 (52.2%) with inter-observer reliability Kappa 0.7. The study found that calculi in upper ureter and larger than 4mm are more likely to be seen on the scout film.

CONCLUSION: Usage of CT scout film should be encouraged and reported routinely in conjunction with CTKUB as a base line for treatment follow up.

ROLE OF MULTISLICE CT ANGIOGRAPHY IN PRE-OPERATIVE VASCULAR MAPPING OF RENAL TUMOURS

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PURPOSE: The aim of this prospective study was to determine the accuracy of multislice CTA in vascular mapping of renal tumours as part of their preoperative assessment, and its consequent impact on management.

SUBJECTS AND METHODS: 30 patients with various types of renal tumours, all candidates for surgery, referred for pre-operative assessment by dual-phase multislice CT renal angiography. The imaging protocol included non-contrast, arterial and venous phases. The vascular anatomy of the kidney harboring the tumour was depicted using 3D reconstruction techniques (MPR, VRT, and MIP). Findings were compared to operative data.

RESULTS: Arterial supply was correctly depicted in all patients, 78% of whom had a single renal artery, 16% had two renal arteries, 3% had three renal arteries, and 3 % had four. Prehilar arterial branching was found in 13%. Parasitic arterial supply was found in two patients, one of them was missed on CTA. 90% of patients had a single renal vein and 10% had two renal veins. One small accessory renal vein was missed on CTA. Prehilar venous branching was detected in 10%. Dilated peritumoral veins and anomalies of the left renal vein were all correctly depicted; retroaortic left renal vein was found in two patients. Presence and extent of renal vein and caval thrombosis were all correctly identified and confirmed by surgery, with three cases showing thrombus reaching the right atrium.

CONCLUSION: Vascular mapping by multislice CT angiography offers many advantages in preoperative assessment of renal tumours while carrying negligible risk to the patient.

MDCT UROGRAPHY IN PATIENTS WITH HAEMATURIA

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INTRODUCTION: Multi-Detector CT Urography (MDCTU) is increasingly used in the investigation of haematuria in high risk patients with negative ultrasound and flexible cystoscopy. This study was performed to ascertain the incidence of malignancy and other causes for haematuria on MDCTU.

METHOD AND MATERIALS: Patients who underwent MDCTU in a large tertiary centre from May 2004 to October 2009 were identified. MDCTU reports were obtained and the following was analysed: indication for MDCTU, ultrasound, cystoscopy, cytology results and MDCTU findings.

RESULTS: 1138 MDCTU were performed, 60% (n=684) in male and 40% (n=454) in female patients. The age range was 13-94 years (mean=62.2 years). 620/1138 (54.5%) MDCTU were performed in patients with haematuria (465 frank, 79 microscopic 76 non-specific). Of patients with microscopic haematuria 4/79 had renal calculi, 6/79 TCC (1 bladder, 5 upper tract) and 1/79 RCC. Non-specified haematuria found 9/76 stone and 9/76 TCC (3 bladder, 6 upper tract). MDCTU findings in patients presenting with frank haematuria were 62/465 stone, 3 RCC, 35 TCC, 16 possible TCC. Of these patients, 86.5% (n=402) were aged 45 years or over, in which 34 histologically proven TCC were found. 13.5% (n=63) MDCTU were performed in patients <45years and no TCC was found in <45 age groups.
A total of 48 TCC were confirmed histologically (34 in patients with frank haematuria, 8 non-specified, 6 microscopic). 19 were renal, 16 ureteric and 13 bladder tumours. 5/1138 cases had histologically confirmed upper tract TCC without haematuria.

The overall incidence of TCC is 4.7% (53/1138) with upper tract TCC 3.5% (40/1138).

**CONCLUSION:** MDCTU is a valuable tool in the investigation of high risk patients with unexplained haematuria when both ultrasound and cystoscopy are negative. In this study, the overall incidence of histological proven upper tract TCC was 40/1138 (3.5%) and 8.5% in high risk patients.

**DIGITAL ANGIOGRAPHY IN THE EVALUATION OF CHALLENGING FOCAL RENAL LESIONS**

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**PURPOSE:** to evaluate the added value of intra-arterial digital subtraction angiography (i.a. DSA) in the diagnosis of indeterminate renal lesions.

**MATERIALS AND METHODS:** during a year period we have performed 18 selective renal DSAs in patients with renal lesions and inconclusive findings in other examinations like Ultrasonography (U/S), Computed Tomography (CT) or even Magnetic Resonance Imaging (MRI). All examinations were conducted on Philips Allura XP/Per FD 20. In most of the cases the main differential diagnosis was between neoplastic or inflammatory lesion. Based on the DSA appearance the lesions were graded into four grades: grade I, avascular lesions; grade II, minimal vascularity; grade III, moderate vascularity; grade IV, marked vascularity. DSA results were compared to final pathology findings either after percutaneous fine needle aspiration biopsy (FNAB) or following lesion surgical resection.

**RESULTS:** In 6 cases renal cell cancer was revealed, in 1 bilateral primary renal cell synchronous carcinoma, in 1 oncocytoma, in 4 angiomylipoma, in 2 complicated renal cysts and in the rest 1 liposarcoma, 1 metastasis from prostate cancer and 1 xanthogranulomatous pyelonephritis. In the last patient DSA proved that the mass in the upper pole of the kidney was attributed to adrenal pheochromocytoma. DSA helped to establish the diagnosis in 15 cases. In the rest 3 cases (liposarcoma, metastasis from prostate cancer and xanthogranulomatous pyelonephritis) DSA results were also inconclusive and patients underwent percutaneous CT-guided FNAB.

**CONCLUSIONS:** the diagnostic role of DSA in indeterminate renal lesions should not be underestimated. Despite its interventional nature this technique could be used when all other diagnostic tests are inconclusive to point out a definite diagnosis. Patient management could be affected when DSA is added in the diagnostic evaluation following specific clinical indications.

**EXTRA-URINARY FINDINGS ON MULTI-DETECTOR CT UROGRAPHY**

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**INTRODUCTION:** Multi Detector CT Urography (MDCTU) is performed in many centres when investigating haematuria, in follow up of urothelial malignancy and in complicated stone disease. MDCTU produces excellent images of both the urinary tract and the other abdominal organs, and this poster aims to provide a pictorial review of extra-urinary findings seen on MDCTU.

**MATERIALS AND METHODS:** All patients who had MDCTU between May 2004 and October 2009 in a large tertiary centre were identified. Clinical reports were evaluated and data collected on patients with an extra-urinary finding.

**RESULTS:** During this period a total of 1138 CTU were performed, 60% in male (n=684) and 40% in female (n=454) patients. Age range was 13-94 years with a mean of 62.2 years. An extra-urinary finding was documented on the clinical report in 98/1138 (8.6%). The commonest abnormalities were aortic aneurysm (n=12), liver lesion (n=12), ovarian cyst/mass (n=10), lung mass (n=10), bone lesion (n=8). 2 patients had an anatomical variant in the venous anatomy. Incidental primary carcinomas were detected in the lung (n=7), ovary (n=5), pancreas (n=2), prostate (n=2), cervix (n=1) and sigmoid colon (n=1), with secondary deposits seen in bone (n=4), liver (n=2) and adrenal gland (n=1).

**CONCLUSION:** MDCTU is a useful investigation in looking for urinary tract abnormalities and it is important to be aware that clinically significant extra-urinary findings may be detected when reporting MDCTU so that these findings can be managed in a timely fashion.
CT UROGRAPHY PROTOCOLS: DO WE NEED THE UNENHANCED PHASE TO CHARACTERIZE RENAL MASSES?
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INTRODUCTION: Different techniques have been proposed to reduce CT Urography (CTU) radiation dose: low mAs settings, restricting CTU to high-risk patients and lowering the number of CTU phases. CTU protocols include the unenhanced phase to provide attenuation measurements for any detected renal mass but, to our knowledge, there are no studies regarding the value of the different CTU phases detecting renal masses.

PURPOSE: To evaluate the detection and characterization of renal masses on CTU studies in order to avoid the unenhanced phase.

MATERIAL AND METHODS: 76 patients prospectively underwent a single bolus-three phase CTU. Two independent readers analyze each phase in random order (unenhanced- nephrographic and excretory) identifying the number, type, localization and size (> 1 cm) of renal masses. The lesions attenuation (Hounsfield Units) were measured in the unenhanced and nephrographic phases. Median change in attenuation between phases was calculated and correlated with size, and localization. The readers agreement was calculated with the Interclass correlation.

RESULTS: We found a total of 58 renal masses: the most frequent, 53 (91%), were benign cystic lesions, and only 3 were malignant lesions (2 RCC, 1 TCC). Median lesions size was: 2.7 cm (SD:1.5, range:1.1-8.6). There was no relation between lesion size, localization and its density in any phase (p> 0.005). The median value for renal masses on the unenhanced phase was 10 HU (QD= 6.4) and 15 HU (QD= 8.9) in the nephrographic phase with a linear regression between the two phases (r: 0.67), p < 0.0001. All lesions were correctly characterized in the nephrographic phase. The readers agreement was good: 0.79, p< 0.0001

CONCLUSIONS: The unenhanced phase is not necessary in a CTU study since most of the renal lesions can be characterized in the nephrographic phase by lowering radiation doses.

PREOPERATIVE MRI OF THE PROSTATE: A ONE YEAR RETROSPECTIVE AUDIT
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INTRODUCTION AND OBJECTIVES: MRI is used for staging patients with prostate carcinoma who are eligible for radical treatment. Pathology is the accepted gold standard in staging disease. This study aims to demonstrate the experience in a tertiary centre correlating pathology and MRI staging, and to illustrate some difficulties and failings of preoperative staging with MRI.

METHOD AND MATERIALS: All patients who underwent a prostatectomy in our institution in 2009 were identified. MRI and pathology reports were obtained and the results compared to assess the accuracy of the radiology report. T and N staging and haemorrhagic change on MRI following prostate biopsy were assessed.

RESULTS: 110 prostatectomies were performed in 2009 of which 76 patients had preoperative MRI available for review. 1 report was unavailable, so 75 MRI and pathology reports were compared. 45/75 MRI reported organ confined disease, of which 11/45 (24%) were deemed to be correct on pathology and 34/45 (76%) incorrect (mostly microscopic T3a disease). 30/75 were reported as non-organ confined disease, of which 27/30 (90%) were found to be correct at pathology and 3/30 (10%) incorrect. 4/75 patients had metastatic lymph nodes at surgery not detected prospectively by imaging. Only one of these cases was present on review of the MRI with 3 cases demonstrating micro-metastatic disease at pathology. 28/75 (37%) had artefact from haemorrhage contributing to the inaccuracy of T staging. MRI scans were then looked at retrospectively to ascertain any common pitfalls in interpretation. Areas of difficulty included: (a) Early microscopic T3a, T3b and T4 bladder disease, (b) Micro-metastatic pelvic lymph nodes. Images will be shown to demonstrate difficult areas.

CONCLUSION: MRI is insensitive in the detection of microscopic T3 disease, microscopic nodal disease and early T4 bladder disease. The positive predictive value of non-organ confined disease was high.
UTERINE FIBROID EMBOLIZATION
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OBJECTIVES: To evaluate midterm results, clinical outcome, grade of fibroid necrosis and patient’s satisfaction after uterine fibroid embolization (UFE) for symptomatic or large uterine fibroids.

MATERIAL AND METHODS: 165 UFE were performed in 159 women with symptomatic or large uterine fibroids. Outpatient women were evaluated by an interventional radiologist (IR) before UFE. The patients were admitted and assigned to IR for one day after UFE. The follow-up was carried out 1 and 12 months after embolization. Postembolization syndrome, clinical outcome and MR grade of necrosis was recorded. The patients were phoned and asked about their grade of satisfaction.

RESULTS: Technical success was achieved in all cases. Follow-up was available in all women (27 patients embolized last year have a shorter follow-up). In the vast majority (90%) there was a substantial improvement of symptoms. Additional treatment was needed 11 patients: 6 of them were re-embolized and 5 had a hysterectomy. 1 month after embolization MR showed complete necrosis of fibroids in 58% of embolizations, and partial necrosis in 39%. One year after, MR showed 50% complete necrosis and 34% partial necrosis. There were only 13 complications related to embolization procedure (7.8%): 1 uterine fibroid infection (0.6%); 2 minimal inguinal haematomas (1.2%); 1 allergic reaction (0.6%) and 7 women had vaginal discharge or fibroid expulsion after UFE (4.8%). When asked by phone, more than 95% showed high grade of satisfaction and would repeated the experience.

CONCLUSION: UFE is safe and effective with low grade of complications. The midterm results show significant improvement of symptoms and satisfaction in the majority of women.

THE VALUE OF MR UROGRAPHY (MRU) IN THE ASSESSMENT OF RENAL DUPLEX SYSTEM IN CHILDREN
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AIM: The purpose of this retrospective study was to determine diagnostic value of magnetic resonance urography in cases of duplex renal system.

MATERIAL AND METHODS: Thirteen cases between five month to nine years with suspected or known duplex renal system were evaluated by ultrasound (USG), voiding cystourethrography (VCUG), intravenous urography (IVU) and magnetic resonance urography (MRU). The findings of these diagnostic imaging studies were compared with each other and against the results of final diagnosis established at surgery.

RESULTS: Duplex renal system was identified in 9 of these cases on USG. IVU was revealed duplex renal system in four cases and in two was raised the suspicion of this condition. IVU was revealed duplex renal system in 5 more patients in delayed (one to two hours) views. VCUG was suggestive for renal abnormality in one in the base of cystoureteric junction positioning and in three cases by the urine regression. Finally the condition was diagnosed in all cases with MRU.

CONCLUSION: MRU is superior and far accurate than IVU, MCU and USG in diagnosing duplex renal system. In a significant number of cases of possible renal tract duplication, additional relevant information to other imaging modalities can be obtained from MRU. MRU gives the potentiality to illustrate the collecting system, renal parenchyma and the surroundings structures as well as to quantify renal function and urinary drainage, and all these without using radiation.

IMAGING CHARACTERISTICS OF MATURE CYSTIC TERATOMAS: US, CT AND MRI FINDINGS
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INTRODUCTION: Mature cystic teratoma (MCT) is the most common germ cell neoplasm. It is the most common ovarian mass in children. We present radiologic findings of 15 female patient have been complaining of dysmenorrhea and abdominalgia at inferior quadrants and diagnosed as mature cystic teratoma at radiologic imaging.

MATERIALS AND METHODS: Fifteen women patients referred to our hospital between the dates August 2008 and January 2010. At radiologic evaluation successively we performed US, CT and MRI.
RESULTS: The most US finding was cystic lesions with heterogenous component in the cystic lumen and the others were fluid-fluid levels and multiple thin echogenic cystic cavities at ovarian levels. By using CT, fat is easily measurable. Fat has lower attenuation than water. By observing MRI, fat shows short T1 relaxation time together with a relatively long T2 relaxation time; thus appears hyperintense on T1-weighted and intermediate intense to hyperintense on T2-weighted fast spin echo images. Hyperintense foci produced by fat within ovarian tumors allow specific diagnosis of teratomas, even though these signal intensities are not specific, and signal intensity on T1- and T2-weighted images does not always allow reliable identification of the fat. At MRI our cases showed T1 hipointensity and heterogenous variable T2 appearance according to the fat component. With contrast injection nearly half of the cases showed mild enhancement with MRI.

CONCLUSION: Most mature cystic teratomas can be diagnosed at US. However, the US diagnosis is complicated by the fact that these tumors may have a variety of appearances. The diagnosis of mature cystic teratoma at CT and MRI is fairly straightforward because these modalities are more sensitive for fat.

ROLE OF FETAL MRI IN THE EVALUATION OF PULMONARY DISEASE
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INTRODUCTION: The aim of this study was to evaluate the role of fetal MRI in pulmonary development and characterization of pulmonary disease.

MATERIALS AND METHODS: We enrolled in the study 23 fetuses with an ultrasonography diagnosis of either pulmonary or abdominal diseases. Fetal MRI examinations were performed with 1.5-T magnet (Siemens Somatom Avanto) using multiplanar T2 weighted sequences, HASTE (Half-Fourier Acquired Single-Shot turbo Spin-Echo) and True FISP (Fast Imaging in Steady State), T1 weighted sequences FLASH 2D (Fast Low Angle Shot) and DWI imaging.

RESULTS: MRI confirmed ultrasound suspicion of pulmonary disease in 9/23 fetuses (6 CCAM, 3 monolateral pulmonary hypoplasia); MRI confirmed ultrasound diagnosis of abdominal pathology and characterized an associated pulmonary disease in 5/23 fetuses (5 bilateral pulmonary hypoplasia). In 1/23 cases MRI excepted a monolateral pulmonary hypoplasia diagnosed by ultrasound confirming the pleural effusion. In 3/23 fetuses MRI confirmed the ultrasound diagnosis of pulmonary and abdominal diseases and revealed associated thoracic-abdominal anomalies. In the end MRI confirmed ultrasound suspicion of pulmonary disease and diagnosed associated pulmonary anomaly in 5/23 fetuses (3 CCAM associated to intralobar bronchopulmonary sequestration and 2 CCAM associated to extralobar SBP), raising the new question concerning “hybrid” lesions.

CONCLUSION: MRI represents an adjunctive tool, complementary to ultrasound, in the evaluation of pulmonary maturation and characterization of thoracic masses, useful in the postnatal therapeutic planning.

THE ROLE OF INTRAOPERATIVE ULTRASOUND IN DECISION OF RADICAL AND PARTIAL NEPHRECTOMY
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INTRODUCTION: The aim of this study was to examine renal tumors by intraoperative ultrasound (IOUS) and investigate its effect on the decision of the type of nephrectomy.

MATERIALS AND METHODS: Forty-four patients were assessed by IOUS and MR examinations to determine the type of surgery that would be recommended. Reviewing the gross specimens and postoperative reports, the pathologist and urologists made a decision about the type of nephrectomy that should have been performed. The observers scored their decisions as: 1) Radical nephrectomy, 2) Partial nephrectomy can be (could have been) attempted, 3) Partial nephrectomy.

RESULTS: In radical nephrectomy group (n=36), 23 lesion decision of IOUS and pathologist was the same as Score-1. In 7 of 8 lesions, IOUS Score-2 were confirmed by pathology. In 5 lesions IOUS Score-3 was similar to pathologist’s. The scores of MR observers were: Score-1 in 27 and 30 patients, Score-2 in 4 and 7 patients, and Score-3 in 2 and 2 patients. In partial nephrectomy group, 9 of 10 lesions received the same decision of Score-3 and one as Score-2 from both IOUS and pathologist. The MR observers’ scores were disconcordantly distributed. The overall correlation of IOUS-pathology was 0.991, and MR observers-pathology were 0.786 and 0.731.
CONCLUSION: The IOUS can be suggested as a valuable method in centrally located tumors with suspicious sinus extension which can not clearly be demonstrated by MRI. The close cooperation of urologist and radiologist in renal tumor work-up would reduce unnecessary radical nephrectomy operations.

DIAGNOSIS OF URETERAL AND PELVIC TUMORS AND SPLIT BOLUS CT UROGRAPHY
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PURPOSE: To study the ability of split bolus CT urography to diagnose pelvic and urothelial tumors and to distinguish between malignant and benign tumors.

METHOD: Retrospective analysis of patients who 1) had an urothelial or pelvic tumor removed surgically from 2005 through 2009, 2) underwent CT urography and 3) had the tumor examined by histopathology. The attenuation of the tumor was measured before and after CM administration.

RESULTS: A total of 53 patients (58 % men) with a mean age of 71 years (mean age 33-86) were included. Histopathology showed that 49 % of the lesions were malignant. None of the 53 patients underwent CT-urography within 12 months of the actual CT-urography. No statistically significant difference in increase in attenuation between malignant and benign tumors was revealed.

CONCLUSION: Split bolus CT urography is a highly sensitive method for diagnosing upper urinary tract cancers, but it can not be used to distinguish between malignant and benign tumors.

VASCULAR RESISTANCE IN THE PROSTATE: CAN IT BE AN INDEX IN BPH?
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OBJECTIVE: To evaluate the relationship between prostatic vascular resistance and prostate, transitional zone index, and IPSS (International Prostatic Symptom Score) in patients with Benign Prostatic Hyperplasia (BPH).

MATERIAL AND METHOD: 30 BPH patients with moderate or severe IPSS were compared with their normal counterparts. Transrectal Ultrasonography was used to calculate the prostate volume (PV) and Transitional Zone Index (TZI: Transitional zone volume / PV). Power doppler imaging was used to identify the capsular and urethral arteries of the prostate and measured the Resistive Index values. The relationship between volumetric parameters (PV, TZI) and Resistive Indexes (capsular artery RI, urethral artery RI) were assessed. Also, the correlation between IPSS scores and RI values of the patients were calculated.

RESULTS: The mean age was 52.0±4.8 and 54.3±5.2 years in BPH patients and controls, respectively. PV and TZI values were higher in BPH group (42±7.1 vs 36±6.3, p=0.02) and (0.43±0.18 vs 0.26±0.21, p<0.01), respectively. Regarding RI, higher capsular artery RI in study group was measured (0.72±0.04 vs 0.57±0.05, p<0.01). The difference between urethral artery RI of both group was not significant. Patients with high IPSS score (20-35) had higher capsular artery RI values than patients with moderate IPSS score (8-19). The difference was significant (0.77±0.05 vs 0.67±0.09, p<0.01). Also, positive correlation between TZI and capsular artery RI was found (r=0.697, p<0.01).

CONCLUSIONS: TZI and PV values among BPH patients was higher than controls. There is a positive correlation between TZI and capsular artery RI. Higher capsular artery RI was found in patients with severe IPSS score. Our findings indicate that, high resistive index values can be an index for patients suffering from BPH related symptoms. But, further clinical study with large number is necessary to establish this relation.

FEASIBILITY OF FETAL MRI IN EVALUATION OF URO-GENITAL MALFORMATIONS
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INTRODUCTION: Our study aimed to evaluate the feasibility of fetal magnetic resonance imaging(MRI) to visualise and characterize the uro-genital malformations.

MATERIAL AND METHODS: From March 2009 to March 2010 we performed 42 fetal MRI, enrolling 42 pregnant women with the US suspect of a fetal urogenital mass or because the US resulted not
diagnostic because of oligohydramnios. Fetal MRI was performed with a 1.5-T Magnet System (Siemens Avanto), with one or two multichannel phased-array surface coils, in standard condition and without sedation of the mother.

**RESULTS**: Fetal MRI detected: 2 isolated urinoma, 2 posterior urethral valves, 3 isolated multicystic dysplastic kidneys, 1 polycystic dysplastic kidneys associated with hypertrophic bladder, 1 stenosis of pyelo-ureteral junction, 4 ectopic kidneys, 1 megalourethral, 1 isolated renal pyelectasis, 2 hydrourteronephrosis, 2 adnexal cysts, 1 kidney horseshoe, 1 mega bladder, 3 renal agenesis (1 bilateral), 1 urinoma associated with stenosis of pyelo-ureteral junction, 1 urinoma associated with hydrourteronephrosis, 1 multicystic dysplastic kidney associated with ureterocele, 7 double renal pelvis associated (respectively to: 1 ureterocele, 1 ectopic kidney and hydrourteronephrosis, 1 urinoma and pyelectasia, 1 hydrourteronephrosis and pyelectasia, 1 ureterocele, 1 polycystic dysplastic kidneys associated with hydrourteronephrosis, 1 renal pyelectasis and ureterocele), 1 ectopic kidney associated with hydrourteronephrosis, 3 renal pyelectasis associated with 2 hydrourteronephrosis and 1 to hypertrophic bladder, 1 mesenteric cyst, 1 sacrococcygeal teratoma. FMRI confirmed the suspect in 35/40 cases, excluded the pathology in 2 cases and changed the diagnosis In 3 cases; furthermore in hypertrophic bladder, 1 mesenteric cyst, 1 sacrococcygeal teratoma.

