Imaging recommendations in paediatric uroradiology: Minutes of the ESPR workgroup session on urinary tract infection, fetal hydronephrosis, urinary tract ultrasonography and voiding cystourethrography

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ESUR Paediatric guideline subcommittee and ESPR paediatric uroradiology work group
Table 1. Grading of Hydronephrosis (HN)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HN 0</td>
<td>no or minimal collecting system visible, considered normal</td>
</tr>
<tr>
<td>HN I</td>
<td>just the renal pelvis visible with an axial diameter less than 5-7 mm,</td>
</tr>
<tr>
<td></td>
<td>usually considered normal</td>
</tr>
<tr>
<td>HN II</td>
<td>axial renal pelvis diameter less than 5/7-10 mm</td>
</tr>
<tr>
<td></td>
<td>some calices with normal fornical shape visible</td>
</tr>
<tr>
<td>HN III</td>
<td>marked dilatation of the renal calices and pelvis larger than 10 mm</td>
</tr>
<tr>
<td></td>
<td>with reduced fornical and papillary differentiation</td>
</tr>
<tr>
<td></td>
<td>without parenchymal narrowing</td>
</tr>
<tr>
<td>HN IV</td>
<td>gross dilatation of the collecting system with narrowing of the parenchyma</td>
</tr>
<tr>
<td></td>
<td>(HN V = used in some places additionally, to communicate an extreme HN</td>
</tr>
<tr>
<td></td>
<td>with only a thin, membrane-like residual renal parenchymal rim)</td>
</tr>
</tbody>
</table>

Note: HN V is an additional grade used in some places to communicate an extreme case of hydronephrosis.
### Table 2

**Procedural guideline: standard paediatric urosonography**

well hydrated patient, full bladder, adequate equipment & transducer & training...

<table>
<thead>
<tr>
<th>urinary bladder: size (volume), shape, ostium, wall, bladder neck include distal ureter &amp; retrovesical space / inner genitalia</th>
<th>optional: CDS for urine inflow, perineal US, scrotal US...</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>kidneys: lateral and/or dorsal, longitudinal and axial sections</th>
<th>parenchyma? pelvo-caliceal system? standardised measurements in 3 axes &amp; volume calculation if dilated: + max. axial pelvis &amp; calix, narrowest parenchymal width + uretero-pelvic junction</th>
<th>optional: (a)CDS &amp; duplex-Doppler, ...</th>
</tr>
</thead>
</table>

| post void evaluation | bladder: residual volume, bladder neck, shape & configuration kidneys: dilatation of pelvo-caliceal system / ureter changed? | optional: ce-VUS, 3DUS... |

**Note:** Cursory US of entire abdomen is recommended for 1st study, and in mismatch of findings and query

**Abbreviations:**

(a)CDS = (amplitude coded) colour Doppler sonography = power Doppler, ce-VUS = contrast-enhanced voiding urosonography, US = ultrasound, 3DUS = three-dimensional ultrasound
Table 3

Procedural guideline: contrast-enhanced voiding urosonography (ce-VUS)

No diet restriction or enema, urine analysis ...

Accepted indications: VUR-follow-up, girls, family screening, bedside

Catheterism: feeding tube, 4-8 french, or suprapubic puncture

anaesthetic lubricant or coated plaste

Latex precaution: neuro tube defect, bladder exstrophy

Standard US of bladder & kidneys (supine, ± prone)

Bladder filling with NaCl (only from plastic containers)

US contrast medium, e.g., Levovist® - 300 mg/ml, 5%-10% of bladder volume

slow, US-monitoring, potentially fractional administration

Peri-/ post-contrast US of bladder & kidneys

US modalities: fundamental, HI, CDS, dedicated contrast imaging

alternate scans of right & left side during & after filling

During + after voiding: US of bladder & kidneys

supine ± prone, sitting or standing

VUR diagnosis: echogenic micro-bubbles in ureters or renal pelves

Abbreviations:
CDS = colour Doppler sonography, aCDS = power Doppler, ce-VUS = contrast-enhanced voiding urosonography, HI = Harmonic Imaging, US = ultrasound, VUR = vesico-ureteral reflux
Table 4

Procedural guideline: voiding cystourethrography (VCUG)

**Indications:** febrile & recurrent UTI, particularly in infants, suspected PUV
UT-malformation, HN > II° or "extended criteria"

**Preparations:** no diet restriction or enema, urine analysis, after AB are completed...
- **Catheterism:** feeding tube, 4-8 french or suprapubic puncture
  - Anaesthetic lubricant or coated plaster
- **Latex precaution:** neuro tube defect, bladder extrophy

**Fluoroscopic view** of renal fossae & bladder, initial + early filling
- Bladder filling with radiopaque contrast
  - Gravity drip = bottle 30-40 cm above table, watch dripping, AB?

