ADVANCES in PEDIATRIC UROSONOGRAPHY

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1. US contrast agents: not FDA approved in children
2. No financial disclosure
OBJECTIVE

Urosonography:

Advanced modalities to enhance sonographic imaging of the urinary tract in children

Modalities: which?

Function: how?

Application: when?
Advanced Uro-US: ?

- Visualization improved
- Documentation clearer
- Presentation convincing
- Diagnosis enhanced
- Modalities with radiation lessened
- Cost reduced
- Uro-US research advanced
- Turf battle overcome through quality
**HARMONIC IMAGING**

- **Harmonics:** multiples of lowest frequency
- **Tissue compression & rarefaction**
  
  [Water density change $\rightarrow$ US propagation velocity]

<table>
<thead>
<tr>
<th>Fundamental</th>
<th>Harmonic</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_f = T_f$</td>
<td>$R_f \neq T_f$</td>
</tr>
</tbody>
</table>

- **Separation of fundamental & harmonic frequencies**
  - Filter
  - Phase/pulse inversion technique

- **Advantages**
  - Spatial & contrast resolution $\uparrow$
  - Artifacts $\downarrow$ & clarity $\uparrow$
HARMONIC IMAGING

Applications

- Stone
- Calcification
- Cyst
- Focal solid lesion
- Tumor
Extended-field-of-view US

Conventional US:
- transducer length → scan length
- necessity to piece images together

Ultrafast motion detection + image processing

Real-time scan longer distance [~ 60 cm]

Advantages:
- measurement capabilities ↑
- complex & large pathologies:
  visualization, documentation, demonstration ↑


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PANORAMIC IMAGING

Applications

- Tumor
- Polycystic kidney disease
TRANSPERINEAL US

- Additional US window
- High frequency linear transducers
- Patient in modified lithotomy position
- Sagittal plane

Advantages
- Facilitate view of urethra and anorectal region
- High resolution
- Real-time scan during voiding


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TRANS PERINEAL US

Applications

- Urethral pathology
- Ectopic ureter
- Anorectal malformation
DOPPLER ARTIFACT US

- Color Doppler artifact
- Behind a reflecting structure
- At the site of acoustic shadow
- Rough surface/intrinsic machine noise
- Depiction influenced by US settings
- Advantages: stones and calcifications
  - increase conspicuity
  - increase detection rate
Factors influencing depiction of "Twinkling sign"

- US machine type
- US power level
- Transducer frequency
- Focus position
- "Color write" priority
- Depth
- Scan position
- Stone composition

↑ PRF

[Pulse repetition frequency]
Nephrocalcinosis
Autosomal recessive polycystic kidney disease [ARPKD]
DOPPLER ARTIFACT US

Applications

Twinkling sign

Stones
- Calcium
- Struvite
- Uric acid
- Cystine

Calcifications

Twinkling +ve and CT-ve
NOT necessarily = no stone

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3-D/4-D ULTRASOUND

- Volume data acquisitions
- Displayed:
  - multiplanar reformats
  - Rendered projections
- 3D –
  - Manual sweep
  - Reconstruction lag
  - No measurement
  - Automatic sweep
  - Continuous volume scan
  - Volume measurement
- Advantages:
  - Renal volume: total and parenchymal
  - Bladder volume [2D-28% vs 3D-4% difference]
  - Testicular volume

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### DIFFERENCE

3D renal volume measurement

<table>
<thead>
<tr>
<th>Method</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D US</td>
<td>25.80%</td>
<td>32.2</td>
</tr>
<tr>
<td>MRU</td>
<td>-2.50%</td>
<td>7.8</td>
</tr>
<tr>
<td>DMSA</td>
<td>1.20%</td>
<td>9.2</td>
</tr>
</tbody>
</table>

**Difference:** PARENCHYMAL VOLUME
Testicular volume – follow-up for varicocele

Fernandez LJ et al. Ultrasound Q 2004 20:119-125

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3D color Doppler
3-D/4-D ULTRASOUND

Applications

- Hydronephrosis: renal parenchymal volume [split renal function]
- Testicular volume: varicocele
- Tumor volume

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Intravesical administration of US contrast agent: microbubbles
Vesico-ureteric reflux
ceVUS procedure:
US bladder & kidneys
Intravesical UCA administration
Re-scan including during voiding
Urethrosonography
Harmonic/contrast-specific modality
Safety: no UCA related adverse event
Diagnostic yield: high
USA:
Optison® & Definity®
Off-label use
Contrast-specific
CONTRAST ENHANCED VOIDING UROSONOGRAPHY

Applications

- Vesico-ureteric reflux
- Urethroscopeonomy
- US genitography

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