**CONCLUSION**: Fetal MRI is a new adjunctive imaging modality in the diagnosis of fetal congenital urogenital malformations and the eventual associated abnormalities; it provides additional information regarding the lungs, improving the delivery management.

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**COMPARISON OF REAL TIME SONOElastography WITH T2 WEIGHTED ENDOrectal MAGNETIC RESONANCE IMAGING FOR Prostate CANcer DETECTION**

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**OBJECTIVE**: To compare the value of real-time sonoelastography (RTE) with T2 weighted endorectal magnetic resonance imaging (T2w-eMRI) for prostate cancer (PCa) detection.

**MATERIAL AND METHODS**: 33 patients with an elevated prostate specific antigen (PSA) level were investigated. All patients underwent RTE and T2w-eMRI at 1.5T for PCa detection before systematic prostate biopsy. RTE was performed to assess prostate tissue elasticity. High-spatial-resolution endorectal T2-weighted turbo-spin MRI of the prostate was obtained in 2 planes. The imaging findings of the 2 techniques were assigned to 6 outer gland areas. The cancer detection rates for the 2 imaging modalities were analysed.

**RESULTS**: Overall, PCa was detected in 13 of 33 patients (39.4%). Both, RTE and T2w-eMRI detected 11 PCa positive patients (84.6%). RTE demonstrated 27 suspicious lesions in the 198 outer gland areas, and 15 (55.6%) were PCa positive. T2w-eMRI demonstrated 31 suspicious lesions in the 198 outer gland areas, and 13 (40.6%) were PCa positive. This resulted in a sensitivity and in a negative predictive value by patient of 84.6% and 86.7% for RTE and of 84.6% and 83.3% for T2w-eMRI. The by area analysis showed a sensitivity and a negative predictive value of 57.7% and 93.6% for RTE and 50.0% and 92.2% for T2w-eMRI.

**CONCLUSION**: RTE as a non invasive method for PCa detection showed results comparable with findings on T2w-eMRI.

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**RENAI SAFETY IN PEDIATRICS: XENETIX 300 VERSUS VISIPAQUE 270 IN MSCT**

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**OBJECTIVES**: Iodinated contrast media (CM)-induced nephropathy (CIN) is one of the most common reasons for acute kidney injury. It is still debated whether the use of iso-osmolar CM versus low-osmolar CM would be associated with a lower incidence of CIN.

**MATERIALS AND METHODS**: 146 children, 11 months to 16 years old, included in this multicenter trial underwent enhanced CT for any indications and randomly received a mean injection of either 1.8 ± 0.4 ml/kg Xenetix® 300 (iobitridol) or 1.9 ± 0.2 ml/kg Visipaque® 270 (iodixanol). The primary
endpoint was the variation of the creatinine clearance between pre (48h) and post-injection (72h) values, using a non-inferiority analysis. Secondary endpoints were incidence of CIN (defined as a creatinine clearance decrease of 25% or more), global contrast quality (3-point scale: poor, moderate, good), diagnostic efficacy (3-point scale: impossible, difficult, easy) and clinical safety (adverse events and vital signs over 10 days).

RESULTS: In the intent-to-treat population (128 children), the mean difference (iobitridol – iodixanol) in creatinine clearance variation from baseline was -1.2% and was different from the -5% non-inferiority margin (p=0.042), demonstrating the non inferiority of iobitridol over iodixanol. The results were consistent in the per-protocol population (68 children), with a mean difference of 2.2% (p=0.027). CIN incidence was observed in 3 patients (4.8%) with iobitridol and 7 patients (10.6%) with iodixanol. No statistical significant differences were found for the other secondary criteria.

CONCLUSION: Good renal safety profile, with no difference between Xenetix® 300 and Visipaque® 270, was confirmed in children with normal renal function.

VARICOCELE, THE NUTCRACKER SYNDROME AND ULTRASONOGRAPHIC FINDINGS

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INTRODUCTION: Varicocele is a vascular lesion commonly associated with infertility. Its etiology is only partly understood, hence to purpose of the study was to establish its correlation with intrinsic anatomic differences and the nutcracker syndrome.

METHODS: 169 patients were enrolled: 93 patients with varicocele and 76 patients without varicocele. The diagnosis of varicocele was based on physical examination, followed by ultrasonographic evaluation of the left renal vein (LRV) at hilar and aortomesenteric (AMP) portion. The anteroposterior diameter in mm and peak flow in cm/s in each region were measured.

RESULTS: 28 patients with the nutcracker syndrome were identified in the case-group (30.10%) and 2 in the control group (2.63%). Mean diameter of the hilar portion of LRV was 7.38±1.19 mm in case group and 6.11±0.97 mm in the control (P <0.0001). The mean diameter of LRV at the AMP was 1.63±0.54 in varicocele-affected patients, and 2.29±0.46 in the control group (P<0.0001). The mean peak velocity at the hilar portion was 20.49±3.77 in the case group and 25.66±4.29 in the control. The mean peak velocity at the AMP was 87.91±22.79 in case group and 63.89±15.94 in the control. Both values were significantly different (P<0.0001). Patients with varicocele and the nutcracker syndrome did not demonstrate a significant difference in either the hilar or AMP diameter in comparison with varicocele patients. They show a significant difference in both the hilar and AMP peak flow velocity (p=0.0001 and 0.0001).

CONCLUSIONS: The nutcracker syndrome is a frequent finding in varicocele-affected patients and should be routinely excluded as a possible cause of varicocele. In addition, intrinsic anatomic differences in AMP and hilar portion of LRV could be directly responsible for the onset of varicocele. Surgical treatment may be of benefit to those patients.

THE ROLE OF INTERVENTIONAL RADIOLOGY IN VENOUS BLOOD SAMPLING REVISITED

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OBJECTIVES: Venous blood sampling (VBS) was “routine” procedure to localize endocrine tumors before “noninvasive” imaging. Lately the need of VBS decreased. With newer CT scanners, small tumors (<5mm) are found. Most young IRs do not learn VBS procedures. Some physicians are unaware of these “obsolete” but important IR procedures. Therefore, VBS must be “resuscitated” and “revisited.”

METHODS: VBS procedures reviewed are: inferior petrosal sinus VBS and sinography, cavernous sinus VBS and sinography, VBS and venography of neck, chest and mediastinal veins, percutaneous catheterization of the portal vein for VBS, adrenal gland VBS and venography, right hepatic vein VBS during arterial stimulation with CA++, gonadal VBS and venography, and renal vein and IVC VBS.
RESULTS: Radiologists, IRs, and clinicians alike must be aware of the role of VBS and venography in evaluating patients with clinical and laboratory evidence suggesting an endocrine tumor(s) in whom, a complete workup, including “noninvasive” imaging, is nondiagnostic.

CONCLUSION: We review VBS and venography in patients with clinical and laboratory evidence of endocrine tumor(s) and a workup, and “noninvasive” imaging nondiagnostic. VBS accurately localize endocrine tumors in those patients. Furthermore, some tumors are not hormone-producing: “incidentalomas.” VBS is simple, safe, easy, must be “resuscitated,” revisited, and included in the training of young IRs.

ESTABLISHMENT OF ORTHOTOPIC HUMAN RENAL CELL CARCINOMA MODEL IN AN ANIMAL MODEL: RADILOGIC FINDING AND HISTOLOGIC CORRELATION

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OBJECTIVES: The preclinical evaluation of new treatments requires an animal tumor model that mimics the human counterpart. Although various animal renal cancer models have been described, orthotopic xenografts of human tumor cells can more accurately reproduce the original disease state than the more commonly used subcutaneous xenografts in preclinical development. The purpose of our study was to develop orthotopic xenograft models of human renal cell carcinoma (RCC) in SCID (Severe Combined Immunodeficiency) mice and to demonstrate MR findings and histologic findings.

MATERIALS AND METHODS: Eight 5-week-old female SCID mice were utilized to establishing an orthotopic RCC model. They were acclimated for 1 week under specific pathogen-free conditions. The hair and skin overlying the right flank were sterilized after the mice were anesthetized with intraperitoneal injection. A 1 cm longitudinal incision was made and the right kidney was exposed through the incision. Human RCC cell line (ACHN) suspension of 5 x 10⁵ cells was injected under the renal capsule. Six weeks later, contrast-enhanced MR was performed using clinical MR scanner with a dedicated coil. The mice were sacrificed by CO₂ inhalation. The tumor-bearing kidney was harvested and fixed for hematoxylin and eosin staining.

RESULTS: Tumor implantation was successful in all mice. Mean tumor size was 1.1 cm (0.8 – 1.3 cm). All tumors were subcapsular in location and showed exophytic growth. Seven were confined in the kidney and one showed invasion to adjacent fat tissues. The implanted tumors demonstrated low signal intensity on T1-weighted images and high signal intensity on T2-weighted images, and heterogeneous enhancement on Gd-enhanced T1WI.

CONCLUSIONS: This study shows the potential feasibility of orthotopic human RCC models in SCID mice. Orthotopic human RCC animal models are expected to improve the knowledge of pathophysiology of renal cancers and may be useful in studies for the response to cancer treatments.

GAMMA KNIFE RADIOSURGERY FOR NON-INVASIVE MANAGEMENT OF BRAIN METASTASES FROM RENAL CELL CANCER

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INTRODUCTION: The long-term survival often achieved in patients with renal cell carcinoma (RCC) requires aggressive management, even in the presence of multiple brain metastases. Standard surgery and whole-brain radiation (WBRT) are not the most effective treatment and can have undesirable long-term side-effects. In this study we retrospectively review our results using gamma knife radiosurgery (GKRS) for brain metastasis from RCC from a single institution.

MATERIAL AND METHODS: From November 1993 through March 2010, 93 radiosurgical treatments using the Leksell GKRS unit were performed on 56 patients with brain metastases from RCC. There were 37 males and 19 females, ages ranging from 38 to 87 years (median: 68 years). The indications for treatment were failure after WBRT or de novo treatment. All radiosurgical treatments were given on an outpatient basis using local anesthesia plus conscious sedation. The work-up included MRI in all patients except two who had CT only. The mean minimum tumor dose was 16.1 Gy, and the mean volume was 2.9 cc. Previous WBRT had been given in 19 out of 56 patients (34%). Sixteen of 56
patients (29%) presented with single brain metastasis, and 40 patients (71%) had multiple metastases, from 2 to 24.

**RESULTS**: The Kaplan-Meier median survival estimate (n=53) is 8 months (current maximum survival is 112 months). The Kaplan-Meier survival estimates at 1-5 years are 29%, 15%, 8%, 5% and 4%. Four patients out of 42 evaluated patients (9.5%) experienced brain-related deaths. The remaining 38 patients (90.5%) died of non-neurological causes. Overall local control was 95%. Seventeen of 56 patients (32%) had a site retreated with GKRS. One patient developed radiation necrosis. No other significant complications were encountered.

**CONCLUSIONS**: GKRS is an effective noninvasive modality of treatment for RCC metastatic to the brain. It offers high local control rate and improved survival with minimal complications.

**PERCUTANEOUS RADIOFREQUENCY ABLATION OF SOLID RENAL MASSES: TECHNIQUES AND OUTCOMES OF 21 TREATMENT SESSIONS IN 16 CONSECUTIVE PATIENTS**

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**OBJECTIVE**. The purpose of this study was to retrospectively evaluate the results of percutaneous radiofrequency ablation (RFA) of solid renal masses.

**MATERIALS AND METHODS**. 16 patients (17 tumors) were treated with 21 percutaneous RFA sessions over a 4-year period. During 20 sessions, radiofrequency ablation was performed using CT guidance, and one, using sonographic guidance. The indications for nonsurgical treatment were high surgical risk (n=11), bilateral renal cell carcinomas (n=1), solitary kidney (n=3), and the presence of metastatic disease (n=1). The average patient age was 77.6±6.1 years (range, 62-85 years), and the average renal mass size was 3.2±0.6 cm (range, 2.7-4.3 cm). Follow-up imaging was performed at 3 and 12 months and yearly thereafter.

**RESULTS**. 15 of 16 patients had successful treatment of the solid renal mass using percutaneous imaging-guided radiofrequency ablation. Successful treatment was defined as lack of enhancement of the treated region on follow-up CT. Five of 16 patients had residual enhancing tissue after the first treatment session and returned for a second session. Four residual tumors were successfully ablated by a second RFA procedure. The other one was not treated because of the progress of metastatic disease. One patient had perinephric hematomas (which did not require transfusion), and one patient had large perinephric abscess needing drainage. The average follow-up time was 24.1±15.9 months (range, 1-48 months).

**CONCLUSION**. Percutaneous imaging-guided radiofrequency ablation is a successful method for patients with small solid renal masses, which are not ideal candidates for surgical resection.

**EMBOLIZATION TO TREAT HAEMATURIA IN TRANSITIONAL CELL CARCINOMA OF THE BLADDER**

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**INTRODUCTION**: Haematuria is a common symptom in patients with advanced transitional cell carcinoma (TCC) of the bladder. These patients are often inoperable. We report our experience using radiologically guided embolization in the palliative treatment of intractable haematuria in this patient cohort.

**MATERIALS AND METHODS**: From August 2007 to October 2009, 5 male patients with TCC aged 66 – 81 (mean 74.4 years) underwent radiologically guided embolization to treat haematuria. All patients had inoperable disease. Pre-embolization haemoglobin was between 6.6 g/dl and 8.9 g/dl (mean 7.6 g/dl). Gelfoam was used as the embolization agent in 3 patients and coils were used in 2.

**RESULTS**. 4 patients (80%) experienced permanent cessation of haematuria. Bleeding stopped permanently in 100% of patients embolized with gelfoam. It took between 2 – 3 days (mean 2.3 days) for the urine to become clear. 1 patient (20%) had continued haemorrhage despite 3 attempts at embolization. Repeated surgical attempts to treat his haematuria were also unsuccessful. One patient developed asymptomatic iliac artery thrombosis as a peri-procedural complication.

**CONCLUSIONS**: Radiologically guided embolization is a safe and effective method for palliating haematuria in patients with TCC. It should be considered as a primary alternative when conservative measures have failed. Our results compare favourably with previously published data, the success
rates of which vary from 43 – 100%. On the basis of our experience we would recommend gelfoam as the embolic agent of choice.

ISOTROPIC 3D T2-WEIGHTED MR IMAGING FOR FEMALE PELVIS WITH 3.0 TESLA MRI: FEASIBILITY STUDY
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OBJECTIVE: The aim of this study was to compare the quality of images obtained with 3D T2-weighted sequence at 3.0 Tesla with the quality of conventional 2D T2-weighted images.

SUBJECTS AND METHODS: Thirty-eight consecutively registered patients (average age, 43 years old; age range 11-79) underwent imaging at 3.0 T with a 6-element body array coil. All imaging was performed with three T2-weighted images: 3D axial T2-weighted images (SPACE; TR/TE=2700/287, PAT=2, Slice thickness=1.0mm, Matrix= 256x256, FOV250, ETL=71) and conventional 2D axial and sagittal T2-weighted images (FSE; TR/TE=4000/93, Slice thickness=3.0mm, Matrix= 288 x 384 FOV200, ETL=19). Quantitative measures of image signal and contrast (coupus: myometrium (MY)/junctional zone (JZ), MY/endometrium (EM), MY/JZ, cervix: MY/stromal ring(SR), EC(endocervix)/MY, EC/SR) were evaluated by analysis of variance and paired Student’s t tests. A 5-point scale (1, non-diagnostic, to 5, high diagnostic confidence) was used to compare the 3D and 2D data sets for image quality and definition of uterus and ovarian anatomic features. We also analyzed 3D images could be used as the alternative sequence or not. Friedman’s nonparametric and Wilcoxon’s rank sum tests were performed for statistical analysis of the qualitative assessments.

RESULTS: Quantitative results showed significant differences contrast of MY/EM, MY/JZ and EC/MY between 3D and 2D T2-weighted images(p<0.001). The overall quality had no significant differences (4.0±0.95:2D-T2WI, 4.0±0.89:3D-T2WI). 3D images could stand comparison with that of 2D images, and 3D imaging was better at depicting uterine anatomy especially tortuous uterus and ovarian detection(p<0.001).

CONCLUSION: Three-dimensional volumetric T2-weighted images with 3.0T MRI are of content quality and give better anatomical recognition than conventional 2D images and have the added advantage of multiplanar and postprocessing capabilities.

11C-CHOLIN-POSITRONEMISSIONTOMOGRAPHY/COMPUTERTOMOGRAPHY (C-PET/CT) FOR THE DIAGNOSIS OF LOCAL PROSTATE CANCER RECURRENCE AFTER RADIATION THERAPY
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INTRODUCTION: The salvage radical prostatectomy (sRPE) represents a secondary therapy with curative intent for patients with local prostate cancer recurrence. Patients with organ confined prostate cancer seem to profit most from the salvage radical therapy. The C-PET/CT is an innovative imaging technique, which is being used more frequently for the local diagnosis of prostate cancer. However, valid study results are lacking. The aim of our study was to analyse the sensitivity of the C-PET/CT in the detection of intra- and extraprostatic prostate cancer and lymph node metastasis.

PATIENTS AND METHODS: 45 Patients with histologically proven prostate cancer recurrence after radiotherapy underwent a salvage radical prostatectomy after a CT, a bone scan and a C-PET/CT was performed. The prostate specimen were analysed according to the Stanford Protocol and correlated with the C-PET/CT results concerning intraprostatic localisation and number of cancer tissue spots >5mm.

RESULTS: Mean preoperative PSA was 7.8 (2-24) ng/ml; the mean Biopsy Gleason Score was 5.6 (4-9). No significant intraoperative complications were encountered. Mean blood loss was 420 (200-950)ml, on average 19 (10-32) lymph nodes were dissected. Histopathologically, a pT1-2pN0 was seen in 27 (60%), a pT3a/b and pTxpN1 PCA in 9 (20%) and 9 (20%) patients. A positive resection margin was identified in 5 (11%) patients. The C-PET/CT identified 1, 2, > 2 significant intraprostatic cancer spots in 23 (51.1%), 13 (28.9%) and 9 (20%) patients. The sensitivity for the prediction of intraprostatic cancer is 85%. The C-PET/CT correlated 100% with the histopathology of the transrectal biopsies, no false negative case was observed. There was a low sensitivity of C-PET/CT in the prediction of lymph node metastasis. A positive spot in the iliacal region and fossa obturatoria was
observed in 14 (31%) patients; histologically only 9 patients were detected to harbour lymph node metastasis, only 4 of them had a positive PET/CT.

CONCLUSION: The C-PET/CT is an innovative imaging technique for the diagnosis of local prostate cancer recurrence after radiation therapy. Due to its high sensitivity for the detection of prostate cancer recurrence, a C-PET/CT is of particular interest as additive diagnostic tool for patients with negative prostate cancer biopsies. The role in the diagnosis of lymph node metastasis is limited and of poor clinical significance.

THE INTRODUCTION OF A NEW CT REQUEST FORM FOR (CE) CT: A PILOT STUDY
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INTRODUCTION: Patients at high risk for contrast induced nephropathy (CIN) should be identified before performing a contrast-enhanced CT (ceCT). In order to identify these patients we introduced a new CT request form which tabulates all risk factors and provides a risk score. Simultaneously a special outpatient clinic for patients at high risk for CIN was opened. In a pilot study we evaluated this new procedure for planned elective ceCT in out-patients in a collaborative setting between the departments of Radiology, Urology, and Nephrology.

MATERIALS AND METHODS: During two months, request forms for ceCT of 122 patients who met the study inclusion criteria were received by the department of Radiology. Patients included were ≥ 18 years, outpatients from the department of Urology, and undergoing elective examinations. Information to be indicated on the request form was: eGFR estimated with the MDRD formula, and the risk factors: diabetes mellitus, known Kahler’s / Waldenstrom’s disease, peripheral vascular disease, heart failure, age over 75, anemia (=hematocrit < 0.39 for men and < 0.36 for women), symptomatic hypotension, large doses of contrast medium (>150 ml), decreased extracellular volume, and use of nephrotoxic drugs. A risk score was calculated. Patients at high risk for CIN were identified at the department of Radiology and referred to the “outpatient CIN clinic”. The nephrologist decided which precautionary measures were needed. The patients were admitted for day-care in case of hydration.

RESULTS: Thusfar, 122 patients were included. Of these, 38 patients had a pre-CT MDRD-GFR < 60 ml/min/1.73m2 and 20 patients were defined at high risk and referred to the “outpatient CIN clinic”. Todate, 5 patients received pre- and post-hydration in combination with the ceCT, 4 patients are planned for ceCT with hydration, 2 patients are planned for ceCT without hydration. The remaining patients are waiting for an outpatient visit.

In nearly all patients, the data required by the request form was given, the data was reliable, and the MDRD value was recently determined. In the patient group with a MDRD < 60 pre-CT, there was no CIN. Registration of pre- and post hydration and the amount of contrast media given was registered in a hydration passport.

The introduction of the new request form for patients undergoing ceCT, allows good identification of patients at risk for nephropathy. This resulted in closer patient monitoring and optimal preparation, thereby improving patient safety.

CONCLUSION: An adequate request form, appointment strategy and cooperation between the referring department, the departments of Radiology and Nephrology are obligatory in patients undergoing ceCT. This in order to identify patients at (high) risk for nephropathy and ensure that adequate measures are taken to prevent CIN.

DETECTION OF PROSTATE CANCER WITH HISTOSCANNING™
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INTRODUCTION AND OBJECTIVES: HistoScanning™ is a tissue differentiation, visualization and quantification tool which identifies changes to solid organ tissues. It uses native ultrasound in order to predict and visualise prostate carcinoma. HistoScanning uses a specific three dimension transrectal ultrasound device to acquire and transmit data to the HistoScanning program. The data are differentiated and suspicious areas in the prostate are localised and spotted in 3D. Our objective was to compare HistoScanning with histopathology of radical prostate specimens and to determine the HistoScanning sensitivity regarding to cancer volume and localization.
MATERIAL AND METHODS: From October 2009 until April 2010, 68 patients underwent a radical prostatectomy for clinically organ confined prostate cancer. HistоІncaging was performed one day preoperatively in 52 of them. 90% underwent ≥2 scans in order to exclude artefacts; the scan with the largest suspicious volume(s) was used for evaluation. Suspicious lesions measured ≥0,2 ml were considered positive. All prostatectomy specimens were processed according to the Stanford protocol and evaluated by an experienced uro-pathologist (RKC). The prostate specimen was divided into a grid of 9 different areas. HistоІncaging findings were correlated with final pathology of the radical prostatectomy specimens regarding to localisation and volume. A match was defined as a HistоІncaging positive lesion in a correspondent histopathologically positive area. The results were analysed regarding to pT-stadium, Gleason Score, PSA, tumour volume and volume of HistоІncaging-lesions.

RESULTS: Mean patient age was 63,6 (40-75) years, mean PSA was 8,97 (2,2-41,2) ng/ml, mean prostate volume was 45,4 (22-100) ml and mean tumour volume was 4,1 (0,35-22,8) ml. 27 (52%) patients had a pT2 tumour, 25 (48%) had a pT3 carcinoma. 4 (8%) patients had a salvage prostatectomy. 6 (11,5%) patients had a final Gleason Score (GS) 6, 34 (65%) and 8 (15%) patients had GS 7 and GS ≥8 respectively. HistоІncaging had 75% sensitivity for detecting and locating prostate carcinoma. 64% of these cases showed a good correlation for tumour volume. The results were identical for normal and salvage prostatectomy. The sensitivity was higher for pT3 tumours (92%) than for pT2 tumours (59%). HistоІncaging detected 50% of the GS 6 tumours, 74% of GS 7 and 100% of GS ≥8. The preoperative PSA had no statistical significance. HistоІncaging detected small (17/52) tumours (<1 ml) in 60%, intermediate (24/52) tumours (1-5ml) and large (11/52) tumours (>5ml) in 87 and 82%, respectively. Identical findings are seen regarding to the volume of suspicious HistоІncaging lesions. For small (17/52) (≤0,5 ml), intermediate (22/52) (0,5-2ml) and large (13/52) (>2ml) lesions, HistоІncaging correctly predicted prostate carcinoma localisation in 53%, 86% and 85%, respectively.