**Fluoroscopy:** signs of increased bladder pressure, imminent voiding, urge
- Bilateral oblique views of distal ureters, include catheter
document VUR, include kidney (spot film, intra-renal reflux)

**When voiding:** remove catheter, unless cyclic VCUG = 3 fillings, 1st y (s)
- Female: 2 spots of distended urethra (slightly oblique)
- Male: 2-3 spots during voiding (ap & high oblique / lateral)
  - Include renal fossae during voiding, if VUR => spot film

**After voiding:** ap view of bladder & renal fossae
- Assess contrast drainage from kidney if refluxed

**Note:** VUR staging, minimise fluoroscopy time and spot films, no blind film

**Abbreviations:**
AB = Antibiotics, CM = contrast media, HN = hydronephrosis, PUV = posterior urethral valve, UT = urinary tract, UTI = urinary tract infection, VCUG = voiding cystourethrography, VUR = vesico-ureteral reflux
Table 5

Postnatal imaging algorithm in mild or moderate foetal hydronephrosis (HN)

<table>
<thead>
<tr>
<th>prenatal US: mild or moderate dilatation = HN II + III</th>
</tr>
</thead>
<tbody>
<tr>
<td>US: 1st US around day 5</td>
</tr>
<tr>
<td>abnormal: pelvis ≥ 7 mm + dilated calyces, or other anomalies (HN &gt; II°)*1</td>
</tr>
<tr>
<td>normal: (≤ HN II°)</td>
</tr>
<tr>
<td>VCUG *3</td>
</tr>
<tr>
<td>normal</td>
</tr>
<tr>
<td>pelvis ≤ 10 mm (≤ HN II°)</td>
</tr>
<tr>
<td>US at 3 mo</td>
</tr>
<tr>
<td>abnormal</td>
</tr>
<tr>
<td>pelvis &gt; 10 mm (≥ HN II°)</td>
</tr>
<tr>
<td>US at 1 mo</td>
</tr>
<tr>
<td>abnormal</td>
</tr>
<tr>
<td>pelvis &gt; 10 mm, HN &gt; II°</td>
</tr>
<tr>
<td>other malformation*2, “extended criteria”*1</td>
</tr>
<tr>
<td>normal</td>
</tr>
<tr>
<td>further morphological &amp; functional evaluation: Scintigraphy, IVU, MRU</td>
</tr>
<tr>
<td>Stop follow-up</td>
</tr>
</tbody>
</table>

*1 use extended US criteria considering urothelial sign, kidney size & structure, etc ...
*2 US genitography: in all patients with single kidney, MCDK, ectopic kidneys etc ...
*3 ce-VUS can be used in girls and for screening populations...

Abbreviations:

ce-VUS = contrast-enhanced voiding urosonography, HN = hydronephrosis, IVU = intravenous urography, MCDK = multicystic dysplastic kidney, MRU = magnetic resonance urography, US = ultrasound, VCUG = voiding cystourethrography
Table 6

Imaging algorithm in children with urinary tract infection (UTI)

**UTI** \( ^1 \)

if clinically clear + known normal urinary tract anatomy \( \Rightarrow \) no imaging?

only delayed imaging for scaring in upper UTI?

**US + aCDS**

recommended within first days, particularly in severe symptoms and in infants / neonates

**Pyo(hydro)nephrosis \( \Rightarrow \) PCN**

if no response to AB-treatment

**normal US**

clinically cystitis

stop

follow-up

**normal US**

no power Doppler or Doppler equivocal \( ^2 \)

clinically upper UTI

**acute DMSA**

acute renal MRI?

\( ^2 \) for DD \( \Rightarrow \) MRI/CT

Indications:

- complicated stone disease (CT, un-enhanced scan)
- complicated UTI (XPN, Tb, abscess ...)
- question of tumour

\( ^1 \) **UTI criteria:** urine sample and blood count

- Leucocyturia, positive nitrite
- positive culture (\( 10^4 = \) catheter sample, \( 10^6 = \) normal voiding),
- Leucocytosis, elevated CRP

reliable clinical diagnosis essential = most important entry criteria for imaging!!

**Pyelitis / Nephritis** \( ^2 \)

aPN / scar / upper UTI

• follow-up US
• VUR-evaluation
  - always in infants
  - mostly in \( < 5 \) years
  - recurrent UTI in \( > 5 \) ys
  - VCU in boys
  - ce-VUS in girls (if available)
  - for VUR follow-up
  - ce-VUS or RNC (if available)
• late DMSA
  - after 6 - 12 months
  - or (functional) renal MRI
• bladder function studies

Abbreviations:

(a)CDS = (amplitude coded) colour Doppler sonography = power Doppler, (a)PN = (acute) pyelonephritis, CRP = C-reactive protein, CT = computed tomography, DD = differential diagnosis, DMSA = static renal scintigraphy, ce-VUS = contrast-enhanced voiding urosonography, MRI = magnetic resonance imaging, PCN = percutaneous nephrostomy, RNC = radionuclide cystography, Tb = tuberculosis, US = ultrasound, UTI = urinary tract infection, VCU = voiding cystourethrography, VUR = vesico-ureteral reflux, XPN = xanthogranulomatous pyelonephritis