CONCLUSION: HistоІncaging seems to have a great potential in the detection of significant prostate cancer. In particular, extracapsular, poor differentiated and large prostate cancers show a high detection rate. However, larger prospective studies are needed to verify these preliminary results.
OBJECTIVE: Although the incidence of lymph node (LN) metastases of prostate cancer (PCa) is now lower than in the pre-PSA era, series of extended lymph node dissection (LND) have shown that the actual rate of LN metastases is higher than observed with obturator LND. The presence of LN metastases is an important prognosticator. Assessing which patients require LN staging and the preferred method for this is still under debate.

The objective of this study is to assess the sensitivity, specificity, positive and negative predictive values (PPV and NPV) of LN status for choline (CHOL) PET-CT and diffusion weighted (DW) MRI prior to a radical prostatectomy (RP) with super-extended LND (seLND) in patients at high risk for LN involvement.

MATERIAL AND METHODS: Patients with a risk ≥10% but <35% of LN metastasis (Partin tables) and with no clear evidence of LN involvement at contrast-enhanced CT, were prospectively enrolled in an imaging study consisting of a pelvic DW-MRI and a CHOL PET-CT. All patients underwent a seLND (resection of LN in the obturator fossa, the internal, external and common iliac region and presacral) and RP. Additionally, pararectal, paraaortic and paravesical nodes were sampled in 1 patient each, guided by sentinel node detection. All LN were serially sectioned (each 300µ) and completely histopathologically examined. These results (the gold standard) were then compared with the results of the functional imaging studies.

RESULTS: So far, 36 patients are available for analysis (see table for patient characteristics). In total, 733 LN were removed. 17 patients (47%) had a pN1 stage: 7 patients with 1 positive LN, 6 with 2, 2 with 3, 1 with 6 and 1 with 7 (38 positive LN in total). Overall, 32 different LN regions were affected (some had multiple positive LN). DW-MRI was able to detect 6 of these regions correctly. 26 regions were false negative and 7 were positive on DW-MRI but not on pathological examination. CHOL PET-CT identified 3/32 positive LN regions, which were all confirmed histologically. 29 regions were false negative and there was 1 false positive result for CHOL PET-CT.

CONCLUSION: These preliminary results suggest a low sensitivity but a high specificity and NPV in determining affected LN regions of PCa for CHOL PET-CT and DW-MRI. More patients are required to draw final conclusions.

ACKNOWLEDGEMENT: This work was supported through a research grant of IWT – Institute for the Promotion of Innovation by Science and Technology in Flanders – IWT TBM 060793

Table: Patient characteristics

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### P2. HERLYN-WERNER-WUNDERLICH SYNDROME: KEY IMAGING FEATURES AND POTENTIAL PITFALLS

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**OBJECTIVE:** Herlyn-Werner-Wunderlich Syndrome (HWWS) is a rare congenital malformation of the female urogenital tract. Uterus didelphys, blind hemivagina and ipsilateral renal agenesis are characteristic features of this syndrome. Therapy consists of surgical opening of the blind hemivagina. With timely diagnosis and correct management further complications are prevented and the fertility of these individuals can be preserved. Knowledge of the imaging features is therefore of high importance. The aim of this study was to review the key Ultrasound and MRI features of HWWS.

**MATERIAL AND METHODS:** The relevant radiological examinations of patients with suspicion of HWWS were reviewed in our PACS system. Selection of pertinent images with classic features of HWWS and/or potential pitfalls was made.

**RESULTS:** Ultrasonography of the abdomen classically shows a bifid uterus, heterogeneous fluid in the vagina and absence of a kidney. Pelvic MRI, though, is the modality of choice, because of the superb soft tissue contrast resolution. Standard T1 and T2 weighted imaging provides detailed information about uterine and vaginal morphology, the vaginal septum and hematocolpos and/or hematometra. Gadolinium-enhanced T1 weighed imaging or DWI clearly shows potential complications, like abscess formation. The limited scan range of pelvic MRI can lead to misdiagnosis of renal agenesis. An ectopic atretic ureter is another potential pitfall.

**CONCLUSION:** HWWS is rare congenital malformation of the female urogenital tract. Knowledge of the key imaging features and potential pitfalls will enable timely diagnosis and correct surgical management.

### P3. WHAT HAPPENS TO URETERIC STONES WHILE NOT IN THE X-RAY DEPARTMENT?

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**PURPOSE:** The aim of the study was to investigate the course and management of ureteric stones from the acute diagnosis with CT, to the first control examination. A second aim was to investigate which factors influenced on stone passage.

**METHODS AND MATERIALS:** 271 consecutive patients with acute flank pain were examined with CT. In 116 patients ureteric stones were diagnosed. 93 of these patients were followed. The size, localisation of the stone and the degree of obstruction were recorded at both examinations. The management between the two examinations was recorded.

**RESULTS:** The most common management was expectancy, 62/90 patients (69%), while 28/90 patients (31%) were treated with nephrostomy. The stone passed spontaneously in 48/93 patients (52%). Three parameters had a significant influence on stone passage, size of the stone (p=0.002), localisation of the stone (p<0.001) and nephrostomy treatment (p=0.003). In the expectancy group 40/62 (65%) stones passed spontaneously before the first control. 77% of the stones located in the lower ureter, 67% located in the middle ureter and 23% in the upper ureter passed spontaneously. 9/10 stones with a diameter ≤7 mm passed spontaneously. In the nephrostomy group 8/29 (28%) of the patients were free of stone at the first control. 38% of the stones localised to the lower ureter, 0% in the middle and 17% in the upper ureter passed spontaneously. Stones, which passed spontaneously, had a median diameter of 4.5 mm while remaining stones were 8 mm.
CONCLUSION: In the majority of patients managed with expectancy (65%) the stone passed spontaneously. This was especially true if the stone was located in the lower ureter and if the diameter was ≤7 mm. In almost 1/3 of the patients treatment with nephrostomy was needed. In patients treated with nephrostomy only 28% of the stones passed spontaneously. Patients treated with nephrostomy had larger stones, more severe obstruction and more often stones in the upper ureter. Size and localisation of the stone together with management were independent factors influencing on stone passage. Treatment with nephrostomy was shown to make the stone passage more difficult.

P4. DETECTION AND CHARACTERIZATION OF PROSTATIC CARCINOMA BY MEANS OF DYNAMIC CONTRAST-ENHANCED MAGNETIC RESONANCE IMAGING (DCE-MRI)

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BACKGROUND: Several randomized studies have shown that a higher radiation dose to the entire prostate improves the disease-free survival of patients with prostate cancer. However, further dose-escalation is limited by normal tissue toxicity of the surrounding structures. Furthermore, it has been demonstrated that local recurrence after external beam radiotherapy usually originates in the primary tumor site rather than in focal prostatic intraepithelial neoplasia. Both findings argue for dose-escalation to the primary tumor within the prostate. Therefore, an accurate visualization and characterization of these intraprostatic tumor nodules is imperative.

AIM: To determine the role of dynamic contrast-enhanced MRI (DCE-MRI) for the detection and characterization of prostatic carcinoma by means of semi-quantitative parameters.

MATERIALS AND METHODS: Fifty-three patients with biopsy-proven prostate cancer were examined by dynamic contrast-enhanced T1-weighted MR imaging at 1.5T. Cancer areas and benign prostatic tissue were identified and delineated based on the histopathology of whole mount sections after radical prostatectomy. Different semi-quantitative parameters were measured in both cancerous and benign regions of interest (ROIs): the time to peak (TTP), the maximal contrast enhancement (Cpeak), the speed of contrast uptake (Wash-in) and the clearance of the contrast agent (Wash-out). The area under the ROC curve was determined for each parameter.

RESULTS: Within individual patients, a consistently higher Cpeak (present in 43/53 patients; 81%) and Wash-in rate (in 50/53 patients; 94%) were observed in the cancerous tissue compared to the benign prostatic tissue. Both the TTP and the Wash-out were shorter in tumoral tissue compared to normal prostatic tissue in 79% (42/53) and 83% (44/53) of the patients, respectively. However, a considerable overlap between the parameter values of cancerous and benign prostatic tissue was seen in this patient group. ROC analysis showed that only for the Wash-in rate a good sensitivity and specificity could be reached (area under ROC = 0.820).

CONCLUSION: Semi-quantitative DCE-MRI parameters can be used for the identification of intraprostatic tumour nodules; in particular the Wash-in rate appeared a good discriminator between malignant and benign prostatic tissue.

P5. CT IMAGING FOLLOW-UP AFTER CRYOABLATION OF RENAL CELL CARCINOMA

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OBJECTIVES: We report a case of an adenomatoid tumor of the tunica albuginea, with abundant fibrosis in a 45-year old man, evaluated by conventional and diffusion MRI. The value of MR imaging in the preoperative diagnosis of benign fibromatous paratesticular tumors and differential diagnosis is discussed.

MATERIALS AND METHODS: A 45-year-old man referred to the Urology clinic for a palpable left scrotal mass, which had progressively enlarged during the last months. MR imaging of the scrotum was performed on a 1.5-T magnet unit, using a pelvic phased-array coil. The protocol included fast spin-echo T2 and spin-echo T1-weighted images in the axial, sagittal and coronal planes. Axial diffusion-weighted (DW) images with a b-value of 900 sec/mm² were also obtained.

RESULTS: MR imaging revealed the presence of a multilobular left paratesticular mass, mainly detected with very low signal intensity on T2-weighted images and restricted diffusion on apparent diffusion coefficient (ADC) maps. These findings were suggestive of a fibrous component, and were
confirmed on histology following lesion excision. Differential diagnosis included adenomatoid tumor of the paratesticular space and fibrous pseudotumor.

CONCLUSIONS: MR imaging in this case provided valuable information in the preoperative work-up, by allowing the precise localization of the mass and helping in characterizing the benign nature of fibrous paratesticular tumor, by using both the conventional and DW images.

P6. **BENIGN FIBROMATOUS PARATESTICULAR TUMOR: MR FINDINGS**  
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OBJECTIVES: We report a case of an adenomatoid tumor of the tunica albuginea, with abundant fibrosis in a 45-year-old man, evaluated by conventional and diffusion MRI. The value of MR imaging in the preoperative diagnosis of benign fibromatous paratesticular tumors and differential diagnosis is discussed.

MATERIALS AND METHODS: A 45-year-old man referred to the Urology clinic for a palpable left scrotal mass, which had progressively enlarged during the last months. MR imaging of the scrotum was performed on a 1.5-T magnet unit, using a pelvic phased-array coil. The protocol included fast spin-echo T2 and spin-echo T1-weighted images in the axial, sagittal and coronal planes. Axial diffusion-weighted (DW) images with a $b$-value of 900 sec/mm$^2$ were also obtained.

RESULTS: MR imaging revealed the presence of a multilobular left paratesticular mass, mainly detected with very low signal intensity on T2-weighted images and restricted diffusion on apparent diffusion coefficient (ADC) maps. These findings were suggestive of a fibrous component, and were confirmed on histology following lesion excision. Differential diagnosis included adenomatoid tumor of the paratesticular space and fibrous pseudotumor.

CONCLUSIONS: MR imaging in this case provided valuable information in the preoperative work-up, by allowing the precise localization of the mass and helping in characterizing the benign nature of fibrous paratesticular tumor, by using both the conventional and DW images.

P7. **TESTICULAR SEMINOMA AND FIBROSIS OF THE CONTRALATERAL TESTIS: MR FEATURES**  
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OBJECTIVES: We report an unusual case of testicular seminoma and synchronous fibrosis of the contralateral testis evaluated by MR imaging. The MR features of both testicular seminoma and fibrosis are presented and the role of MR imaging in the preoperative diagnosis is discussed.

MATERIALS AND METHODS: A 47-year-old man was referred for painless enlargement of the left hemiscrotum. Scrotal MRI was performed on a 1.5-T system, using a surface coil. The protocol included fast spin-echo T2-weighted sequences and both unenhanced and contrast-enhanced spin-echo T1-weighted images. Left radical orchiectomy and biopsies of the right testis showed the presence of left testicular seminoma and densely collagenized fibrous tissue of the right testis.

RESULTS: MR imaging revealed the presence of a large heterogeneous neoplasm, replacing the left testis and extending to the ipsilateral paratesticular space and spermatic cord was detected. The tumor was mainly of low signal intensity on T2-weighted images, strongly and inhomogeneously enhancing. The presence of septa within the mass was suggestive of seminomatous nature. An ill-defined lesion in the upper pole of the right testis showed the presence of left testicular seminoma and densely collagenized fibrous tissue of the right testis.

CONCLUSIONS: MR imaging may provide accurate diagnostic information in differentiating benign from malignant intratesticular masses. A possible diagnosis of benignity based on MR features, as in this case may decrease the number of unnecessary radical surgical procedures.
P8. SECONDARY CTKUB SIGNS OF URETERIC COLIC – THE ESSENTIAL PICTORIAL GUIDE
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INTRODUCTION: The gold standard diagnostic investigation for ureteric colic is Unenhanced Computed Tomography of the Kidneys, Ureters and Bladder (CTKUB). Direct intraluminal stone visualization is not always possible, and this pictorial review illustrates the key signs every radiologist should be familiar with, which support or refute the diagnosis of ureteric colic.

MATERIALS AND METHODS: Documented primary and secondary CTKUB signs supportive of ureteric colic or radiological mimics such as phleboliths are identified. Each radiological sign is illustrated with the best examples from a retrospective review of CTKUB cases. The diagnostic weightings of signs are discussed and placed into a guide to facilitate interpretation based on the findings of an extensive literature review.

RESULTS: Radio dense foci along the expected pathway of the ureter but not definitely within the lumen are said to be indeterminate. However, the presence of hydronephrosis and hydroureter predict that a distal indeterminate calcific focus represents a ureteric stone with an accuracy of up to 99%. Secondary signs in decreasing order of sensitivity and specificity are hydronephrosis, hydroureter, perinephric oedema, and nephromegaly. The soft tissue rim sign has a sensitivity and specificity of up to 77% and 92% for stones proximal to the vesico-ureteric junction. The pale kidney sign has been identified in up to 95% of patients with colic. A comet-tail sign is said to have a positive predictive value of up to 100% for identifying a phlebolith.

CONCLUSIONS: Diagnostic difficulty arises with an indeterminate calcific focus. In these cases a number of supporting secondary signs of ureteric obstruction should be sought. A positive soft tissue rim sign helps to positively identify a ureteric stone. In the absence of these signs a positive comet-tail sign suggests a phlebolith. Secondary signs in the absence of a calcific focus suggest the recent passage of a stone.

P9. VARIATIONS OF THE RENAL ARTERIES AND VEINS: MDCT FEATURES
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PURPOSE
1. An overview of the various anatomical variations of the renal arteries and veins.
2. To show MDCT features of the various variation of the renal arteries and veins (origin, number, branch and course).
3. To show potential pitfalls caused by these vascular variations during abdominal CT.

MATERIALS AND METHODS: Contrast enhanced abdominal MDCT in arterial and venous phases for the past two years are reviewed to assess variation of the renal arteries and veins. Origin, course, number and branch of the renal vasculature are evaluated with MDCT.

RESULT: Various variations of renal arteries and veins are seen which were shown with a review of normal anatomy as well as embryology of the renal arteries and veins. Variations are include multiple renal arteries and veins, prehilar branching of renal arteries, high and low origin of the renal arteries, renal vein joining the common iliac vein, precaval right renal artery and retroaortic and circumaortic left renal vein etc.

CONCLUSIONS
1. To understand the variations of renal arteries and veins, which is necessary for radiologist not only correct diagnosis but also suitable MDCT examination.
2. Knowledge of accurate anatomy of the renal vasculature is crucial before surgery and interventional procedure of the kidneys.

P10. RADIOGRAPHIC APPEARANCE OF THE KIDNEY AFTER LAPAROSCOPIC PARTIAL NEPHRECTOMY
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Radical nephrectomy has traditionally been the treatment of choice for malignant renal masses. Recently, it has become apparent that renal function is impaired in patients after radical nephrectomy,
with concomitant negative effects on longevity. As a result, partial nephrectomy has become the preferred means of managing renal masses up to 4 cm in size and even for larger masses when technically feasible. Partial nephrectomy offers equivalent oncologic benefit to radical nephrectomy for these lesions, with less insult to renal function. With maturation of laparoscopic and robotic techniques, minimally invasive partial nephrectomy has become more common. While having clear clinical benefit, laparoscopic partial nephrectomy (LPN) also has the highest rate of complications amongst surgical treatments for renal cell carcinomas.

In this pictorial essay, we present post-operative images of uncomplicated LPN, as well as images of complications. Complications presented in this poster include acute and delayed urine leaks, intra-renal pseudoaneurysm, intra-renal arterio-venous malformation, abscess, and intraoperative ureteral injury and its subsequent repair.

As laparoscopic and robotic skill and equipment become more widely available, knowledge of the appearance of the kidney after both uncomplicated and complicated LPN will become increasingly important for the radiologist.

P11. THE PERINEPHRIC SPACE: ANATOMIC CONSIDERATION AND RELATED PATHOLOGIC ENTITIES ON MDCT IMAGES
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Various pathologic conditions can occur in the perinephric space, primarily originating in the constituents of the perinephric space, and the perinephric space can be secondarily involved by renal parenchymal and adjacent retroperitoneal lesions. Key anatomic details that dictate the feature of perinephric processes include the renal capsule, the perinephric septa, and the renal fascia. Superiorly, the perinephric space is open to the bare area of the liver. The perinephric spaces communicate with one another. The purpose of this exhibit is to describe the normal anatomy and constituents of the perinephric space, present the spectrum of abnormalities that affect the perinephric space, and identify the MDCT findings of various pathologic processes of the perinephric space.

This exhibit presents the broad spectrum of lesions of perinephric space, including inflammatory processes, fluid collections (infection, urinoma, hematoma) and solid process (primary and secondary tumors, fibrosis). Multiplanar CT images can allow exact evaluation of the extent of perinephric disease. Familiarity with the imaging features of various perinephric pathologic processes will facilitate prompt, accurate diagnosis and treatment.

P12. MRI NEUROANATOMY OF FEMALE PELVIS
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INTRODUCTION: During the past 15 years, substantial progress has been made in understanding the neuroanatomy of the autonomic pelvic plexus. This progress has resulted in individually tailored surgery for deep infiltrating endometriosis of the rectovaginal space or for cervical cancer. The concept of preservation of autonomic nerves during radical hysterectomy has become standard in many oncogynaecological centres. Nerve-sparing radical hysterectomy and individually tailored surgery, in comparison with standard radical hysterectomy, have led to a much improved quality of life. Pelvic MRI is commonly used for diagnosis and staging of common diseases such endometriosis and cervical cancer. Aim of our study was creating and offering an educational tool for urogenital radiologists on female pelvic neuroanatomy.

MATERIALS AND METHODS: Our study started with a deep review of female pelvic neuroanatomy, then we tried to identify the nervous structures at MRI. The study was carried out with five female patients who had not undergone hysterectomies on high-resolution 2 mm thick, 0 spaced FSE T2-weighted slices in the three planes of space: the strict axial, coronal and sagittal planes.

RESULTS: We identified the course of main nerves and pelvic plexuses and pointed out the imaging appearance and location of them at pelvic MRI, stressing their anatomical relationship with other better known anatomical landmarks in order to let the urogenital radiologist become familiar with the main
pelvic nervous structures. Deep anatomical knowledge of osseous, ligamentous, muscular, vascular and visceral structures of the female pelvis is crucial to identification of main nervous structures.

CONCLUSIONS: MRI may identify the main pelvic nerves and the anatomical location and course of main pelvic nervous plexuses and may be of help when planning nerve-sparing surgery or for better understanding the clinical relationship with disease location and clinical symptoms and signs.

P13. IMAGING FEATURES OF RUPTURED ENDOMETRIAL CYSTS
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OBJECTIVE: Rupture is an uncommon complication of endometrial cyst. The purpose of this exhibit is to demonstrate the imaging findings of ruptured endometrial cysts and to identify the features that differentiate it from ruptured corpus luteal cyst.

MATERIALS AND METHODS: Through a review of medical records during a recent 5-year period, eleven patients with a surgically proven ruptured endometrial cyst were included in this study. Preoperative CT was available in nine and MR in two patients. For comparison, we reviewed preoperative CT of twenty patients with a surgically proven ruptured corpus luteal cyst. Evaluation was performed regarding the size and shape of cyst, thickness of cyst wall, presence of discontinuity of cyst wall, acute hematoma, and mesenteric or omental abnormalities. Statistical comparison using Mann-Whitney test and Student t-test were performed.

RESULTS: Ruptured endometrial cysts showed unilocular (n = 8) or multilocular (n = 3) cystic mass and a variable amount of peritoneal fluid. The amount of peritoneal fluid was small (limited to the pelvic cavity) in four, moderate (extending to the paracolic gutter) in three, and large (extending to the subphrenic space) in four patients. Acute hematoma around the cyst was seen in only one (9%) of 11 endometrial cysts. The mean diameter of the endometrial cysts was 8.2 cm and mean thickness of cyst wall was 2.7 mm. Distorted shape of cyst was seen in seven of 11 endometrial cysts (63%). Omental haziness was seen in seven (63%) and peritoneal thickening was seen in three (27%) of 11 endometrial cysts. Size of the cyst, thickness of cyst wall, acute hematoma around the cyst, and peritoneal thickening were found to be statistically significant for differentiating ruptured endometrial cyst from ruptured corpus luteal cyst (P<.05).

CONCLUSION: Although rare, the possibility of endometrial cyst should be considered when we encounter ruptured ovarian cyst showing a large cyst with thick wall and associated peritoneal thickening. Acute hematoma around the cyst may suggest ruptured corpus luteal cyst rather than endometrial cyst.

P14. MR IMAGING FINDINGS OF DEEP PELVIC ENDOMETRIOSIS – PICTORIAL ESSAY
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INTRODUCTION: To review the current concepts of deep pelvic endometriosis. To show MR findings associated with deep pelvic endometriosis. To discuss the importance of MR imaging for preoperative diagnosis of deep pelvic endometriosis.

MATERIALS AND METHODS: The MR imaging in 35 patients (average age, 35.4 years; range, 23-49 years) with pelvic endometriosis were retrospectively reviewed. We analyzed the presence and pattern of deep pelvic endometriosis. Imaging findings were correlated with medical records and pathological reports.

RESULTS: We reviewed the definition and recent concepts of deep pelvic endometriosis, pathogenesis, etiology and epidemiology, clinical presentation and preoperative diagnostic tools. We represented the typical and atypical manifestations of deep pelvic endometriosis. The usefulness of 3.0 T MRI for diagnosis of deep pelvic endometriosis was also described.

CONCLUSIONS: MRI is the most useful imaging modalities for the preoperative diagnosis of patients with deep pelvic endometriosis, showing high accuracy in the prediction of the disease extent.
P15.  **ENHANCING SOLID COMPONENT WITHIN MATURE TERATOMA OF OVARY ON MR: DOES IT MEAN MALIGNANT TRANSFORMATION?**  
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**INTRODUCTION:** Mature teratoma is one of the most common benign ovarian neoplasm, but the tumor undergoes malignant transformation in 1-2% of cases. Squamous cell carcinoma is the most commonly associated malignancy. Enhancing portion of mature teratoma is known as possibility of malignant transformation on contrast enhanced MR. We recently experienced the cases of benign mature teratoma with enhancing solid component on pelvis MR. We have had a question about enhancing solid component within mature teratoma of ovary on MR always means malignant transformation. The purpose of this work is to evaluate the enhancing solid component within mature teratoma of ovary on pelvis MR.

**MATERIALS AND METHODS:** The MR images of 30 patients with histologically verified ovarian mature teratoma were retrospectively studied. The ages of patients ranged from 52 to 79 years (mean; 61 years).

**RESULTS:** Eight patients had enhancing solid component within mature teratoma of ovary. They were one squamous cell carcinoma arising from mature teratoma, two mixed germ cell tumors (mature teratoma and yolk sac tumor) and five benign mature teratomas. Larger Enhancing area, and nodular and mass-like appearance are more common in malignancy rather than in benign teratoma.

**CONCLUSION:** Enhancing solid component associated with mature teratoma of ovary is not infrequent. It does not necessarily indicate malignant transformation.

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P16. **INFECTED EXTRAGONADAL TERATOMA – EXCEPTIONAL CASE REPORT**  
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**INTRODUCTION:** The authors present a case of an complicated extragonadal teratoma in a 31-years-old female without relevant personal or family history. The initial presentation was fever, pelvic pain and painful defecation for three days before her admission.

**MATERIALS AND METHODS:** Ultrasound, CT and MRI

**RESULTS:** Ultrasound showed cystic lesion, with uniform low-level echoes, posterior to the vagina. CT revealed low-attenuation multiloculated lesion, with thickened walls, in the perirectal subcompartment, extending to right ischiorectal fossa, that exerted mass effect in the cervix and the vagina and compression of the rectum, without invading them. MRI study revealed four walled-complex non-communicating cystic lesions. The major one had irregular thickened margins, low-signal intensity on T1-weighted images and high signal-intensity on T2-weighted images. Posterior to this lesion, there were two of medium-signal intensity on T1 and T2-weighted images. A small lesion showed high signal-intensity on T1-weighted images and low signal-intensity on T2-weighted images. Complete surgical excision was indicated to establish the diagnosis (cystic mature teratoma with infection) and avoid complications.

**CONCLUSION:** This case was consistent to a rare complicated (infected) extragonadal (ischiorectal space) teratoma, illustrated by relevant MR images. MR images allowed the characterization of this tumour where the signal intensity of each cyst represents different types of content and the thick wall of the lesion and intermediate signal intensity are related to infection. Teratomas are neoplasm composed of tissues foreign to the anatomic site in which they arise and usually are found in the testes and ovaries, during the reproductive years. Extragonadal teratomas are rare and mainly occur in the anterior mediastinum, pineal gland or in the sacrococcygeal region. Most of Sacroccocygeal teratomas are diagnosed in the newborns and usually are benign. Rarely, they are discovered in adult life and are completely presacral. Complications include torsion, rupture and infection (1% of cases).
P17. EARLY-STAGE CERVICAL CARCINOMA: ROLE OF MULTIDETECTOR CT

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OBJECTIVES: The aim of this retrospective study was to assess the diagnostic performance of multidetector CT (MDCT) on a 16-row CT scanner in staging patients with surgical-pathological proven early-stage cervical carcinoma.

MATERIALS AND METHODS: The study cohort constituted of 18 women with surgical-pathological proven early-stage carcinoma of the uterine cervix. All CT examinations were performed on a 16-row CT scanner and the protocol included scanning of the abdomen after the i.v. administration of iodinated contrast material (portal phase) using a detector collimation of 16 x 0.75 mm and a pitch of 1.2. MDCT images were retrospectively studied by two radiologists, unaware of the final histological results. Multiplanar reformatted images and three-dimensional reconstructed images were used for CT data interpretation. The evaluated parameters were: tumor detection, tumor maximal diameter, tumor extension to the uterine body and/or the vagina, parametrial invasion and presence of pelvic lymph node metastases. CT stage was assigned for each cervical carcinoma. The surgical-pathological stage was assigned on the basis of the operative findings and the histologic report.

RESULTS: MDCT detected 15 out of 18 (83%) carcinomas in this study. Multidetector CT was accurate in all (100%) cases regarding the presence or absence of invasion of the uterus body and in 17 out of 18 (94%) patients regarding the presence or absence of vaginal invasion. CT had an accuracy of 92% in diagnosing the presence or absence of parametrial invasion and 81% in diagnosing neoplastic involvement of pelvic lymph nodes. The overall accuracy of multidetector CT in staging primary cervical carcinoma was 83%.

CONCLUSIONS: MDCT on a 16-row CT scanner proved accurate in the detection and local staging of early-stage cervical carcinoma.

P18. FIBROMATOUS UTERUS IN A 16-YEAR OLD GIRL: REPORT OF A CASE

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OBJECTIVES: Uterus leiomyomas are extremely uncommon in the paediatric and adolescent population. We present a case of a 16-year old girl with fibromatous uterus, studied with multidetector CT and MR imaging examination. As to our knowledge, this is the first report of a fibromatous uterus in an adolescent girl in the English literature. The value of preoperative imaging evaluation in these patients is discussed.

MATERIALS AND METHODS: A 16-year-old female patient was referred for abdominal pain and distention. CT examination of the abdomen in a 16-row CT scanner was performed, after sonography of the pelvis. MR imaging examination of the pelvis on a 1.5 Tesla unit was followed. Histopathologic examination following exploratory laparotomy confirmed the presence of uterus leiomyomas.

RESULTS: Both MDCT and MR examination revealed an enlarged uterus, with lobular, deformed contour. Multiple uterus leiomyomas, of variable size were found, heterogeneously enhancing after contrast material administration. On her annual follow-up with MRI two years after surgery, recurrence of fibromatous uterus was found.

CONCLUSIONS: Uterine leiomyomas, although rare they should be considered in adolescent women presenting with a pelvic mass and abdominal pain, as in this case. Preoperative imaging evaluation is mandatory for the accurate detection, localization and characterization of uterus leiomyomas. The superb contrast, multiplanar capability combined with the absence of ionizing radiation render MR imaging the modality of choice in detecting and characterizing these benign tumors.

P19. MRI OF THE URINARY TRACT - COMPLEX ANATOMY REVEALED!

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INTRODUCTION AND OBJECTIVES: Evaluation of urinary tract anomalies may be limited using standard sonography and voiding cystourethrography (VCUG). MR Urography (MRU) plays important role in defining complex urinary anatomy. The objectives are: 1) learn MRU techniques 2) illustrate MRU as a problem solving tool 3) discuss added value by presenting complex cases with ultrasound and VCUG correlation.

MATERIALS AND METHODS: Series of pediatric patients evaluated with sonography, VCUG and MRU will be presented. MRU technique will be discussed in detail, including: noncontrast MR Hydrography, post-contrast (dynamic) sequences with two dimensional (2D) and three dimensional (3D) imaging and volume rendering (VR). Added clinical value of MRU will be summarized.

RESULTS
Case 1: VACTERL association patient with cloacal malformation and bilateral hydronephrosis on sonography; no reflux on VCUG. MRU (axial 2D T2W, 3D MIP and VR images) revealed uterus didelphys horns causing bilateral distal ureteral narrowing. Added value: Single upper urinary tract anatomy confirmed; the reason for ureteral dilatation established; functional assessment on dynamic imaging obtained.

Case 2: Patient with known right collecting system duplication and new left hydronephrosis on sonography. On MRU: bilateral duplication with ureteropelvic junction obstruction (UPJO) of the left lower moiety. MRU findings guided percutaneous left lower pyeloplasty.

Case 3: Severe hydronephrosis and torturous left ureter on sonography; large ureterocele and no vesicoureteral reflux on VCUG. MRU confirmed duplication and dilatation of both moieties; demonstrated non-functionality of the upper moiety and guided left upper heminephrectomy. Additional cases: unilateral duplicated collecting system with UPJO of the lower moiety and distal obstructions of both moieties; UPJO with severe hydronephrosis and non-functional renal parenchyma.

CONCLUSIONS: MRI plays important role in assessment of complex urinary tract anatomy complimentary to sonography and VCUG. MR hydrography excellently depicts dilated urinary tract segments without contrast material. MRU affects patient management and surgical decision making.

P20. CT UROGRAPHY IN PRONE POSITION – EFFECTS ON CONTRAST LAYERING IN THE EXCRETORY PHASE
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INTRODUCTION: CTU must accurately assess the mucosal surfaces of the collecting system. One limitation of excretory phase imaging is fluid-fluid levels between the non-opacified urine and the excreted contrast material. Small TCC’s might be missed if they are not surrounded by opacified urine. This study is a follow up to an earlier experimental study where the mixing of urine and iodinated contrast medium where investigated using a bladder phantom.

AIM: The aim of the study was to investigate the mixture of iodinated contrast medium (Iomeron 400mg/ml) with urine would be better when CTU was performed in prone position compared to the standard supine position.

MATERIAL AND METHODS: 20 patients, age 64±9 (54, 77) years, referred for CTU were included in the study and underwent CTU in prone position. The 20 included patients were compared to 20 matched controls undergoing CTU in the standard supine position. Examinations were performed on a 64 slice GE LightSpeed VCT with a four phase CTU protocol. Patients ingested 1000 ml of water in the hour before the examination and were told not to void 45 minutes prior to the exam. The excretory scan was performed 8 minutes after injection of 400 mg I/kg body weight.

RESULTS: The layering effect in the kidney pelvis were almost non-existent in the prone patients whereas layering were seen in 35% of the supine controls. In the bladder the mixing of urine and contrast were significantly better in the prone group were only 10% of the bladder contained non-opacified urine compared to 40% in the supine group.

CONCLUSION: Adapting the findings from the initial bladder phantom study to clinical practice by performing CTU in prone position provides better visualization of the mucosal surfaces of the collecting system in the excretory phase, increasing the accuracy of CTU.
P21. **CT DIFFERENTIAL DIAGNOSIS OF ADRENAL INCIDENTALOMAS**

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**INTRODUCTION:** Due to the rapid advance in medical imaging (such as CT, MR imaging, PET-CT, etc.) many (especially asymptomatic) masses are detected on the adrenal gland. Among these adrenal incidentalomas, adenoma and adrenal metastasis are the most common tumors. Because the management of these three lesions is different, it is very important to differentiate them adequately on imaging study. The objective of our scientific exhibition is in the CT differential diagnosis of these three adrenal incidentalomas.

**MATERIALS AND METHODS:** Among the 300 adrenal incidentalomas found at abdominal or abdominopelvic CT and proven clinically and/or pathologically in our hospital for recent 10 years, we tried to differentiate adrenal adenoma (including lipid-poor ones), adrenal metastasis, and adrenal cancer by using CT attenuation, and washout calculation on dynamic adrenal CT. In some cases, chemical shift MR imaging and FDG PET were performed complementally.  

\[
\text{Percentage of enhancement washout} = \frac{(E - D)}{(E - U)} \times 100  \\
\text{Percentage of relative enhancement washout} = \frac{(E - D)}{E} \times 100  \\
E: \text{Early enhanced CT (1 minutes)} \quad D: \text{Delayed enhanced CT (15 minutes)} \quad U: \text{Unenhanced CT}
\]

**RESULTS:** Most of the adrenal adenomas were over than 60% of enhancement washout, and over than 40% of relative enhancement washout. However, the differential diagnosis of adrenal cancer and metastasis is not easy on CT only, so CT guided adrenal biopsy or FDG PET were performed additionally. FDG PET can characterize adrenal metastasis with 100% sensitivity and questionable specificity.

**CONCLUSIONS:** Most adrenal incidentalomas were adenomas, and could be accurately characterized by dedicated CT. The percentage change in contrast material washout on CT is a useful adjunct to absolute CT attenuation values in differentiating adrenal adenomas from adrenocortical carcinomas. CT guided adrenal biopsy or FDG PET can help to differentiate adrenal metastasis from adrenal cancer.

P22. **IMAGING PATTERNS OF XANTHOGANULOMATOUS PYELONEPHRITIS – PICTORIAL REVIEW**

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**PURPOSE:** Xanthogranulomatous pyelonephritis is a rare chronic inflammatory disorder of the kidneys which usually occurs in women in the 5th or 6th decade of life. A broad range of presentations exist from vague symptoms of being chronically unwell, with weight loss, anorexia, haematuria, unexplained fever, elevated inflammatory markers or dull persistent flank pain. Pyuria is noted in only 50% of patients and 30% of patients have sterile urine culture. The radiological findings are often the first clue to the true underlying diagnosis.

**MATERIALS AND METHODS:** Conventional radiography, ultrasound, CT and DMSA cases performed at our institution with a subsequent diagnosis confirmed of Xanthogranulomatous Pyelonephritis were reviewed. A literature search was performed to determine the most characteristic findings of Xanthogranulomatous Pyelonephritis which help to differentiate it from other renal pathologies.

**RESULTS:** We provide an illustrated account of the spectrum of radiological and clinical patterns of Xanthogranulomatous Pyelonephritis as experienced in our institution. We demonstrate the varied patterns of calcification seen in conventional radiography, examples of renal masses seen on ultrasound and the extent of renal and extrarenal involvement seen on CT.

**CONCLUSION**

1. The varied imaging patterns of Xanthogranulomatous Pyelonephritis are presented
2. We demonstrate the utility of multi modality imaging in these patients.
3. We discuss the imaging features which are most strongly associated with a diagnosis of Xanthogranulomatous Pyelonephritis.

P23. **IMAGING PATTERNS OF BLADDER LYMPHOMA – PICTORIAL REVIEW**

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PURPOSE: Bladder lymphoma is a rare entity, with an incidence of 0.2% of primary bladder tumours and 1.8% of metastatic lesions. One sixth of these are cases of primary bladder lymphoma and the remainder are either non-localised or secondary forms. The clinical presentation varies considerably, from asymptomatic to bilateral hydronephrosis. We demonstrate the imaging findings associated with bladder lymphoma across a range of imaging techniques, particularly CT and MRI.

METHODS: The pathology database in our hospital over the last 10 years was used to identify patients with a diagnosis bladder lymphoma confirmed with histology. We reviewed any imaging the patients had undergone in our institution. Patient charts were reviewed to gather information regarding demographics, clinical presentation, investigations, treatments and outcomes. A selection of imaging was selected for purposes of this review.

RESULT: We provide an illustrated account of the spectrum of radiological and clinical patterns of bladder lymphoma across a range of techniques. We discuss the differential diagnoses and the limitations of imaging alone in differentiating from more common bladder tumours.

CONCLUSION
1. Although rare it is important to recognise possible bladder lymphoma as it is often more responsive to treatment than other bladder tumours.
2. Imaging findings can be as diverse as the clinical presentation.
3. Bladder lymphoma cannot be differentiated from the more common tumours of the bladder on the basis of CT or MRI characteristics alone. Histology is required. Other differential diagnoses and the role of various imaging techniques in the diagnosis and management of bladder lymphoma are considered.

P24. IMAGING PATTERNS OF RENAL TB – PICTORIAL REVIEW
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LEARNING OBJECTIVES: To highlight the distinctive imaging findings associated with renal TB. This is an entity which may present in a variety of ways – haematuria, weight loss, dysuria, fever, fatigue, anorexia, back ache ... The genitourinary system is one of the most common site of extrapulmonary spread of TB and in fact the majority of patients who present with renal TB do not have a prior diagnosis of pulmonary TB.

BACKGROUND: Conventional radiography, ultrasound, CT and MRI cases performed at our institution with a subsequent diagnosis confirmed of renal TB were reviewed. A literature search was performed to determine the most characteristic findings of renal TB which help to differentiate it from other renal pathologies.

IMAGING FINDINGS: In this pictorial review we provide an illustrated account of the spectrum of radiological and clinical patterns of renal TB as experienced in our institution. We demonstrate the varied patterns of calcification seen in conventional radiography, examples of scarring seen in IVP and the extent of renal and extrarenal involvement seen on both non-contrast and contrast enhanced CT.

CONCLUSIONS
1) The varied imaging patterns of renal TB are presented.
2) We demonstrate the utility of multi modality imaging in these patients.
3) We discuss the imaging features which are most strongly associated with a diagnosis of renal TB.

P25. IMAGING PATTERNS OF RETE TESTIS – A PICTORIAL REVIEW OF ITS VARIED APPEARANCES AND THEIR COMMON DIFFERENTIAL DIAGNOSES
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PURPOSE: With advances in ultrasound technology normal anatomical structures become easier to visualize. The rete testis, located within the mediastinum testis, is a network of tubules which carry sperm from the seminiferous tubules to the epididimis. Previously overlooked variations in the appearances of the rete testis are now more easily seen and the subjective nature of ultrasound may lead to diagnostic uncertainty if the operator is unsure as to the normal variations in the appearance of the rete testis. The purpose of this exhibit is to highlight the variation in normal anatomy and the benign features that distinguish it from more sinister pathology.

METHODS: A retrospective review was performed to identify all sonograms showing variations in the appearance of the rete testis performed from 2002 to 2009 using the radiological database in our institution.
department. We subselected a variety of ultrasound images which best demonstrate the varied appearances of the rete testis.

RESULTS: The rete testis has a highly variable appearance, from a poorly defined hypoechoic area at the testicular hilum, to a tubular structure with arboriform projections into testicular tissue. We present the spectrum of ultrasound appearances of the normal rete testis in a pictorial format. It is important to identify the variability in normal anatomy and the benign features that distinguish it from pathological processes.

CONCLUSION: Variation in the appearance of the normal rete testis on ultrasound can result in diagnostic uncertainty if not recognised as such. Enhanced appreciation of these variations provides confidence in determining which lesions require further investigation and which patients can be confidently reassured. Recognition of these features limits further unnecessary imaging and follow-up.

P26. NEUROANATOMICAL EVALUATION OF PERIPROSTATIC NERVE IN PATIENTS SUBMITTED TO NERVE-SPARING PROSTATECTOMY: DTI FIBER TRACKING AND 3D FAST-RECOVERY FAST SPIN- ECHO (FRFSE) CUBE OVERLAPPING AT 3T
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PURPOSE: Aim of this study is to depict neuroanatomical distribution and relationship with capsular profile of periprostatic nerve in patients submitted to a bilateral nerve-sparing prostatectomy using DTI Fiber Tracking and 3D fast-recovery fast spin-echo (FRFSE) cube at 3T magnet.

MATERIALS AND METHODS: The study is performed on patients candidate to nerve-sparing prostatectomy (33 pts) at 3T Magnet ((Discovery M750, GE Healthcare) equipped with surface phased array and endorectal coil. Scan protocol includes morphologic imaging with TSE T2-weighted sequences on the axial, sagittal and coronal planes, DWI sequences at different b value (500, 1000, 3000) and 3D fast-recovery fast spin-echo (FRFSE) cube sequence; in addition DTI fiber tracking with b value 1000 and 16 directions (funtool protocol, version 7.4) is done.

RESULTS: Overlapping 3D cube sequence and fiber tracking we can obtained a precise view of the NVB in terms of: thickening of nerve fibers, distance from nerve fiber to prostate capsule, integrity and course on each part of the prostate. Periprostatic nerve fibers reveal a relatively even distribution in both lateral and dorsal parts of the prostate, asymmetric course bylaterally.

CONCLUSIONS: DTI fiber tracking and 3D FRFS Cube overlapping proposed in this study, would provide an additional diagnostic tool in decision making process in the patient nerve-sparing prostatectomy management.

P27. UTERINE CORPUS RHADOMYOSARCOMA IN A POSTMENOPAUSAL WOMAN WITH PRIOR HISTORY OF CERVIX ADENOCARCINOMA
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OBJECTIVES: Embryonic rhabdomyosarcoma is a rare tumor of mesenchymal origin, accounting for less of 1% of the uterine neoplasms. It characteristically occurs as a vaginal lesion in children and in young adults. The authors describe a case of uterine corpus rhabdomyosarcoma in a postmenopausal woman who was treated for a cervix adenocarcinoma 5 years before.

MATERIALS AND METHODS: A 65-year-old woman noticed a palpable pelvic mass. She had a 5-year past history of poorly differentiated adenocarcinoma of the uterine cervix, treated with chemotherapy plus radiotherapy, with complete response and no apparent relapse of the disease. After clinical examination, a MRI was performed, which revealed a 9x3x3.5 cm heterogeneous mass located in the right fundus, apparently with no extra-uterine extension. MRI also demonstrated that the uterine cavity was blood- filled in relation to obstructive cervicitis. She underwent total abdominal hysterectomy and bilateral salpingo-oophorectomy. Histologically, the mass was consistent with a pure embryonic rhabdomyosarcoma, which was furtherly confirmed by immunohistochemical results.

CONCLUSION: This is a rare case of rhabdomyosarcoma with respect to its anatomic location, age of presentation and its possible association to anterior treatments received. This diagnosis is usually reserved only for cases in which the carcinomatous component has been excluded.
Renal cell carcinoma (RCC) has a high propensity for early metastasis and evidence of metastases is present in about one third of patients at presentation. RCC frequently manifests first as an osseous metastasis from a clinically occult primary tumor. Osseous metastasis occurs in 20%-60% of patients with RCC. Most of the metastases are aggressive lytic lesions, usually with cortical erosion or destruction. The most common metastasis from RCC is a lytic destructive lesion in the pelvis or sacrum. Calvarium is an unusual site of RCC metastasis. The first case of calvarial RCC metastasis has been reported in 1960 by Melicov and Uson. The best treatment for a single metastasis is surgical excision. We report a case RCC with calvaryl metastasis revealed before the primary tumor become apparent.

INTRODUCTION: Testis tumors can arise from several different cells within the testicle. The most common and aggressive type of testis tumor are germ cell tumors. Germ cell tumors may be either seminomas or non-seminomatous tumors. The tumors are identified as pure form (those of one histologic type) and mixed form (more than one histologic type). The most common mixed germ cell tumor (MGCT) is the combination of teratoma, embryonal carcinoma,yolk sac tumor. We present a case of testicular mixed germ cell tumor in a 27-year-old man who presented for with widespread metastatic mass.

MATERIALS AND METHODS: 27 years old male patient referred to our hospital complaining with right testicular pain, swelling and rigidity. We performed Coloured Doppler US (CDUS), CT and PET for radiological evaluation.

CASE REPORT: CDUS showed heterogenous, hipoechoic, vasculareted right testicular mass. Thorachal CT showed bilaterally conglomareted, hipodense, partial enhancing heterogenous lymphadenopathies. Also Abdominal CT revealed lots of conglomareted hipodense lymphadenopathies located at aortacaval space, retroperitoneal space at left renal hilus level and iliac chain. By observing PET we realised mediastinal and abdominal paraaorticocaval lymphadenopathies. Pathological correlation confirmed our findings.

CONCLUSION: The most component of the MGCT is embryonal carcinoma and is often combined with teratoma, seminoma, or yolk sac tumor. Serum marker elevation is common and is reflective of the individual components of the tumor. Imaging findings of MGCT’s are reflective of their histologic components. Orchidectomy is still considered the standard of care for local treatment and definitive pathologic diagnosis.

LEARNING OBJECTIVES: The authors propose a bibliographic revision about the most recent publications concerning Fallopian Tube Primary Tumors imaging aspects. The main aim is to reveal the most typical and fundamental imaging characteristics of these tumors and differentiate them from other adnexal masses.

BACKGROUND: Primary Fallopian tube malignant tumors are a rare gynecologic entity, representing only 0.3% of all gynecological female tumors. Histologically and clinically resemble epithelial ovarian tumors, making their differential diagnosis difficult, even through pathologic analysis. The difficulty in obtain the correct pre-surgical diagnosis leads to a laparotomy based in a presumed diagnosis of primary ovarian cancer.

IMAGING ASPECTS: Imaging techniques, mainly MR, characterize and differentiate fallopian tube tumors from other complex anexial lesions. Imaging findings typically demonstrate a complex cystic and solid adnexal mass.
Sonography may show an irregular sausage shaped or multilocular mass with wall thickening, papillary projections or mural nodules. On T1W MRI the tumor is hypointense and is often homogeneously hyperintense on T2W images. MRI can most often detect cystic and solid components that enhance after gadolinium administration. Tumor infiltration into adjacent structures is better demonstrated on MRI. MRI has the advantage of identifying normal ovarian tissue adjacent to tubal disease, and so limiting differential diagnostic considerations.

CONCLUSIONS: Usually there is not a typical clinical presentation for the Fallopian Tube primary tumors, leaving to a usual advanced stage diagnosis. Imaging methods namely RM give an important contribute to earlier diagnosis with a better prognosis.

P31. IMAGING PATTERNS OF ATYPICAL RENAL CELL CARCINOMA RECURRENCE – PICTORIAL REVIEW
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PURPOSE: To illustrate the extensive variety of imaging patterns of atypical renal cell carcinoma recurrence. Renal cell carcinoma has a predilection for reappearing in unusual sites and may do so over an unpredictable time-frame, up to and beyond ten years post curative resection. The aim of this exhibit is to demonstrate the use of multi-modality imaging in these patients and to discuss pathways of spread and follow up of patients with renal cell carcinoma.

METHODS: We reviewed the radiological database of patients with recurrent renal cell carcinoma in our institution over the past ten years. We subselected the atypical cases and reviewed the relevant images and patient charts.

RESULTS: In this pictorial review we provide an illustrated account of the diverse and atypical nature of the radiological and clinical patterns of renal cancer recurrence, as experienced in our institution. Examples detailed include recurrence along a post-operative drain tract, isolated pancreatic deposit, splenic metastasis, bilateral adrenal deposits, a fistulating recurrence involving large bowel as well as testicular, pituitary, parotid and unusual bony and distant muscle deposits.

CONCLUSION: This multi-modality pictorial review of unusual patterns of renal cancer recurrence highlights the unpredictability of this disease process, both clinically and radiologically. Optimal imaging protocols and a high index of suspicion are required in the follow up of patients with a history of renal cell carcinoma.

P32. ASSESSMENT OF MSCT DIAGNOSTIC POSSIBILITIES IN STAGING OF MALIGNANT RENAL TUMORS AND THE PLANNING OF SURGICAL TREATMENT
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According to different sources kidney tumors in adults account for 2-3% up to 6% of all cancers and take the third place among malignant diseases of the genitourinary system after prostate and bladder cancers. Besides the problem of identifying tumors at an early stage there are various equally important issues in the planning of surgical intervention: the location and dimensions of lesion, tumor extension, blood supply, involvement of regional lymph node, lesions in renal vein or inferior vena cava and secondary lesions of other organs. The aim of our study was to determine the capacity of multislice computed tomography in staging of kidney tumors and planning of surgical intervention.

MATERIALS AND METHODS: 58 patients from 29 to 77 years with kidney tumors were examined. CT chest, abdomen, retroperitoneum, pelvis and brain has been performed in all patients. Examination of the abdomen and retroperitoneum was conducted in the native form and after a bolus of nonionic contrast; arterial, parenchymatous and urographic phases were performed. Research in the arterial phase has allowed visualization of blood supply to the kidney (including the presence of additional blood vessels) and massive lesion. In addition to the parenchymatous phase of lesion location and condition of renal veins and inferior vena cava were estimated. In urographic phase massive process and CHLS ratio was estimated. Practically all tumors up to 7cm accumulated intensively contrast in the arterial phase, the density characteristics were much higher than the density of unmodified renal parenchyma. In the parenchymatous phase density of the lesion was significantly lower. Lesions quite large in size >7 cm, were as a rule of heterogeneous structure due to the areas of necrosis and foci of
calcification. Massive lesion of the right kidney was found in 26 patients, the left kidney was involved in 28 patients, and in 4 patients both kidney were involved. In two patients the tumor extension to pelvis and ureter was found. In one patient with bilateral lesion the tumor size did not exceed 3.0 cm and bilateral resection of the kidneys was performed. In two patients the tumor size in the contralateral kidney did not exceed 3.0 cm and nephrectomy on one side and resection on the other one were performed. Massive lesions in peripheral parts of the kidney up to 4 cm in size were assessed in terms of patient selection for laparoscopic partial nephrectomy. The criteria for selection were extrarenal tumor growth, ≤ 4cm in diameter and the distance between the tumor and CHLS (this distance should not exceed 10mm for laparoscopic resection). In 19 patients the tumor size did not exceed 4.0 cm and in three of them tumor sizes were ≤1,5 cm. Lesions did not go beyond the renal parenchyma. Enlarged regional lymph nodes and distant mts-lesions in these patients were not found. All patients underwent partial nephrectomy, including laparoscopic resection in 11 patients. Tumors up to 7.0 cm were found in 25 patients, >7.0 cm in 14 patients. In that group of patients single lymph node ≤2.0 cm were observed in 16, from 2.0 to 5.0 cm in 9 and conglomerates >5.0 cm in 3 patients. In 11 patients enlarged lymph nodes were not visualized (the size of tumors in this group did not exceed 4.0-5.0 cm).

Massive invasion of adrenal glands were found in 10 cases. Secondary lung lesions were observed in 11 patients (size of foci in average 5-7mm, in some cases up to 15mm). In one patient enlarged mediastinal lymph nodes up to 18-24mm were identified. In one case the secondary pleural involvement was found. Foci of destruction in the vertebral bodies were found in two patients. In 1 patient secondary involvement of liver was diagnosed. In 2 cases focal lesion of the brain was found. Given MSCT data, 32 patients underwent nephrectomy with lymphadenectomy as needed. Patients with mts-lesions of lung underwent open laparoscopic cytoreductive surgery. Particular attention was given to patients with thrombosis of the inferior vena cava (5 cases). In 3 cases the thrombotic masses did not reach the level of the diaphragm. In 2 cases thrombosis reached the level above the diaphragm to the right atrium. Given the absence of tumor invasion into neighboring organs and the absence of distant mts-invasion, nephrectomy was performed with lymphadenectomy, resection of the inferior vena cava to the level of hepatic veins. Patients were discharged in satisfactory condition. The control CT study after 3 and 6 month didn’t show local recurrence of tumor. Thus MSCT with the subsequent need for different data processing has allowed to visualize kidney and its vessels, to localize the tumor process, to assess its extensiveness before the operation and to visualize the vascular architectonics of tumors, to assess the condition of the inferior vena cava and the regional lymph nodes and to find the secondary lesion of the other organs and systems.

P33. REVIEW OF CT UROGRAMS ON BONE WINDOW SETTINGS – A PICTORIAL REVIEW
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INTRODUCTION: Imaging plays an important part in the diagnosis of urological disease. CT Urography has become an important examination in the investigation of haematuria, complex stone disease and follow up of urothelial malignancy. It allows a thorough evaluation of both upper and lower tracts. In our practice, images are routinely reviewed on bone window settings as this can accentuate subtle pathology. If this approach is not used, gross pathology may also be missed.

MATERIALS AND METHODS: Ten cases of renal tract pathology detected on CT urography will be presented as a pictorial review. Each abnormality will be shown on standard abdominal and bone window settings in order to demonstrate the advantage of using both settings in interpretation. Examples of pathology shown are masses, calculi and blood clots.

RESULTS: This poster demonstrates how urinary tract pathology can become more obvious when looked at using bone window settings compared to standard abdominal settings. Subtle abnormalities can be easily missed if this is not done in routine practice.

CONCLUSION: CT Urograms should be routinely reviewed on both abdominal and bone window settings to avoid missing important pathology.

P34. COINCIDENTAL DETERMINED BLADDER LEIOMYOMA
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INTRODUCTION: Urinary bladder leiomyoma is a rare benign neoplasm originating from mesenchymal tissue. Clinical symptoms may change because of tumors location and diameter.

MATERIALS AND METHODS: 26 years old female who had a mass in the right lateral wall of the bladder detected at pelvic US examination referred to our hospital with secondary amenorrhea assessed with MRI and CT. Diagnosis corrected with cystoscopy.

CASE REPORT: In our study we found bilobulated, markedly heterogeneous hypoechogenic approximately 35x25 mm diameter mass in the right lateral wall of the bladder at US examination. Although prior CT of the patient reported as ovarian mass, MRI showed the mass located on the bladder base measured craniocaudally 4 cm at the superior and posterior part of the trigon, which was bilobulated, well defined, in T2W isointense to the muscles and in T1W isointense to the myometrium and had no enhancement.

CONCLUSION: Mesothelial neoplasms of the bladder are rare and the most one of them are leiomyomas. Mesothelial neoplasms are % 1-5 of the bladder neoplasms and leiomyomas are % 0.43 of them. They seen occasionally between 30-60 years old females. Malignant transformation was not reported in the literature. Treatment depends on the diameter and the location with the bladder wall of the mass.

P35. CTU OPTIMIZATION IN A 64 MULTIDETECTOR CT
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INTRODUCTION: CT Urography (CTU) has replaced intravenous urography in the study of the pathology of the urinary excretory system, but the radiation continues to be one of its main problems. Knowing the different technical parameters of a given scanner can optimize the dose in each study of CTU.

PURPOSE: Optimizing the study of CTU in 64 MDCT in order that radiation doses are within the appropriate parameters.

MATERIAL AND METHODS: Between September and December 2009, we did CTU on 44 patients (> 40 years old) referred to our department for gross hematuria. The single bolus 3-phase CTU was performed on a 64 MDCT (LightSpeed VCT, General Electric, Milwaukee). The acquisition protocol is consistent with the Body Mass Index (BMI) according to Quetelet Index (kg / m2), adjusting the tube current: Kp, mA, slice thickness, pitch, rotation time and noise index. The reconstruction parameters were adjusted to obtain adequate images for diagnosis. We used as a measure of radiation the CTDI vol and DLP referred by the scanner to analyze the average doses of radiation in different patient groups.

RESULTS: Of the total of 44 patients, 16 (36.3%) had normal weight, 20 (45.4%) were overweight and 8 (18%) were obese. None were morbidly Obese or underweight. The average doses of radiation given to the different groups were 16 (+ 6 SD) CTDI vol, 792 (+ 448 SD) DLP for the normal BMI group, 20 (+1.5 SD) CTDI vol, 825.6 (+ 109 SD) DLP for the overweight and 21.3 (+ 3.8 SD) CTDI vol, 931 (+ 147 SD) DLP for the Obese Group.

CONCLUSIONS: We set a CTU protocol for each group of patients according to their BMI in CTU studies with acceptable radiation dose 64MDTC.

P36. THE ROLE OF INTERVENTIONAL RADIOLOGY IN THE MANAGEMENT OF PATIENTS WITH END-STAGE RENAL DISEASE
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OBJECTIVES: Each year there are 200 new patients with End-Stage Renal Disease (ESRD) per 1,000,000 people in USA. Therefore, the population at risk is estimated at 50-60,000 patients per year. Those patients are managed with hemodialysis (HD) via an arteriovenous fistula (AVF), peritoneal dialysis or a central catheter and, ideally, with a renal transplant. Complications of these two main managements are common. Our institution is pioneer in the world in renal transplantation. Therefore, we have vast experience in the management of those complications.

METHODS: Interventional radiology (IR) plays a very important role in the management of patients with ESRD with two main types of interventions: A. Management and maintenance of complications of HD accesses: AVF and central and peritoneal dialysis catheters. B. Management of all types of complications of renal transplantation. The complications of renal transplantation are: (a) vascular, (b)
urologic, and (c) iatrogenic. We illustrate the IR management of these complications with many examples of most, if not all, events. The dual role of IR in the insertion of central and peritoneal catheters and in the management of the complications associated with central catheters and AVF (both native and with graft) are illustrated with many examples as well.

**RESULTS:** All IR procedures are safe, quick, successful, and cost effective in the long-term maintenance of patients with ESRD.

**CONCLUSION:** IR plays an important role in the management of patients with ESRD with:

A. Insertion of central and peritoneal catheters for dialysis;
B. Management of complications of central catheters;
C. Management of complications of renal transplantation;
D. Management of complications of AVF. IR must be ready and available in all institutions performing renal transplantation, placement of AVF and insertion of central and peritoneal catheters for dialysis in patients with ESRD.

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**P37. RADIOGRAPHER’S ROLE IN EMBOLIZATION OF MYOMAS AND FOLLOW-UP WITH MRI**

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**INTRODUCTION:** Diagnostic and interventional radiological procedures require a “team work” with discrete roles for the radiologist, the radiographer and the nurse. The purpose of this study is to analyze on the role of radiographers in the treatment and follow up evaluation of uterine myomas undergoing arterial transcatheter embolization.

**MATERIALS AND METHODS:** The study enrolled 16 women (41-51 years old, mean 43yo) with symptomatic uterine myomas, detected by US and MRI. The arterial transcatheter embolization of the uterine fibromas (UAE) was performed by ipsilateral and contralateral super-selective catheterization of the feeding arteries of the myomas under fluoroscopy guidance. Fluoroscopy time was recorded by the radiographer. Response to treatment was evaluated by control angiography after procedure completion and MRI at 1st, 3rd, 6th and 12th month. The MRI examination protocol included T2-WI, T1-WI before and after IV administration of gadolinium and fat saturation sequences.

**RESULTS:** The degree of contrast enhancement and the volume of myomas were measured by the radiographer on each MRI examination. Volumes were calculated employing the summation of areas technique on a workstation. The mean reduction in size was 17% on the 1st, 55% on the 3rd, 73% on the 6th month and 94% on the 12th respectively.

**CONCLUSIONS:** The radiographer is an indispensable part of the “team work” and he/she is involved in the fluoroscopic guidance of the procedure, the acquisition of MR images and the volume measurements required for the completion of the study.

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**P38. PRIMARY URINARY BLADDER LYMPHOMA IN THE ACUTE RENAL FAILURE PATIENT**

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**INTRODUCTION:** Lymphoma originating primarily in the bladder is extremely rare. % 0.2 of the extranodal lymphomas originates from bladder. In our study we present clinical and radiologic findings of acute renal failure developing secondary to the primary bladder lymphoma.

**MATERIALS AND METHODS:** 65-years-old man referred to our hospital with anuria and progressed to acute renal failure. We made US, MR Urography(MRU) and cystoscopy examinations for the diagnosis.

**CASE REPORT:** At US examination we found heterogenous hypechogenic mass which was the cause of diffuse bladder wall thickening. MRU showed that the bladder mass involves the uretary orifices and the distal parts of the ureters. Cystoscopy revealed diffuse bladder wall thickening solitary mass. The pathologic correlation reported as large cell B cell lymphoma.

**CONCLUSION:** Extranodal spreading of the lymphomas to the bladder are rare and occasionally seen in older females. Although secondary involvement of the bladder was approximately % 13 in all lymphomas, primary bladder lymphoma is extremely rare. These kind of tumours forms % 0.2 of all extranodal lymphomas and less than % 0.1 of non-ureterial bladder neoplasms. Bladder lymphoma patients complains most of hematuria, dysuria and nocturnia. The most seen form is solitary mass. Diffuse bladder wall thickening seen in our patient is rare and found in % 10 of the patients. They response to radiotherapy and chemotherapy very well. They differs from other bladder neoplasms with well prognosis and exact remission ratios.
**P39. FEASIBILITY OF MRI IN THE EVALUATION OF ROKITANSKY SYNDROME**
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**INTRODUCTION:** To evaluate the feasibility of MRI in the evaluation of Mayer-Rokitansky Kuster-Hauser Syndrome (MRKH)

**MATERIALS AND METHODS:** We evaluated the MR findings of 33 women affected by MRKH Syndrome, diagnosed by US exam and Gynecological examination integrated. MRI was performed with a 1.5 T Magnet (Siemens Avanto), with one or two multichannel phased-array surface coils, in standard condition.

**RESULTS:** We considered the vaginal canal and its extension, Mullerian residues, the adnexals, possible associated abnormalities of kidneys.

**CONCLUSION:** MRI is an adjunctive tool in the anatomical evaluation of patients with MRKH syndrome providing additional informations for surgical management and post surgical follow up.

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**P40. THE ROLE OF INTERVENTIONAL RADIOLOGY IN THE MANAGEMENT OF COMPLICATIONS OF RENAL TRANSPLANTATION. A COMPREHENSIVE REVIEW**
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**OBJECTIVES:** Renal transplantation, the definitive and curative management for patients with end-stage renal disease, is effective, safe, and widespread, and being performed in more institutions; therefore, as more transplants are done, more associated problems and complications are found. Our institution is pioneer in renal transplantation in USA and world; therefore, we have acquired a vast experience on the management of its complications.

**METHODS:** Few comprehensive reviews are available. Therefore, we review our experience in the IR management of most complications including (a) vascular and (b) non-vascular. Vascular: PTA of renal artery stenoses, stenting of renal arteries, arterial and venous thrombolysis, placement of filters in the IVC and iliac veins, embolization of AVFs secondary to kidney biopsy. Non-vascular: Percutaneous nephrostomy, internal and external urinary drainage, dilatation of pelvic and ureteral strictures, stenting of ureters, drainage of lymphocele and other fluid collections, needle aspiration and core biopsies, and others.

**RESULTS:** Most, if not all procedures, are successful in managing all the minor and major complications listed in the above section.

**CONCLUSIONS:** The IR are one the most important members of the “team” managing renal transplant complications. The IR procedures are simple, quick, safe, effective and cost-effective. Surgery with its attendant morbidity must be avoided, if possible. The IRs must be available 24 hours a day, 7 days a week. Every effort must be made to salvage a transplanted kidney as the shortage of organs for transplantation is critical in our country.

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**P41. IMAGING AND PATHOLOGICAL FEATURES OF SPERMATIC CORD LESIONS**
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**INTRODUCTION:** The objective is to present the imaging and pathological features of various spermatic cord lesions and to demonstrate the specific diagnostic imaging findings with pathological correlations.

**MATERIALS AND METHODS:** The gray-scale, panoramic and Doppler sonography; computed tomography and magnetic resonance imaging (MRI) examinations of patients with spermatic cord lesions who was admitted between 2002-2010 were retrospectively evaluated. The most demonstrative images of the common lesions and the diagnostic clues of the uncommon lesions were determined in correlation to the pathological specimens and/or follow-up imaging of the patients.

**RESULTS:** The demonstrative examples include benign and malignant primary tumors and the metastases to the spermatic cord which are very rare. The non-tumoral lesions as spermatic cord cysts, lipomatosis, inflammatory lesion (funiculitis spermaticus) examples are also presented.

**CONCLUSION:** Spermatic cord lesions are relatively rare. Some may present with characteristic features on sonography or MRI, and specific diagnosis may be achieved at the initial admittance.
Further investigations and unnecessary surgical procedures may be avoided if radiologists become more familiar to the imaging features of these rare lesions.

P42. **DCE-MR IN THE ASSESSMENT OF TUMOR RESPONSE IN METASTATIC RENAL CELL CARCINOMA PATIENTS SUBMITTED TO ANTIANGIOGENIC THERAPY**

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**PURPOSE:** Tumor vascularity is a potential predictor of treatment outcomes in metastatic renal cell carcinoma (mRCC), and contrast enhancement of tumors in MR is correlated significantly with microvessel density. In this study, we investigated if tumor enhancement in MRP is useful for predicting outcomes in patients with mRCC who are receiving antiangiogenic therapy.

**METHOD AND MATERIALS:** Thirty-one consecutive patients, twenty eight males and three females, with a mean age of 63 years (49-72 years), with mRCC were enrolled. A total of 108 lesions were evaluated but we considered 31 lesions as target lesion (one for each patient). All patients underwent MR examination on 1.5 T scanner (Magnetom Avanto, Siemens, Germany) equipped with double surface phased array (abdomen and pelvis); sequences were acquired before and after i.v. contrast agent administration (10 mL of Gadobutrol, 1M). MR examination was performed before treatment and 4 weeks, 8 weeks and 12 weeks after treatment. Scan protocol included morphologic imaging with TSE T2-weighted sequences on the axial, sagittal and coronal planes dynamic contrast enhanced imaging using 3D FLASH T1-weighted sequence.

**RESULTS:** Tumor size was reduced in 23/31 lesions (74%), was increased in 6/31 lesions (19%) and was stable in 2/31 lesions (6%). Tumor vascularization was reduced in 25/31 lesions (80%) and other 8 lesions showed marked disease progression.

**CONCLUSION:** Our data indicate that MR imaging provides a tool for early monitoring of antiangiogenic treatment and can identify lesion reduction in terms of volume and vascularization. MR is a radiation free modality useful in the evaluation of antiangiogenic treatment response in patients with mRCC and influences clinical decision for oncologic patients’ management.
In case of increased PSA values, an ultrasound prostate exam with standardized biopsies is clinically used to confirm prostate tumour or inflammation. However, in patients with negative biopsies where the PSA stays elevated for a period of time, further examination is required for accurate diagnosis or guided repeat biopsy (1, 2). Thanks to the excellent soft tissue contrast, magnetic resonance with anatomical T2-weighted images is often used, although the sensitivity varies strongly between centres. One of the newer imaging methods to diagnose prostate pathology in a clinical setting is diffusion weighted magnetic resonance imaging (DWI).

DWI is an MR technique based on the Brownian motion of the spins in biologic tissues (3). Examining the molecular diffusion using magnetic resonance relies on sensitizing an imaging sequence with two equally strong but opposed gradients along a certain diffusion direction. While the first of these two gradients introduces a dephasing, the second will rephase all stationary molecules. Moving molecules will only be partially rephased, resulting in a signal loss in the resulting images. The tissue contrast is then generated by differences in quantity of moving molecules and their respective speed. The diffusion-sensitizing effect from the gradients is indicated by the b-value, which is a combination of the gradient strength and the timing characteristics:

\[ b = \gamma^2 G^2 \delta^2 \left( \Delta - \frac{\delta}{3} \right). \]

While the fast moving molecules will quickly lose all of their phase coherence and signal, even at low b-values, the slow moving molecules will retain high signal intensities far into the higher b-value ranges. By examining the remaining signal at different b-value DW images, we can therefore estimate the amount and speed of movement present. Quantitative evaluation of the DW images acquired using different b-values is done using the so called apparent diffusion coefficient (ADC), which is calculated by fitting the signal intensities at the images acquired using different b-values with a diffusion model, either monoexponential

\[ S = S_0 \times e^{-b^*ADC} \]

or biexponential

\[ S = S_0 \times \left[ (1 - F_p) \times e^{-b^*ADC_d} + F_p \times e^{-b^*ADC_p} \right]. \]

The biexponential fit was introduced when it was noted that the estimated curves did not fit well with the monoexponential model in the low b-value range. It is currently assumed that in the b-value range from b=0 s/mm² to b=1000 s/mm² there are two major contribution factors to the diffusion signal: the slower molecules in the extracellular extravascular space and the faster molecules in the structures, usually indicated as the perfusion fraction (Fp).

For both diffusion models, the measured signal S is expressed as the signal intensity at b=0 s/mm² (S₀) multiplied by a decreasing exponential function based on the ADC and the b-value used. Because the monoexponential fit only examines the total signal loss between the minimal and maximal b-value used, it combines the effects of capillary perfusion (ADCp) and water diffusion in the extracellular extravascular space (ADCd) if both low and high b-values are used. The biexponential fit, on the other hand, tries to separate these contributions, thereby approximating the true diffusion coefficient of the tissue ADCd, and the fraction of perfusion present in the examined tissue (Fp).

Diffusion-weighted MRI already is an established technique for the diagnosis of acute stroke which works on the principle that an acute ischemic injury leads to a profound restriction in water diffusion of the affected brain probably due to a cytotoxic edema (4) reflected in a decreased ADC value. This principle has been expanded to the study of other pathological processes including cancer. In this regard a tumor with more densely packed tumor cells and more cell membranes presents a greater impediment to diffusion and consequent lower ADC value. On the other hand a less cellular tumor, a

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**DIFFUSION WEIGHTED IMAGING: BASICS AND APPLICATIONS**

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In case of increased PSA values, an ultrasound prostate exam with standardized biopsies is clinically used to confirm prostate tumour or inflammation. However, in patients with negative biopsies where the PSA stays elevated for a period of time, further examination is required for accurate diagnosis or guided repeat biopsy (1, 2). Thanks to the excellent soft tissue contrast, magnetic resonance with anatomical T2-weighted images is often used, although the sensitivity varies strongly between centres. One of the newer imaging methods to diagnose prostate pathology in a clinical setting is diffusion weighted magnetic resonance imaging (DWI).

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cystic or necrotic tumor, or a tumor which is responding to treatment, has a decrease in the restrictive cell membranes with less impediment to diffusion and consequent higher ADC value. Promising results have been reported in animal and human studies showing the potential of DWI in evaluation of a wide range of cancers including those in the breast, prostate, liver, brain, and rectum (5).

When applying DWI in the prostate, some care must be taken to get optimal images. The lower abdomen does not suffer from very strong movement artefacts, although bowel movements and bladder filling do have an effect on positioning of the prostate. Therefore, fast spin-echo echoplanar imaging (SE-EPI) techniques are nearly always used, due to their speed, and absence of 180° refocusing radiofrequency pulses, reducing specific absorption rate (SAR) issues. In cases where there are large amounts of air in the colon, or when movement artefacts are too important to ignore, you can attempt to use a single-shot turbospin echo sequence, which has inherently a lower signal-to-noise ratio (SNR), but has a less detrimental effect of susceptibility differences in the resulting images. Also, rectal filling and bowel relaxants can be used to help minimize these effects. As DWI in the pelvis is always prone to low SNR, even with SE-EPI sequences, a good coil selection, and preferably parallel imaging, should be used to reduce the echo time, and increase the SNR as much as possible. If not enough coils are present, you can still perform DWI, but you will have to increase the number of averages to obtain acceptable image quality, thereby increasing scan time. Finally, choosing the b-values that need to be used is one of the most important points in DWI of the prostate. Using only 2 b-values gives fast ADC maps, but the interpretation of these values can be quite tricky, as acute inflammation can mimic a hypervascular hypercellular tumour. A higher number of b-values in the range of 0 to 1000 s/mm² can better offer this distinction, but at the cost of longer scan times. Currently, there is no gold standard on how many and which b-values to use, which echo time to aim for, or which type of postprocessing model to use. If multicentre studies are to be set up, agreement must first be reached on the setup to use, otherwise the results of different centres are most likely incomparable.

References

MRI OF THE PROSTATE
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Most prostatic lesions are detected on the basis of elevated serum prostate-specific antigen (PSA) levels and abnormal digital rectal examination. Serum PSA is up to present the best available test for early detection of prostate carcinoma, but it is also elevated in benign prostatic hyperplasia (BPH), acute and chronic prostatitis and recent urologic procedures [1, 2]. To improve the differentiation between benign and malignant causes of PSA-elevation, the PSA density is frequently calculated, which relates serum PSA level to the prostate volume [2, 3]. The gold standard for diagnosis of prostate carcinoma is histological assessment obtained by transrectal ultrasound-guided systematic core needle biopsy. In the future, imaging-based targeted biopsy may improve biopsy yield and decrease the number of biopsy cores. An important histopathologic parameter is the Gleason score. It reflects the grade of differentiation and thus correlates with tumor aggressiveness [4]. A score of 3+4 or lower corresponds to a less-aggressive tumor with lower risk of non-organ confined disease, while a score of 4+3 or higher corresponds to a more aggressive tumor with higher prostate cancer risk mortality.

In patients with elevated PSA or an abnormal digital rectal examination imaging studies such as transrectal ultrasound (TRUS) and Magnetic Resonance Imaging (MRI) can be of value. TRUS is used for initial morphologic assessment of the prostate and seminal vesicles, to measure the prostatic
volume (for calculation of PSA density), and is excellent for biopsy guidance [1, 5]. TRUS has only moderate accuracy in detection of prostate carcinoma and is therefore not useful for screening [1, 5]. The role of MRI in both the diagnosis and staging of prostate carcinoma, has evolved tremendously in the past decade. Particularly the introduction of endorectal-coil imaging and the emergence of functional techniques such as MR Spectroscopy (MRSI), Diffusion Weighted Imaging (DWI) and Dynamic Contrast Enhanced MRI (DCE-MRI) has boosted the diagnostic accuracy of MRI [1]. MRI is not a first-line approach for the diagnosis of prostate cancer, but it may improve the detection or exclusion of high grade tumors, which is of interest in patients with prostate cancer who choose for active surveillance or in patients with elevated PSA but previous negative biopsies to guide targeted rebiopsy.

Standard morphologic imaging sequences should include 4 mm transverse, sagittal and coronal fast-T2 weighted images (T2-WI), supplemented with a 4 mm transverse breath-hold T1-weighted sequence (T1-WI) [1, 6]. On 1.5T equipment, the use of an endorectal coil in conjunction with a pelvic phased-array coil is highly recommended [1, 6]. The balloon-covered endorectal coil is inflated with 60cc of air or filled with 40cc of a liquid such as barium sulfate suspension or perfluorocarbon (PFC) to increase the magnetic field homogeneity by eliminating the air-tissue interface and reducing susceptibility artifacts [1, 6]. Before the examination Scopolamine (Buscopan) IV is administered to reduce peristaltic motion of the rectum and adjacent bowel segments.

Morphologic T2-WI exquisitely depict the prostatic zonal anatomy. The prostate gland is located caudal to the urinary bladder, with the urethra running through it. The caudal part of the prostate is called the apex, the cranial part the prostate base. The central gland (composed of periurethral glands along the proximal urethra, paired pear-shaped transition zones and central zone, which envelopes the ejaculatory ducts) consists of nodular areas of varying signal intensity [2]. The normal peripheral zone has high signal intensity. Anteriorly, the prostate is covered by the anterior fibromuscular stroma. Morphologic T2-WI are used in the assessment of prostatic volume (and calculation of PSA density), and may demonstrate benign prostatic hyperplasia (BPH). In BPH the prostate shows a marked central gland nodular enlargement with thinning of the peripheral zone. BPH is a widespread disorder affecting aging men, with reported prevalence of 50% in >60y and even 90% in >85y [7]. The patients complain of decreased force of urine stream, nocturia, straining, urinary frequency, urinary urgency and residu after miction [7]. On imaging studies the bladder wall is thickened, and diverticula may be present. Treatment options include watchful waiting or transurethral resection of the prostate (TURP). Morphologic T2-WI are able to assess the presence and extent of prostate carcinoma. Most tumors are found in the peripheral zone and show low signal-intensity surrounded by normal high signal-intensity peripheral zone tissue [8]. Prostate cancer is one of the most common tumors in Western countries, but up to 40% of the detected cancers will never become symptomatic during the patient’s lifetime [1, 2, 6]. Clinically significant prostate cancers are identified on the basis of serum PSA level, morphologic TNM staging, histological Gleason grading and the patient’s life expectancy and comorbidity [1, 3]. On the basis of these variables, patients may be either allocated to surgery or radiotherapy, or to active surveillance when the impact of the prostate cancer on the patient’s life expectancy and quality of life is deemed insignificant.

On morphologic T2-WI prostatitis shows diffuse wedge-shaped low signal intensities in the peripheral zone of the prostate, simulating prostate cancer [9]. In most cases prostatitis is an incidental finding on MRI, and imaging is not required in uncomplicated cases [10]. Prostatitis affects 15-30% of all men at some time in their lives [10, 11], but in 90% this is asymptomatic. Chronic non-bacterial prostatitis may be related to chronic pelvic pain syndrome (CNBP/CPPS). Acute bacterial prostatitis is associated with acute illness, fever, pelvic pain and discomfort. Complications are prostate abscess, recurrent low urinary tract infections or epididymo-orchitis.

On morphologic T2-WI prostatic cysts may be visualised as high-signal intensity fluid-containing structures near the midline of the prostate. Most of them are asymptomatic and incidental findings on imaging, but sometimes they are complicated by intracystic infection or bleeding causing pain or hematospermia, or they may enlarge and compress the ejaculatory duct causing infertility [9]. These cysts may be of Mullerian origin (utriculus cyst) or Wolffian origin (originating in the ejaculatory duct, ampullae of the vas deferens or seminal vesicles). In symptomatic cases the cyst may be aspirated by TRUS-guided puncture, or be resected by transurethral endoscopic surgery.

Standard morphologic MRI imaging not only includes T2-WI but should be supplemented with a 4 mm transverse breath-hold T1-WI [1, 6]. The normal prostate has an isosignal similar to that of the adjacent muscles [10], but high signal intensitie foci indicate post-biopsy intraglandular hemorrhage [10]. As mentioned above, a low signal intensity area on morphologic T2-WI is not specific for prostate cancer, since benign conditions such as prostatitis, hemorrhage, hyperplastic nodules or post-
treatment (hormonal or irradiation) changes may equally show low signal intensity [1, 8, 12].
Furthermore, morphologic T2-WI is less accurate for evaluating central gland cancers, unless they
show an irregular area of uniform low signal-intensity [4]. Overall, diagnostic accuracies of about 70%
have been reported for morphologic T2-WI in the detection of prostate cancer [8, 13]. To increase both
the sensitivity and specificity of magnetic resonance imaging in the detection of prostate cancer,
several functional techniques can be added. These take advantage of various tumor phenotypes, such
as tumor metabolism (MRSI), angiogenesis (DCE-MRI), and cellular density (DWI). While the
diagnostic efficacy of DWI still remains unclear, accuracies up to 90 % have been reported for DCE-
MRI and MRSI.

Diffusion weighted imaging provides information about the amount of random ‘Brownian’ movements
of water molecules. 4mm single-shot fat-suppressed echo-planar images (EPI) are acquired at various
gradients of diffusion (b-values = 0, 250, 500, 750 and 1000 s/mm²), with calculation of quantitative
data using the apparent diffusion coefficient (ADC) [6, 8]. Water diffusion in biologic tissues is
inversely correlated to the tissue cellularity and integrity of cell membranes [12]. Normal prostate
tissue is composed of an abundant glandular component, with relatively unhindered motion of water
molecules [12] and thus a high ADC. Prostate cancer typically shows a higher cellular density, with
restricted movement of water molecules, and thus a low ADC [6, 8, 12].

MR spectroscopy provides information about the relative concentrations of cellular metabolites in the
prostate. A three-dimensional data set with spectra from small voxels of 0.5 cc or less is acquired
throughout the prostate. MRSI sequences suppress signal contributions from water and fat and
measure the relative concentrations of citrate, choline, creatine and polyamines, which resonate at
distinct frequencies in the spectrum [1, 8, 14]. Low citrate levels and high choline levels are
demonstrated in prostate cancer, especially in higher grade tumors. The complimentary changes of
these metabolites are used to predict the presence or absence of prostate cancer by means of the
choline-plus-creatine-to-citrate (CC/C) ratio, in which higher ratios are suggestive of more aggressive
prostate cancer [15, 16].

In dynamic contrast enhanced MRI the prostate is evaluated on serial (every 2-5 sec) 3D GE T1-WI
after intravenous bolus injection (0.1 mmol/kg) of a low-molecular weight contrast agent (Gadolinium
chelate) [1]. Most prostate carcinomas show earlier and higher peak enhancement with initial steep
slope of the signal intensity – time curve, as well as early washout [1]. Several quantitative
postprocessing parameters have been developed, such as $K_{trans}$ (describing leakage of contrast from
vascular to extravascular space), $v_e$ (estimate of extravascular extracellular space) and $K_{ep}$ (reverse
reflux rate constant between extracellular and plasma space) [1, 6, 13, 17]. Most prostate carcinomas
are associated with significantly higher $K_{trans}$, $K_{ep}$, and $v_e$ [17]. The combination of morphologic and
functional MRI techniques will undoubtedly play an increasing role in imaging of the prostate.

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CONTRAST ENHANCED MRI: BLADDER, PROSTATE, LYMPH NODES

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Prostate
Worldwide, more than 650,000 men are diagnosed with prostate cancer every year, accounting for a tenth of all new male cancers. In Europe the lifetime risk of being diagnosed with prostate cancer is approximately 1 in 13.

MR imaging is a powerful tool to image the prostate. A large number of studies have been performed to assess the value of DCE-MRI in prostate cancer. The most important applications of MR imaging of the prostate are detection and localization of prostate cancer, local staging and local recurrence detection.

For a tumor, one critical factor that affects development, growth, invasiveness, and progression into the metastatic form is the ability of the tumor to generate new blood vessels. Angiogenesis, the sprouting of new capillaries from existing blood vessels, and vasculogenesis, the de novo generation of new blood vessels, are the two primary methods of vascular expansion by which nutrient supply to tumor tissue is adjusted to match physiologic needs.

Dynamic contrast-enhanced MR imaging is a non-invasive method to probe tumor angiogenesis. DCE-MRI following the administration of low molecular weight contrast media (<1 kDa) is the most popular imaging method for evaluating human tumor vascular function in situ. Insights into these physiologic processes are obtained qualitatively by characterizing kinetic enhancement curves or quantitatively by applying complex compartmental modeling techniques. Data reflecting the tissue perfusion (blood flow, blood volume, and mean transit time), the microvessel permeability, and the extracellular leakage space can be obtained.

MR imaging sequences can be designed to be sensitive (a) to the vascular phase of contrast medium delivery, so-called susceptibility-weighted (T2*-weighted) DCE-MRI, which reflects tissue perfusion and blood volume and (b) to the presence of contrast agent, so-called T1-weighted DCE-MRI, which reflects the perfused microvessel area, permeability and extravascular extracellular leakage space. The essence of DCE-MRI of the prostate lies in the differences in microvascular characteristics that have been observed between normal and malignant prostatic tissues. The obtained T1-weighted DCE-MRI data can be assessed in two ways:

Firstly, a semi-quantitative approach describing the signal-intensity changes by using a number of descriptors. The following descriptors can be derived from the time-concentration curve: (a) the onset time of the signal-intensity curve (t0 = time from appearance in an artery to the arrival of contrast agent in the tissue of interest); (b) the slope and height of the enhancement-curve (time-to-peak); (c) maximum signal-intensity (peak enhancement); and (d) washin/washout gradient or plateau phase. These parameters are limited by the fact that they may not accurately reflect contrast agent concentration in tissues and can be influenced by the MR scanner settings (including gain and scaling factors).

Secondly, a quantitative approach using pharmokinetic modeling, which is usually applied to changes in the contrast agent concentrations in tissue. Concentration-time curves are mathematically fitted by using one of a number recognized pharmokinetic models, and quantitative kinetic parameters are
derived. The following quantitative parameters can be derived: (a) transfer constant of the contrast agent (Ktrans); (b) rate constant (Kep); and (c) interstitial extravascular extracellular space (Ve). Many studies have found that DCE-MRI is superior to T2-weighted MR imaging for prostate cancer localization. DCE-MRI is less accurate in the localization of tumor within the central gland, while peripheral zone localization is markedly improved.

Although the literature is sparse on the additional value of DCE-MRI in local staging, such imaging does appear to improve local staging performance. The accuracy of the less experienced reader improved significantly by applying contrast agent.

The application of DCE-MRI for local recurrence detection after radical prostatectomy or curative radiation therapy is increasingly being used. Haider et al. found that DCE-MRI performs better than T2-weighted MR imaging in the detection and localization of prostate cancer in the peripheral zone after external beam radiotherapy. DCE-MRI had significantly better sensitivity (72% vs. 38%), positive predictive value (46% vs. 24%) and negative predictive value (95% vs. 88%) than T2-weighted MR imaging. Sciarra et al reported on the use of DCE-MRI and MR spectroscopic imaging in the detection of local recurrence in a post-prostatectomy patient group. They concluded that the combination of these techniques is an accurate method to identify local prostate cancer recurrence with biochemical failure (87% sensitivity and 94% specificity). This information may be helpful in the planning of salvage therapy.

Bladder
Cancer of the urinary bladder is one of the most common types of malignant tumor of the urinary tract. Because the sequence of surgical or systemic treatment and the prognosis depend on the depth of tumor infiltration and the extent of metastatic lymph nodes (1), it is important to accurately assess the stage of the nodes prior to surgery. With current cross-sectional imaging modalities such as computed tomography (CT) and magnetic resonance (MR) imaging, we rely predominantly on nodal size for detecting metastases. However, there is considerable overlap in size between benign and malignant nodes.

Extensive pelvic lymphadenectomy and pathologic nodal assessment at the time of radical cystectomy have a substantial effect on prognosis in patients with muscle-invasive bladder cancer; they enable identification of those patients who require adjuvant chemotherapy. Herr et al (2,3) suggested that a wide extravesical soft-tissue margin with bilateral pelvic nodal dissection of at least nine nodes is required to obtain individual prognostic information and identify patients who will benefit from adjuvant chemotherapy. However, more extensive nodal dissection may expose the patient to increased procedure-related complications.

MR imaging of the bladder is reportedly better at initial staging than CT. Barentsz et al. reported on a series of 61 patients, 57 of whom ultimately underwent cystectomy. They were evaluated by MR imaging 1-4 weeks after transurethral resection and by dynamic contrast-enhanced MR imaging of the bladder that accurately detected extravesical disease in 28 patients with pathologic confirmation. Dynamic contrast-enhanced MR imaging showed an improved differentiation of malignancy from post-transurethral resection artifact.

Lymph nodes
Pelvic lymph nodes play an important role in indicating whether the prostate carcinoma is curable or not. If a detected lymph node harbours metastasis, it’s called a “positive lymph node”. In prostate cancer, one positive lymph node can turn prostate cancer from a local to a systemic disease unsusceptible to curative treatment. The status of the lymph nodes largely dictates the management of the primary tumour.

Surgical open pelvic lymph node dissection (PLND) with histopathological examination is currently the most reliable method of assessing lymph node status. Pelvic lymphadenectomy and in-particular extended pelvic lymphadenectomy, is an invasive procedure associated with potential complications and side effects. A noninvasive, reliable method for detecting and staging nodal metastasis in the pre-operative assessment may redirect clinicians towards less invasive treatment strategies. Because normal and abnormal lymph nodes have similar signal intensities or densities, metastatic lymph nodes are identified based on size and to a lesser extent on shape criteria. These morphological criteria may result in missing small metastases in normal sized nodes. Thus, routine cross-sectional imaging modalities, such as computed tomography (CT) and magnetic MR imaging, have a limited sensitivity in identifying metastases.
The most important in characterizing renal lesions is to try to distinguish the surgical (potentially malignant) and the non-surgical lesions.

In global we have four kind of lesions: the nodular cystic mass, the nodular solid mass, the solid pseudo-lesion and the infiltrative mass.

The most important criterion in differentiating surgical from nonsurgical renal masses is the determination of contrast enhancement. Any enhancing solid mass in a kidney should be considered a renal neoplasm.

How much, how fast and which contrast do we use?
We use 100 mL of 300 mg I/mL at a flow rate of 3-4 mL/sec. The weight of the patient has to be taken into account.

What is contrast enhancement?
An attenuation value of at least 10-20 HU.

In which phase do we measure the enhancement?
The corticomedullary phase (between 25 and 70 seconds after IV contrast injection) has some limitations in the detection of renal lesions: an hypervascular mass in the cortex; hypovascular lesion can be left undetected when they are located in de medulla.

The nephrographic phase (between 80 and 180 seconds after the start of the injection) is the best phase for detecting the masses in the homogeneous enhancing parenchyma of the kidney, as the enhancement of the neoplasms is time-dependent.

The excretory phase (begins 180 seconds after contrast injection) is helpful in centrally located neoplasms, to define the relationship with the calices and the renal pelvis.

The nodular cystic mass.
Size is not important.
Bosniak made a classification for cystic lesions in 1986 which still is very usefull.
Type 1 are benign simple cysts. They have a low attenuation of 0 to 20 HU and a hairline-thin wall. There is no enhancement, no calcification and no septation.
Type 2 are benign, minimally complicated cysts. They may contain a few hairline-thin septa in which enhancement may be perceived (not measured). Fine calcifications or a short segment of thicker califications may be present in the wall of the cyst. In this category, the hyperattenuating cysts are included.
Type 2F (F for Follow up) are hyperdense cysts which may have calcifications, septa and a perception of enhancement and which are bigger than 30 mm. The follow up should be done after 6 months, followed by a yearly scan for the next 4 years.
Type 3 cysts contain thickened walls or septa in which enhancement can be measured. These cysts should be surgically resected. The incidence of malignity is at least 30 %.
Type 4 cysts have enhancing soft-tissue components. These are renal cancers until proven otherwise. The nodular solid mass
Any enhancing mass is a renal carcinoma until proven otherwise, but not all enhancing solid masses are renal carcinomas.
Renal cell carcinoma is indistinguishable from an oncocytoma.
Angiomyolipoma contains fat, but a renal cell carcinoma can also contain fat. Metastatic disease in a kidney is not that often found. If a known primary malignancy is known, only 50 to 85\% of the solitary renal masses are metastatic. Lymphoma is rare in the kidney if there is no other evidence of extrarenal lymphoma.
The pseudotumors
This represents normal renal tumor that may mimic a renal neoplasm. Key to the diagnosis is that the mass enhances in the same way as the normal parenchyma. Congenital pseudotumors include prominent columna of Bertin, renal dysmorphism and dromedary hump. Acquired pseudotumors represent hypertrophied normal renal parenchyma adjacent to scar tissue. Inflammatory pseudotumors are focal pyelonephritis and abscess. Vascular anomalies include aneurysms and AV fistula.
The infiltrative mass
This is seen as a diminished nephrogram with irregular margins. The reniform shape is preserved and is sometimes enlarged. Possibilities are lymphoma, transitional cell carcinoma, metastatic disease and renal cell carcinoma.

**Conclusion/take home messages**
Surgical strategy is mainly based on imaging.
A contrast enhancing mass is malignant until proven otherwise.
Not all enhancing masses are malignant.

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**RFA (RADIOFREQUENCY ABLATION) OF RENAL LESIONS**
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*(see separate (Dutch) contribution at the end of this file)*

**LOW DOSE CT OF UROLITHIASIS**
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*(see separate powerpoint presentation handouts at the end of this file)*
In recent times, CT urography has supplanted intravenous urography for the evaluation of the urinary tract, especially in patients with hematuria. Most of patients with hematuria have either urolithiasis or chronic infection but in rare cases malignant urological tumors, such as urothelial cell carcinoma (UCC), can occur. UCC is a relatively rare malignancy occuring only in 5% of all urologic tumors. Patients usually present with hematuria, dull flank pain or renal colic. Of these tumors, only 10% will be located in the upper urinary tract, mostly papillary tumors in the renal pelvis and lower ureter.

As multiphase CTU is a relatively high radiation dose examination, the CTU should be properly justified and recently a new clinical hematuria guideline has been proposed in The Netherlands. Good patient selection, based on risk stratification, is important and is based on the classic risk factors including age, male sex, smoking, presence of macroscopic hematuria, previous UCC, radiotherapy of the pelvis, and exposure to aromatic amines. Furthermore, as detection strongly relies on adequate CT technique as well as adequate distention and opacification of the upper urinary tract, attention to the details of the CTU protocol remains essential. Despite the publication of the ESUR guideline early 2008, there are still as many protocols as CTU specialists. Many tips for optimization of CT technique and details of CTU protocols will be provided to help the technologist in making good documented protocol choices.
MRI of renal lesions

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ESUR - September 2010 - Brugge
Content

- Why MRI?
- patient setup
- scan protocol
- image interpretation
- special conditions
Why MRI?

patient related reasons
- radiation exposure (children, pregnancy, …)
- (severe) iodinated contrast allergy
- compromised renal function
- lesion incidentally discovered on MRI

lesion related reasons
- non-conclusive sonographic or CT findings (↑tissue characterisation)
- therapeutic management (treatment choice, kidney-sparing surgery, …)
- new advances in imaging (faster imaging techniques, DWI-MRI, MRS, …)

imaging focus
- lesion detection and/or characterization
- lesion location/extension (staging, treatment planning: resectability, RFA, …)
Why MRI?

tissue contrast resolution
Why MRI?
*tissue contrast resolution*
Why MRI?

*tissue contrast resolution*
FIRST inform / educate the patient!

setup
- supine position, arms elevated or upwards supported
- 1.0, 1.5 (3.0) Tesla scanner
- phased array body coil
Scan protocol for renal lesions

**unenhanced imaging**
- T2-weighted sequence
- T1-weighted sequence (in/out phase, with/without fat-suppression)
- optional: DWI-MRI, MRS, …

**contrast-enhanced imaging**
- fast T1-weighted fat-suppressed sequence (breathhold / respiratory triggering)
  - precontrast
  - arterial phase ($\triangle t = \frac{1}{2}$ minute)
  - venous phase ($\triangle t = 1-2$ minutes)
  - late venous phase ($\triangle t = 2-4$ minutes)
  - excretory phase ($\triangle t > 4$ minutes, IV furosemide, 3D sequence)

alternative: dynamic scanning
Scan protocol for renal lesions
fat containing lesion (fat-suppression to differentiate fat-hemorrhage)
Scan protocol for renal lesions

multiplanar imaging
Scan protocol for renal lesions

contrast enhanced imaging

unenhanced

arterial

venous

excretory
Scan protocol for renal lesions

field of view, multiplanar → lesion extension, treatment planning

T-staging:

T1 < 7 cm (limited to the kidney)

T2 <10 cm (limited to the kidney)

T3 extension perirenal, into major veins or sinus

T4 extension beyond Gerota fascia
### Overview renal lesions
**imaging spectrum - characterization**

**BENIGN**
- adenoma
- *angiomyolipoma*
- oncocytoma
- other (rare)

- pseudotumor
  - infectious
  - inflammatory
  - infarction

- cystic lesions
  - **simple**
  - multicystic
  - complex

**MALIGNANT**
- carcinoma
  - solid
  - cystic
  - mixed
  - sarcoma
  - lymphoma
  - metastasis
  - other (rare)

**SURGICAL?**
- benign solid
- cystic indeterminate
- malignant cystic

- pseudotumor

- MRI may have increased sensitivity for **cyst complexity** (exception: calcifications)

- MRI is ideal for further characterization of lesions with **indeterminate enhancement at CT**
Image interpretation

cyst complexity
Image interpretation

cyst complexity
Image interpretation

cyst complexity

unenhanced

arterial phase
Image interpretation

*image subtraction*

- need for accurate image coregistration to subtract images: *end-expiratory breath-hold*
**Image interpretation**

*Image subtraction*

- **solid (components in) lesions:** \(\uparrow 15\% \text{ in signal intensity}\) on postcontrast images
Image interpretation

image subtraction
Image interpretation

image subtraction

unenhanced

arterial phase

subtraction
Image interpretation

*image subtraction*

unenhanced
arterial phase

venous phase
excretory phase

subtraction
Image interpretation

signal intensity versus image subtraction

SI: 90
arterial phase

SI: 163
venous phase

SI: 104
arterial phase

SI: 104
venous phase
Image interpretation

signal intensity versus image subtraction
Bosniak type I-II: benign lesions
Bosniak type IIF: needs follow-up
Bosniak type III: indeterminate / surgical
Bosniak type IV: clearly malignant
Bosniak type I-II: benign lesions
Bosniak type IIIF: needs follow-up
Bosniak type III: indeterminate / surgical
Bosniak type IV: clearly malignant
**Image interpretation**

*diffusion weighted imaging - Taouli et al. Radiology 2009*

Bosniak type I-II: benign lesions
Bosniak type IIF: needs follow-up
Bosniak type III: indeterminate / surgical
Bosniak type IV: clearly malignant
Special conditions
renal transplant
Special conditions
renal crossed fused ectopy
Take home messages

Patient and lesion related reasons to perform MRI.

Inform, educate and instruct patients (breath-hold imaging).

Screen for fat, cyst complexity and lesion enhancement.

Accurate staging of lesion is important for treatment planning.

Adapt protocols for special conditions.
Further reading

Israel GM. MRI of the kidney and urinary tract. JMRI 2006;24:725-734.


Israel GM, Bosniak M. Pitfalls in renal mass evaluation and how to avoid them. Radiographics 2008;28:1325-1338.


**Minimaal invasieve ablatieve behandelingen voor kleine renale massa’s: overzicht en literatuurstudie**

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**Keywords:**
- Radiofrequency ablation
- Cryotherapy
- Renal cell carcinoma (RCC)
- Minimally invasive therapy
- Small renal mass

Renal cell carcinoma (RCC) is de derde meest voorkomende maligniteit op urologisch vlak, na prostaat- en blaaskanker, en staat in voor ongeveer 3-4% van alle kwaadaardige letsels bij volwassenen. Hoewel RCC minder voorkomend is dan prostaat- of blaaskanker, heeft deze kanker echter een minder goede prognose met een minder goede overlevingskans op 5 jaar, vergeleken met prostaat- en blaaskanker (1).

Met de technische vooruitgang en algemene beschikbaarheid van de beeldvormings-modaliteiten zoals CT en MRI, worden meer en meer RCC’s per toeval en in asymptomatisch stadium ontdekt (ongeveer 60% van alle renale tumoren) (2). Het betreft hier dan voornamelijk kleinere tumoren in een lager TNM stadium (3) en het grootste deel hiervan wordt vastgesteld bij oudere mensen (≥ 70 jaar) reeds belast met een aantal comorbiditeiten welke een verhoogd risico met zich meebrengen in geval van chirurgische interventie (4).

Waar vroeger een radicale nefrectomie de gouden standaard was in de behandeling van deze letsels, heeft deze plaats geruimd voor de nephronsparende chirurgie, de partiële nefrectomie (5).

Hoewel we weten dat de meeste van deze kleine letsels traag groeien en weinig metastatisch potentieel vertonen, heeft ruim een derde van deze letsels toch agressieve eigenschappen op APO, waardoor het natuurlijke verloop van dergelijke letsels toch nog onvoorspelbaar is (6).

Voor dergelijke letsels in dergelijke populatie moeten de voor- en nadelen van elke behandelingsoptie per patiënt afgewogen worden. Enerzijds kan er een conservatief beleid aangenomen worden, waarbij de patiënt regelmatige beeldvorming ondergaat om de evolutie van het letsel te volgen: Actieve Monitoring. Anderzijds is er de optie heelkundige behandeling van dit letsel door middel van radicale nefrectomie, partiële nefrectomie of minimaal invasieve behandelingen.

De twee belangrijkste en meest bestudeerde minimaal invasieve behandelingen zijn radiofrequentie ablatie (RFA) en cryo-ablatie (CA). Andere opties zoals high intensity focal ultrasound (HIFU) en microwave therapie worden ook bestudeerd.

**Cryo-ablatie**

Pathofysiologische aspecten

CA zorgt voor weefseldestructie door zowel een acuut als een laattijdig effect. Het acute effect is te wijten aan de vorming van ijskristallen in de weefsels. Deze kristallen vormen zich initieel in de extra-cellulaire ruimte waardoor de osmolariteit daar stijgt. Hierdoor migreert water van in de cel naar de extra-cellulaire ruimte, waardoor zowel intracellulaire schade optreedt als disruptie van de celmembranen. Nadien is er ook ijskristalvorming intracellulair met bijkomende cellulaire schade (7).

Het laattijdige effect treedt op tot uren en dagen na de initiële behandeling met coagulatieve necrose als gevolg van de ijsvorming. Het belangrijkste laattijdige effect is waarschijnlijk weefselisch mist van vasculaire schade welke optreedt ten gevolge van endotheliale celschade en thrombosevorming in het vasculair bed (8). Waarschijnlijk speelt celapoptose ook zijn rol in dit laattijdig effect na CA en mogelijk zou er nog een bijkomend effect zijn van immunomodulatie ten gevolge van de ijsvorming.
Voor normaal renaal weefsel is een temperatuur van < -19.4°C nodig voor celdestructie. Voor renale tumoren wordt volgens de huidige protocols een temperatuur van -40°C aangetroffen (9). De rand van de ijsbol komt overeen met 0°C. Daarom wordt aanbevolen van de ijsbal tot 1cm buiten de tumorwand te laten expanderen zodat de temperatuur 1cm binnenin -40°C bedraagt.

**Technische aspecten**

Technisch gezien gebruiken de meeste een dubbele frys-dooi cyclus. Het doopproces zorgt voor mechanische disruptie van de cellen en met twee cycli kan een grotere necrotische zone verkregen worden dan na 1 cyclus (10).

Het grootste deel van de CA (65%) wordt uitgevoerd tijdens een laparoscopische ingreep met echografische begeleiding. Hierbij kan het intrarenaal deel van de tumor beter gevisualiseerd worden voor het aanprikken ervan en hebben we een visuele en echografische feedback van de gecreëerde ijsbal (Figuur 1) (10). Een open CA wordt nog slechts zelden (10%) toegepast. Slechts een vierde van de CA wordt percutaan uitgevoerd. Deze worden meestal uitgevoerd onder CT begeleiding en onder algemene narcose, maar deze techniek kan ook toegepast worden onder IV sedatie (11).

Percutane cryo-ablities (PCA) kunnen uitgevoerd worden onder echo-, MRI- of CT geleiding. Voor MRI-geleide CA is er echter een open MR toestel en geselecteerd materiaal nodig welke beiden een aanzienlijk kostprijs hebben, wat de techniek praktisch gezien minder toepasbaar maakt.

Echografische begeleiding is bij CA ook mogelijk. Hoewel het een zeer beschikbare en goedkopere techniek is met realtime feedback, kunnen de randen van de ijsbol niet goed in beeld gebracht worden en is de kwaliteit van de beeldvorming beperkt doordat deze niet beeldvormend is. Zodoende wordt echografie zelden gebruikt ter begeleiding van PCA. CT is momenteel de meest gebruikte en algemeen aanvaarde beeldvorming ter begeleiding van PCA. CT laat een goede targetting van het letsel toe evenals een goede visualisatie van de ijsbol tijdens de behandeling.

Een van de gevaren bij PCA is het risico op cryolaesies aan naburige organen zoals darm. Deze letsels kunnen vermeden worden door het creëren van een vochtophoping tussen tumor en naburig orgaan met fysiologisch serum (Figuur 2) (12).

**Beïnvloedende factoren**

Een goede tumorselectie is belangrijk gezien niet alle kleine renale tumoren in aanmerking komen voor CA. Centraal geïsoleerde tumoren zijn moeilijker succesvol te ableren dan perifer gelegen tumoren. Voor tumoren groter dan 4cm blijkt 1 sessie meestal onvoldoende te zijn en is minstens een tweede cryosessie nodig voor succesvolle ablatie (13).

Bij behandeling van tumoren dichtbij of tegen aan het kelkensysteem of pyelon bestaat het risico van lekkage en urinoom vorming na de behandeling. Het risico hierop lijkt echter kleiner te zijn bij CA dan bij RFA (14).

De huidige indicatiestelling beperkt zich dan ook tot perifere gelegen tumoren tot 3cm. Aron en Gill stellen zelfs voor om centraal gelegen tumoren of tumoren groter dan 4cm te aanzien als contra-indicatie voor CA (15).
Postoperatieve opvolging

MRI met Gadolinium levert de meest accurate beeldvorming, maar CT met contrast is meer dan aanvaardbaar en gezien deze veel beschikbaarder is, wordt CT met contrast dan ook meest gebruikt als postoperatieve beeldvorming.

Algemeen wordt aanvaard dat de afwezigheid van contrastaankleuring gelijk gesteld wordt met succesvolle ablatie en afwezigheid van viabele tumor. Het cryoletsel zelf verdwijnt niet onmiddellijk, maar krimpt over de komende maanden na behandeling. Het letsel kan zelfs volledig verdwijnen, maar dit kan tot 48 maanden duren (16).

Er wordt een opvolgingsschema aanbevolen van beeldvorming op dag 1 en nadien op 3, 6, 12, 18 en 24 maanden (10). Sommigen pleitten eveneens voor het nemen van een CT geleide biopsie uit het cryoletsel. Gill et al stelden echter dat het nemen van deze biopsie waarschijnlijk onnodig is gezien de 2 tumor recurrences van 39 behandelde letsels niet alleen gediagnosticeerd werden bij positieve biopsies maar ook gedetecteerd werden op MRI (17).

Technische aspecten

De huidige systemen voor radiofrequente ablatie zorgen voor bijna quasi letsels tot 3cm diameter. Voor grotere tumoren zijn, net zoals voor CA, vaak overlappende ablaties nodig (20). Ook RFA wordt zowel laparoscopisch als percutaan toegepast. In tegenstelling tot CA worden bij RFA tot bijna 95% van de behandelingen percutaan toegepast. In tegenstelling tot CA worden bij RFA tot bijna 95% van de behandelingen percutaan toegepast. Hoewel de tumor bij een laparoscopische ingreep beter vrijgelegd en gevisualiseerd kan worden, heeft percutane RFA het grote voordeel dat deze ingreep onder sedatie kan uitgevoerd worden. Percutane RFA kan uitgevoerd worden onder MRI-, CT- of echogeleide. Echografische begeleiding wordt echter slechts zelden gebruikt gezien de beeldvorming verstoord wordt door de vorming van gasbelletjes (20). Theoretisch gezien is MRI begeleiding de beste keuze gezien deze real-time feedback levert tijdens de ablatie en residuele tumor kan aantonen. Dezelfde argumenten als voor MRI-geleide PCA zijn van toepassing wat deze techniek praktische gezien minder toepasbaar maakt. De meest gebruikte beeldvormingsmodaliteit is CT met contrasttoediening, gezien deze gemakkelijk te verkrijgen is en ook een goede real-time feedback geeft (Figuur 3b).

Ook bij RFA is de mogelijke schade aan omgevende organen een belangrijke complicatie, die op dezelfde wijze als bij CA te vermijden valt met hydrodissectie (Figuur 2a-2d) (21).

Beïnvloedende factoren

Een aantal factoren kunnen het effect van een radiofrequente ablatie beïnvloeden. Zoals hierboven reeds vermeld, beletten gasbelletjes en verkooling van weefsel een efficiënte ablatie, dit tengevolge van een stijging in impedantie, welke de stroomgeleiding belemmert. Als oplossing voor dit probleem werden onder andere ‘wet’ RFA en intern gekoelde naalden ontwikkeld (22).

Ook eigenschappen van omgevende weefsels hebben een invloed op de behandeling. De nabijheid van grote bloedvaten of het kelkensysteem werken als een ‘heat sink’, waardoor minder hoge temperaturen bereikt kunnen worden. Anderzijds kan overliggend vet over een tumor isolerend werken, waardoor net gemakkelijker hogere temperaturen bereikt kunnen worden (23).

Net zoals bij CA is een goede tumorselectie van belang gezien tumorgrootte

Radiofrequente ablatie

Pathofysiologische aspecten

RFA zorgt voor weefseldestructie doort het opwarmen van de weefsels. Er wordt een hoogfrequente wisselstroom door de ablatieprobe gestuurd (Figuur 3a). Door ionische agitatie in de weefsels rondom de niet-gesi-soleerde tip van de naald warmen de weefsels op. Vanaf een temperatuur van 60°C treedt er vrijwel onmiddellijk denaturatie op van eiwitten met verlies aan enzymatische functie, disruptie van celmembranen en coagulatieve necrose met celdood tot gevolg. Bij temperatures boven de 105°C ontstaan er gasbelletjes en kan het weefsel gaan verkolen, wat kan leiden tot minder efficiënte ablatie. Naast een direct cytotoxisch effect treedt er net zoals bij CA een laattijdig effect op. Door de hitte treedt er vasculaire schade op en ontstaan er intravasculaire thrombi hetgeen leidt tot verminderde perfusie na RFA. Dit zorgt voor een laattijdige necrose in de geableerde zone (18). Ook na RFA zou er mogelijk een bijkomend effect zijn ten gevolge van immunomudulatie (19).
en – localisatie een succesvolle ablatie kunnen beïnvloeden. Kleine perifere tumoren lijken de beste kandidaten om een succesvolle ablatie te bekomen. Grote (> 3cm) en centraal gelegen tumoren hebben vaak meerdere sessies nodig om volledige tumornecrose te bekomen (24).

Het uitvoeren van meerdere ablaties in 1 narcosetijd of het herhalen van RFA sessies is echter vrij gemakkelijk uitvoerbaar, terwijl centraal geïsoleerde tumoren eveneens een uitdaging vormen voor partiële nefrectomie.

**Postoperatieve opvolging**

Afwezigheid van contrast op postoperatieve beeldvorming wordt geïllustreerd met een succesvolle ablatie. Residuele tumor wordt gedefinieerd als contrastcapteatie thv de tumorzone, na een initieel negatieve beeldvorming. Gezien ongeveer 90% van de recidieven gedetecteerd worden in het eerste postoperatieve jaar, wordt een strak beeldvormingschema voorgesteld gedurende deze eerste 12 maanden (25).

Momenteel wordt beeldvorming uitgevoerd op 3, 6, 12, 18 en 24 maand in de eerste twee jaar post-operatief. Het is belangrijk om te weten dat er op post-RFA beeldvorming bepaalde zeer typische bevindingen kunnen waargenomen worden. Zo bijvoorbeeld wordt bij percutaan behandelde letsels vaak een peri-lesionele halo gezien, wat een goed teken is, niet te verwarren met residuele tumor. Na behandeling van kleine renale letsels gaat het letsel na een initiële toename van de omvang vaak terug wat krimpen. Residuele tumor presenteert zich op CT vaak als een croissant-vormige contrastcapteatie naast het geableerde letsel (26).

Terwijl de beeldvorming na CA goed blijkt te correleren met de anatomopathologie van de gedetecteerde letsels, is deze correlatie bij RFA minder duidelijk en worden er een deel vals-positieve en vals-negatieve resultaten beschreven (27).

De belang van NADH kleuring voor aanduiden van vitaal tumorweefsel van de post-operatieve biopsies en de correcte timing van deze kleuring werd in kader hiervan reeds uitvoerig beschreven in de literatuur (28). NADH-staining is dan ook onmisbaar vooraleer effectief van recidief of residuele tumor gesproken kan worden op basis van APO. Over het al dan niet standaard nemen van een biopsie op 6 maanden na de behandeling, bestaat nog geen consensus. Wel zijn de meeste auteurs het er over eens dat een biopsie dient genomen te worden indien er op beeldvorming iets verdachts gezien wordt.

<table>
<thead>
<tr>
<th>CRYO studies</th>
<th>N pts/ N tum</th>
<th>Biopsy-proven RCC (%)</th>
<th>Mean age (years)</th>
<th>Mean diam (mm)</th>
<th>Approach</th>
<th>Mean F-U (mo)</th>
<th>Mean Success after 1 session (%)</th>
<th>Final succes (%)</th>
<th>2nd-3rd-4th session N pts (%)</th>
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<tbody>
<tr>
<td>Sewell et al. 2004</td>
<td>103/120</td>
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<td>69,5</td>
<td>NA</td>
<td>PC</td>
<td>35,5</td>
<td>60,0</td>
<td>91,7</td>
<td>15 (14,6)-2(1,9)</td>
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<td>65,2</td>
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<td>Lap</td>
<td>36,0</td>
<td>96,6</td>
<td>96,6</td>
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<td>66,3</td>
<td>25,6</td>
<td>Lap</td>
<td>36,0</td>
<td>98,9</td>
<td>98,9</td>
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<tr>
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<td>46,9</td>
<td>62,0</td>
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<td>48/48</td>
<td>79,2</td>
<td>62,0</td>
<td>26,0</td>
<td>Lap/open</td>
<td>64,0</td>
<td>82,5</td>
<td>85</td>
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<td>89,1</td>
<td>67,0</td>
<td>26,0</td>
<td>Lap/open</td>
<td>10,0</td>
<td>96,4</td>
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<td>65,3</td>
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<td>27,9</td>
<td>66,0</td>
<td>27,0</td>
<td>Lap</td>
<td>22,0</td>
<td>97,0</td>
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<td>PC</td>
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<td>PC</td>
<td>13,3</td>
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<td>NA</td>
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<td>Lap/PC</td>
<td>12,8</td>
<td>95,4</td>
<td>95,4</td>
<td></td>
</tr>
</tbody>
</table>

**Tabel 1: 12 CA-studies.**
**Pre-operatieve biopsienaam**

Zowel bij CA als bij RFA is het nemen van een biopsie uit het letsel van uitzonderlijk diagnostisch en prognostisch belang omdat ook aan de hand hiervan verdere opvolging bepaald zal worden. Het nemen van een biopsie bij kleine renale letsels blijft echter een punt van controverse. Hoe kleiner de tumor, hoe minder accuraat de resultaten van biopsie. Zo zien we in bepaalde reeksen tot 30% niet-representatieve biospienames bij kleine renale letsels. Heilbrun et al stelden dat een pre-operatieve biopsie slechts een beperkte toegevoegde waarde heeft indien de beeldvorming reeds voldoende argumenten van maligniteit vertoont (29).

De eigenschappen van de patiënten en tumoren welke behandeld werden, waren voor beide groepen gelijkwaardig. Bij nazicht van de studies die pre-operatief APO vermelden, zien we dat er in de RFA groep meer bewezen RCC's (82,3% van de gebiopseerde letsels) behandel werden ten opzichte van de CA groep (63,1% van de gebiopseerde letsels).

Wel is er al duidelijk wat langer ervaring met CA dan met RFA. Van CA vinden we de eerste 5-jaars resultaten al terug in de literatuur vanaf 2006, voor RFA is dit nog maar vrij recent met een publicatie vanaf 2008. De kankervrije en kancerspecifieke overlevingspercentages zijn in ieder geval zeer veelbelovend.

**Resultaten**

Om de oncologische resultaten en complicaties van beide technieken met mekaar te vergelijken, doorzochten we de Medline database van 2003 tot augustus 2008. We selecteerden 12 studies met minstens 35 behandelde tumoren van zowel RFA (24, 30-40) als CA (10,17,34, 41-49). Een cut-off van minimum 35 tumoren per studie werd genomen om te voorkomen dat we kleinere studies incluemden welke nog volop in de learning curve zitten. In geval van meerdere publicaties van dezelfde groep, werd de meest gepaste publicatie geselecteerd (*Tabellen 1 en 2*).

Zo zagen we dat de succesratios na 1 ablatie eigenlijk voor beide behandelingen vrij goed zijn, met een kleine voorsprong voor CA. Gaande van 67% tot 100% voor RFA en van 60% tot 98,9% voor CA. We zagen ook wel dat er een significant groter deel van de tumoren een herablatie nodig had in de RFA groep: 8,8% ten opzichte van slechts 2,5% in de CA groep.

**Tabel 2: 12 RFA-studies.**

<table>
<thead>
<tr>
<th>RFA studies</th>
<th>N pts/ N tum</th>
<th>Biopsy-proven RCC (%)</th>
<th>Mean age (years)</th>
<th>Mean diam (mm)</th>
<th>Approach</th>
<th>Mean F-U (mo)</th>
<th>Mean Success after 1 session (%)</th>
<th>Final succes (%)</th>
<th>2nd-3rd ablation N pts (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Su et al. 2003</td>
<td>29/35</td>
<td>31,4</td>
<td>64,4</td>
<td>22</td>
<td>PC</td>
<td>9</td>
<td>94,3</td>
<td>100</td>
<td>2 (6,9)</td>
</tr>
<tr>
<td>Farell et al. 2003</td>
<td>20/35</td>
<td>5,7</td>
<td>64</td>
<td>17</td>
<td>PC/open</td>
<td>9</td>
<td>100,0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Varkarakis et al. 2005</td>
<td>46/56</td>
<td>48,2</td>
<td>63,9</td>
<td>22</td>
<td>PC</td>
<td>27,5</td>
<td>83,9</td>
<td>96,4</td>
<td>5 (10,9)</td>
</tr>
<tr>
<td>Gervais et al. 2005</td>
<td>85/100</td>
<td>90,9</td>
<td>70</td>
<td>32</td>
<td>PC</td>
<td>27,6</td>
<td>67,0</td>
<td>90,9</td>
<td>21 (24,7) (2,4)</td>
</tr>
<tr>
<td>Salajerski et al. 2006</td>
<td>42/45</td>
<td>NA</td>
<td>68</td>
<td>37,5</td>
<td>PC</td>
<td>14</td>
<td>93,3</td>
<td>100</td>
<td>3 (7,1)</td>
</tr>
<tr>
<td>Hegarty et al. 2006</td>
<td>72/81</td>
<td>NA</td>
<td>66,6</td>
<td>25,1</td>
<td>PC</td>
<td>12</td>
<td>91,4</td>
<td>93,8</td>
<td>2 (2,8)</td>
</tr>
<tr>
<td>Park et al. 2006</td>
<td>78/94</td>
<td>69,1</td>
<td>63,6</td>
<td>24</td>
<td>PC/Lap</td>
<td>25</td>
<td>94,7</td>
<td>97,9</td>
<td>3 (3,8)</td>
</tr>
<tr>
<td>Zagoria et al. 2007</td>
<td>104/125</td>
<td>100</td>
<td>70,4</td>
<td>27</td>
<td>PC</td>
<td>13,8</td>
<td>87,2</td>
<td>92,8</td>
<td>7 (6,7)</td>
</tr>
<tr>
<td>Stern et al. 2007</td>
<td>40/40</td>
<td>75,0</td>
<td>60,5</td>
<td>24,1</td>
<td>PC/Lap</td>
<td>30</td>
<td>92,5</td>
<td>97,5</td>
<td>2 (5,0)</td>
</tr>
<tr>
<td>Carey et al. 2007</td>
<td>36/37</td>
<td>83,8</td>
<td>70,7</td>
<td>30-50</td>
<td>PC/Lap</td>
<td>11,3</td>
<td>94,6</td>
<td>97,3</td>
<td>1 (2,8)</td>
</tr>
<tr>
<td>Breen et al. 2007</td>
<td>97/105</td>
<td>NA</td>
<td>71,7</td>
<td>32</td>
<td>PC/Lap</td>
<td>16,7</td>
<td>79,0</td>
<td>90,5</td>
<td>11 (11,3)-1 (1,0)</td>
</tr>
<tr>
<td>Veltri et al. 2008</td>
<td>68/87</td>
<td>NA</td>
<td>64,9</td>
<td>29</td>
<td>PC</td>
<td>24,4</td>
<td>86,2</td>
<td>89,7</td>
<td>3 (4,4)</td>
</tr>
</tbody>
</table>
Zo waren er statistisch meer graad 1 complicaties na RFA, welke geen behandeling behoeven. Na CA waren er dan weer statistisch gezien meer graad 2 of graad 4 complicaties, wat ernstigere complicaties zijn.

**Besluitvorming**

Een open of laparoscopische partiële nefrectomie vormen de gouden standaard voor de behandeling van kleine renale tumoren. CA en RFA hebben hun intrede gemaakt als nieuwe behandelingssystemen voor kleine renale tumoren. Voor laparoscopische CA waren al enkele jaren langere termijnresultaten bekend, welke vergelijkbaar waren met deze van laparoscopische partiële nefrectomie. We zijn dan ook niet ver meer verwijderd van de aanvaarding van laparoscopische CA als volwaardig alternatief voor laparoscopische partiële nefrectomie in de behandeling van kleine renale tumoren. De langere termijns resultaten van RFA beginnen nu ook te verschijnen en blijken vergelijkbaar te zijn met deze van laparoscopische CA.

Voor RFA werden aanzienlijke herablatiepercentages beschreven met een gemiddelde van bijna 10%. Herablatie kan echter vrij gemakkelijk toegepast worden en als we dit accepteren, bereikt RFA een vergelijkbaar succesratio vergeleken met CA. Het grote voordeel van RFA ten opzichte van CA, zoals blijkt uit onze analyse, is dat de complicaties na deze behandelingssystemen van minder ernstige aard zijn dan deze na CA en vaak geen bijkomende behandeling of opvolging vergen. RFA mag dan ook aanzien worden als een relatief veilige ingreep met slechts een klein percentage risico op ernstige complicaties.

Korte termijnresultaten tonen ons tot op heden een succesratio rond de 95% voor beide behandelingen. Echte resultaten van langere follow-up zijn echter

---

**Tabel 3: Complicaties van RFA- en CA-groep volgens Dindo-classificatie.**

<table>
<thead>
<tr>
<th>Study</th>
<th>Adverse Events (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade I</td>
</tr>
<tr>
<td><strong>RFA Group</strong></td>
<td></td>
</tr>
<tr>
<td>Su et al. 2003</td>
<td>60</td>
</tr>
<tr>
<td>Farrell et al. 2003</td>
<td>4</td>
</tr>
<tr>
<td>Varkarakis et al. 2005</td>
<td>16</td>
</tr>
<tr>
<td>Gervais et al. 2005</td>
<td>6</td>
</tr>
<tr>
<td>Salagierski et al. 2006</td>
<td>1</td>
</tr>
<tr>
<td>Hegarty et al. 2006</td>
<td>4</td>
</tr>
<tr>
<td>Park et al. 2006</td>
<td>8</td>
</tr>
<tr>
<td>Zagoria et al. 2007</td>
<td>3</td>
</tr>
<tr>
<td>Stern et al. 2007</td>
<td>2</td>
</tr>
<tr>
<td>Carey et al. 2007</td>
<td>1</td>
</tr>
<tr>
<td>Breen et al. 2007</td>
<td>1</td>
</tr>
<tr>
<td>Veltri et al. 2008</td>
<td>6</td>
</tr>
<tr>
<td><strong>Cryo Group</strong></td>
<td></td>
</tr>
<tr>
<td>Sewell et al. 2004</td>
<td>6</td>
</tr>
<tr>
<td>Gill et al. 2005</td>
<td>1</td>
</tr>
<tr>
<td>Hegarty et al. 2006</td>
<td>4</td>
</tr>
<tr>
<td>Lawatsch et al. 2006</td>
<td>1</td>
</tr>
<tr>
<td>Davol et al. 2006</td>
<td>4</td>
</tr>
<tr>
<td>Schwartz et al. 2006</td>
<td>1</td>
</tr>
<tr>
<td>Weld et al. 2007</td>
<td>1</td>
</tr>
<tr>
<td>Bandi et al. 2007</td>
<td>5</td>
</tr>
<tr>
<td>Cestari et al. 2007</td>
<td>17</td>
</tr>
<tr>
<td>Atwell et al. 2008</td>
<td>1</td>
</tr>
<tr>
<td>Finley et al. 2008</td>
<td>9</td>
</tr>
<tr>
<td>Lehman et al. 2008</td>
<td>8</td>
</tr>
</tbody>
</table>
nog nodig om de gelijkwaardigheid van de therapiën ten opzichte van chirurgie te bevestigen.
LOW - DOSE CT OF UROLITHIASIS

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P. Bellinck, D. Ghysen, M. Baeyaert
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Lier - Belgium
Overview

- Epidemiology
- Pathophysiology
- Clinical presentation
- Medical Imaging
- Standard dose vs. low dose CT
- Diagnostic algorithm
- Future applications
Epidemiology

- **urinary stone disease**: very frequent pathology
  - 12 – 15% of population in western world
  - incidence: 0.5 – 1.0/1000 people/year (~ geography)
  - peak: 30 – 50 year; man 3 à 4 x > woman
  - increasing prevalence last 10-20 years

- **recurrent disease**: ‘stone formers’
  - 40% in 5 y, 60% in 10 y, up to 75% in 25 years

- **before 1970** (< ESWL and endoscopic removal)
  - 1/4 to 1/3 of patients loss of kidney (function)

- **hereditary**: renal tub. acidosis - cystinuria
Stone composition

- **Composite**
  - <5 %
  - Organic cell material ~ cell débris - proteins – Ca++

- **Crystals**
  - > 95%
    - 75%: Ca-oxalate, Ca-phosphate or
    - 10-15%: Struvite (infection)
    - 5-10 %: Urate stones
    - < 1%: Cystine stones
Pathophysiology: ureteral obstruction

- **Ureteral pressure (P):**
  - normal: 5 -15 mm Hg
  - obstruction: up to 75 mmHg
    - peak after 2 - 5 h.; ↓ 50% after 24 h.

- **Diameter:**
  - \(x \ 2\) in 10 min (5-6 mm)

- **Chronic obstruction**
  - P normalizes after 2 weeks
  - diameter \(x \ 3 – 4\) (9-10 mm)
  - reduction of peristalsis
  - loss of peristalsis with infection
Obstruction and renal function

- **progressive loss of renal function:**
  - reduction of RBF: 50% after 3 days, 70% after 2 weeks, 88% after 3 weeks,…

- **complete repair:**
  - by removal of obstruction within 2 - 3 weeks

- **associated infection:**
  - unreparable damage → medical urgency!
Clinical presentation

- ‘Colic pain’ due to stone obstruction
  - distention of ureter – PCS
  - spasm of muscular layer of ureter
  - heavy pain in spinal segments of autonomic nerve system, level Th10 – L3 and S1-S2

- Broad pain zone: ‘band like’
  - back side to flank – bottom (posterior)
  - hemi-abdomen to inguinal region – scrotum en labia
Clinical presentation

- Location and size of stone
  - no correlation with grade of clinical symptoms

- Different abdominal pathologies: identical pain innervation:
  - mimics of renal colic and vice-versa:
    - appendicitis, diverticulitis, cholecystitis, pancreatitis, bowel obstruction or torsion, ovarian mass – torsion, aorta dissection or rupture of AAA
Location and diameter of lithiasis

- **most important parameters:**
  - ~ prognosis and choice of therapy:
    - proximal: ESWL – PCNL (> 1.5 – 2 cm)
    - distal: conservative or endoscopic stone extraction (URS)

- **indication of possibility of spontaneous stone passage:**
  - 22% proximal - 46% mid-ureter - 71% distal
  - diameter: 1 - 4mm > 80%; 5mm: 55%; 6 mm 35%; 7mm: 25% and > or = 8 mm: 10%
Predeliction sites of stone obstruction

- sites of anatomical - fysiologica narrowing

  - PU-junction (5%)
    - diameter 1 cm to 2-3 mm

  - Cross with iliacal vessels (10%)
    - ureter crosses anteromedially ~ slight compression

  - VU-junction (20 - 30%)
Medical evaluation

- Clinical examination

- Laboratory
  - Urine analysis and culture (when signs of infection)
  - stone: chemical analysis

- Therapy
  - More drinking (only water !!!): > 2L/day
  - diet: not very successful

- Medical Imaging
Medical imaging

- **Abdominal radiography:**
  - limited sensitivity and specificity: +/- 50 - 60%

- **IV Urography:** > 50 years ‘golden standard’
  - disadvantage: use of IV iodine contrast
    - renal function – possibility of allergic reactions
  - very lengthy exam when obstruction
    - multiple late exposures: increase of radiation dose
  - radiolucent stones: not visible (urate and cystine)
  - IVU misses stone in 30 – 50 % of cases
  - possibility of contrast extravasation
    - at puncture site and contrast – urinoma
IV Urography

- no possibility for alternative diagnosis
  - with negative IV Urography

- so called ‘physiological information’ with IVU
  - never been found a real correlation with physiological parameters
  - or with outcome or grade of renal damage

- ‘Epitaph for the Urogram’ *
  - E. Stephen Amis Jr : editorial 1999

* Radiology 1999; 213: 639-640
Ultrasound

- direct visualization of stone
  - echogenic focus with retro-acoustic shadow
- very limited visualization of ureter
- in combination with radiography *
  - moderate sensitivity (70-80%) and specificity (60-70%);
  - acceptable NPV (85-90%)
- indirect signs:
  - dilatation of ureter and / or PCS
  - absence or asymmetry of ‘ureteral jet’
- alternative diagnosis: possible

* Catalano O et al. AJR 2002;178:379-386
Spiral CT of urolithiasis

Since 1995 *: replacement of other imaging techniques, because of obvious advantages of CT:

- fast exam (one breathhold)
- no preparation necessary (emergency)
- fast interpretation (< 5 min.)
- no use of IV iodine contrast
- exact location and size of stone
- visualization of (nearly) all stones (even < 1 mm)

* Smith RC et al. Radiology 1995;194:789-794
Spiral CT of urolithiasis

- high sensitivity (95-98%), specificity (94-99%), accuracy (93-98%) *

- low inter- and intra-observer variability

- limited, fast ‘learning curve’ (residents – urologists) **

* Smith RC et al. AJR 1996;166:97-101
Miller OF et al. Urology 1998;52:982-987
Boulay I et al. AJR 1999;172:1485-1490

** Rosser CJ et al. Can Assoc Radiol 2000;51:177-181
Disadvantages of spiral CT of urolithiasis

- relatively high radiation dose
  - in mostly young (and otherwise healthy) population
  - with high chance of recurrence in ‘stone formers’: repeat examinations

- effective dose CT *
  - men: 2.8 – 13.1 mSv
  - women: 4.5 – 18.0 mSv

- effective dose IV Urography **
  - 1.5 mSv (3-film)
  - 2.1 mSv (6-film)

  Tack D et al. AJR 2003;180:305-311

  Wall BT and Hart D. Br J Radiol 1997;70:437-439
Low dose CT of urolithiasis

- Proposition of use of low dose CT
  - Effective dose < or ~ IVU

- Single helical CT *
  - 120 kV, 70 mA, pitch 2
  - Effective dose: 1 – 1.5 mSv

- 4-MDCT **
  - 120 kV, 30 eff. mAs, pitch 1.5
  - Effective dose: 1.2 – 1.9 mSv

- Sensitivity and specificity: comparable to standard normale dose CT (> 95 %)

Knopfle E et al. RöFo 2003;175:1667-1672

** Tack D et al. AJR 2003:180:305-311
Disadvantages of low dose CT

- not possible for *
  - very tall and/or obese patients (exclusion in studies)

- or additional spiral sequence needed for **
  - obese patients when first sequence not conclusive (30 to 60 eff. mAs)

- doubt about accuracy of low dose CT ***
  - in performance of finding alternative diagnoses
  - first goal of good CT exam is correct diagnosis, not lowering dose!
Standard versus low dose CT

- comparable study
  - 300 patients: low vs standard dose MDCT
- use of dose modulation:
  - technique whereby dose is adapted to patient’s anatomy (body habitus)
  - in both protocols: low dose and standard dose
  - ‘CareDose 4D’ - Siemens
- very good correlation of dose (due to modulation) with BMI of patients *
- low dose also possible in obese patients?

<table>
<thead>
<tr>
<th>Parameters: standard vs. low dose MDCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td><strong>6-MDCT - standard dose</strong></td>
</tr>
<tr>
<td><strong>16-MDCT - standard dose</strong></td>
</tr>
<tr>
<td><strong>6-MDCT - low dose</strong></td>
</tr>
<tr>
<td><strong>16-MDCT - low dose</strong></td>
</tr>
</tbody>
</table>
Man, 40 y, 1.80 m, 92 kg, BMI 28.4, acute renal colic R
low dose 16-MDCT:
mean eff. mAs 59; eff dose: 1.5 mSv

Man, 54 y, 1.65 m, 118 kg, BMI 35.4, acute renal colic R
standard dose 6-MDCT:
mean eff. mAs 118; eff dose: 7.6 mSv

Man, 40 y, 1.80 m, 92 kg, BMI 28.4, acute renal colic R
low dose 16-MDCT:
mean eff. mAs 59; eff dose: 1.5 mSv
Man, 25 y, 1.78m, 104 kg,
**BMI 32.8**, 
acute nierkoliek L
Low Dose 16-MDCT:
mean eff. mAs 66;
eff. dose: 1.7 mSv
Man, 48 y, 1.70 m, 88kg, BMI 30.4, standard dose 16-MDCT: acute renal colic R mean eff. mAs 108; eff. dose: 2.9 mSv
<table>
<thead>
<tr>
<th></th>
<th>Standard dose MDCT</th>
<th>Low dose MDCT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TM</td>
<td>PB</td>
</tr>
<tr>
<td>sensitivity (%)</td>
<td>98.8</td>
<td>97.6</td>
</tr>
<tr>
<td>specificity (%)</td>
<td>94.0</td>
<td>95.5</td>
</tr>
<tr>
<td>positive predictive value (%)</td>
<td>95.3</td>
<td>96.4</td>
</tr>
<tr>
<td>negative predictive value (%)</td>
<td>98.4</td>
<td>97.0</td>
</tr>
<tr>
<td>accuracy (%)</td>
<td>96.7</td>
<td>96.7</td>
</tr>
</tbody>
</table>

Note: readers TM and PB are experienced radiologists; SD and RDW are first-year residents.
Results comparative study *

- comparable high accuracy in stone detection
  - low vs. normal dose CT
  - also for non experienced first-year residents

- dose modulation
  - dosis reduction with 25 – 31%

- low dose CT
  - additional dose reduction of 51 - 64%

- mean effective dose low dose CT: 1.5 mSv
  - < IVU; equivalent 2 - 3 x radiographs of abdomen

- alternative diagnosis: found in +/- 15% of patients
  - < score residents: 10-12% standard dose and 4-5% low dose CT **

* Mulkens T et al. AJR 2007; 188: 553-562
** Holdgate A and Chan T. Acad Emerg Med 2003;4:315-319
Man, 37y, 1.78 m, 75 kg, BMI 22.7
acute abdomen
Pain R
suspicion of renal colic
low dose 16-MDCT:
eff. mAs 30; eff. dose 0.78 mSv

Alternative diagnosis

Acute appendicitis

Effective dose CT: comparable to abdominal radiography
Acute appendicitis
with perforation and adhesions
with secondary obstruction of R ureter and kidney

Man, 40y, 1.75m, 82 kg,
BMI 26.7
acute pain R flank and fossa
low dose 16-MDCT:
eff. mAs 60;
eff. dose: 1.6 mSv
Woman, 43y, 1.62 m, 84 kg, **BMI 32**

*L renal colic; low dose 6-MDCT: eff. mAs 52; eff. dose 2.8 mSv*

**Bilateral ovarian teratomas**
Woman, 47 y, 1.6 m, 72 kg, BMI 28.1
acute pain R flank and fossa iliaca
low dose 6-MDCT:
eff. mAs 40; eff. dose: 1.6 mSv

Colon diverticulitis
Man, 24y, 1.79 m, 75 kg, BMI 23.4; R renal colic
Low dose 16-MDCT: eff. mAs 44;
**eff. dose: 1.15 mSv**

*Ductus colligentes carcinoma*
Low dose CT of urolithiasis

- other studies confirmed the possibility to use low dose CT for detection of urolithiasis *

- meta-analysis of 7 studies ** (> 1000 patients) suggests that a low dose spiral CT protocol can be used as the initial imaging technique in the clinical evaluation of patients with suspected renal colic

* Paulson EK et al. AJR 2008; 190:151-157
Ciaschini MW et al. Radiolgy 2009; 251:105-111
Jin DH et al. Radiology 2010; 255:100-107

** Niemann T et al. AJR 2008;191:396-401
Disadvantages low dose CT

- limited examination technique: cave !!!
  - bowel ischemia and infarction
  - bowel inflammation and tumors
  - difficult to diagnose without bowel preparation (opacified bowel) and IV iodine contrast
  - tumors of solid organs: can be easily missed!

- with persistent symptoms:
  - additional abdominal CT exam with standard dose, bowel opacification and IV iodine contrast is needed

- rising use of unenhanced (low dose) CT abdomen as a ‘screening’ exam (ER)
  - with every acute abdomen
  - reduction of positive exams from 50% to 30%

* Chen MY et al. Radiology 1999;173:1447-1450
Secondary CT signs of obstruction

- unilateral dilatation of ureter – PCS
- renal enlargement
- perirenal fat stranding – edema
- ureteral rim sigm (wall edema)
- unilateral renal density decrease (> 5 H.U.)
Secondary CT signs of obstruction

- Dilatation ureter - PCS
- Normal ureter
  - 1 to 3 mm diameter
  - Asymptomatic site = control
- Sensitivity: 90%
- Specificity: 93%
  for obstruction
- Absence in
  - Partial – intermittent obstruction
Edema of perirenal fat

- **sign of obstruction**
  - increase lymphatic drainage by renal edema

- **linear en curvi-linear bands**

- **unilateral**
  - **only** symptomatic site

- **sign of high P**
  - greater chance of spontaneous stone passage

* Takahashi N et al. Radiology, 1998;208:97-102
Secundary CT signs of obstruction

- sometimes only sign of stone presence or passage
- unilateral renal enlargement
- density \( \downarrow \) kidney
  - \( > \) or \( \geq \) 5 HU
- ureter : rim-sign
- combination ureter dilatation+ peri - renal edema *
  - PPV 99%
  - NPV 95%

* Smith RC et al. Rad Clin North America 1999;911-952
Unilateral renal enlargement

Ureteral ‘rim’ sign *

Edema of ureteral wall by stone impaction
sens. 77% - spec. 92%

Due to interstitial edema: not specific for stone disease

Pitfalls

- **Fleboliths in pelvis:**
  - No obvious central lucent area like in radiography!
  - Coronal MPR

- **Slim patients:**
  - Paucity of intra-abdominal fat
  - Difficult evaluation of ureteral position

- **Calcified atheromatous iliacal arteries**
Calcified atheromatous plaques
What is the value of a negative CT exam?

- 45 - 70% CT’s are negative *

- < 5% **
  - already stone passage at time of imaging
  - persistent symptoms due to edema
  - or too small stone to be visible (< 1 mm)

- 10 - 15% **
  - alternative diagnosis

* Lane et al. AJR 1997;168:405-409
** Kambadakone AR et al. Radiographics 2010;30:603-623
What is the value of a negative CT exam?

- 70-75% (incl. negative laboratory results) *
  - spontaneous resolution of symptoms

- if no stone is found and absence of secondary signs: urinary stone disease is very unlikely **

- negative predictive value of CT: > 90% *
  - for exclusion of alternative pathology
  - also proved with additional imaging

* Lane et al. AJR 1997;168:405-409
** Kambadakone AR et al. Radiographics 2010;30:603-623
Diagnostic algorithm

Low dose MDCT

- pos
- neg

- neg
  - negative lab results
  - alternative diagnosis (?)
  - evtl. additional imaging
  - STOP

- pos

Radiography + US

- pos
- neg

- children – adolescents – young patients

STOP
Future applications

Iterative imaging reconstruction *
• new reconstruction algorithm recently introduced in modern MDCT

• expected to replace ‘filtered back projection’ (FBP), in nearby future

• FBP: reconstruction algorithm used since Hounsfield (1972): inherent noise

Significant dose reduction possible with preservation of image quality: mean dose reduction ‘iterative reconstruction’: 30 – 80%; mean of 50%

Effective dose in low dose CT of urolithiasis: mean value of 1.5 mSv
Further reduction to 0.75 mSv: comparable with one abdominal radiograph may be possible in future?

* Silva AC et al. AJR, 2010;194:191-199