New Radiation-free Era in Reflux Imaging for Paediatric Urinary Tract Infection (UTI):

Voiding Urosonography (VUS) with Intravesical Ultrasound Contrast – First Local Pilot Study

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Vesicoureteric Reflux
Vesicoureteric Reflux

- Important cause for childhood urinary tract infection
- Accounts for 25-40% of childhood UTI and 20% of neonatal UTI
Imaging
Micturating Cystourethrography (MCU)

- Gold standard for VUR for decades
- Ionizing radiation
  - More susceptible in children
Voiding Urosonography (VUS)

- **Sonovue**: 2nd generation ultrasound contrast
- **Aqueous suspension** of phospholipid-stabilized microbubbles of sulphur hexafluoride
Voiding Urosonography (VUS)

- ‘... safe and reliable ... ’ Riccabona M 2008
- ‘ ... favourable safety profile ... paediatric application in 5079 examinations’ Riccabona M 2012
- ‘... higher sensitivity than MCU’ Darge K 2004
- ‘... alternative radiation-free imaging method ...’ Papadopoulou F 2009
- ‘... valid alternative to conventional VCUG or RC ...’ Riccabona M 2008
Study Design

- Prospective, comparative study
- September 2010 - August 2012
- KCC Ethic Committee
Study Design

- Recruited subjects
  - Children under 5 years old after first episode of UTI
- Exclusion criteria
  - Active urinary tract infection
  - Known allergy
- Study parameters:
  - Presence and grading of vesicoureteric reflux (Standardized International Reflux Grading System)
  - Duration of examination
  - Complications
  - Reproducibility
Study Design

- Bladder Catheterization (by paediatrician)

- Diagnostic Ultrasound of urinary tract
  - Voiding Urosonography (by paediatric radiologists and senior sonographer)

- Micturating Cystourethrography (by another group of senior radiologists)
VUS – Visualization of microbubbles

Bright echoes
VUS – Visualization of microbubbles

Moving echoes
MCU – Visualization of contrast
Study design - Reproducibility

- Cohen’s Kappa statistics on interobserver agreement
  - On detection and grading of VUR by VUS

- Independent assessment of saved images / cine clips of all VUS studies
  - 6 months after study completion
Results
Results

- 31 patients recruited
- 62 kidney-ureter units (KUUs)
- 23 Males, 8 Females
- Mean age 8.87 months
Results

Reflux Detection
Reflux Grading
Reflux detection by two methods

<table>
<thead>
<tr>
<th></th>
<th>MCU (n=62)</th>
<th>VUS (n=62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflux +ve</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Reflux –ve</td>
<td>57</td>
<td>48</td>
</tr>
</tbody>
</table>

- **Good concordance** (85.5%) based on presence and absence in both methods
- Good agreement in +ve reflux grading (n=5)
Reflux detection by two methods

<table>
<thead>
<tr>
<th></th>
<th>MCU Reflux +</th>
<th>MCU Reflux -</th>
</tr>
</thead>
<tbody>
<tr>
<td>VUS Reflux +</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>VUS Reflux -</td>
<td>0</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>57</td>
</tr>
</tbody>
</table>

- MCU missed 9 reflux KUUs (High grades + Low grades)
- Higher detection rate by VUS than MCU
  - \( P < 0.005 \) (McNemar’s test)
Case 1 - VUS
Case 1 - MCU
Case 2 – VUS (Right)
Case 2 – VUS (Left)
Case 2 – MCU
Results

Examination Duration
Safety of VUS
**Examination duration**

<table>
<thead>
<tr>
<th></th>
<th>Mean (Minutes)</th>
<th>SD (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VUS</td>
<td>11.13</td>
<td>4.90</td>
</tr>
<tr>
<td>MCU</td>
<td>12.39</td>
<td>6.91</td>
</tr>
</tbody>
</table>

- No significant difference in examination duration (Wilcoxin signed ranks test)
  - \( p = 0.277 \)
  - \( \Rightarrow \) *Similar duration*
Safety

- No immediate complications
- No delayed complications up to 72 hours (by phone follow up on Day 3)
- Safe
Results

Interobserver Agreement
Reproducibility

- Independent assessment of saved VUS images
- By two operators

- Cohen's Kappa = 1.0 (p<0.05)
- Perfect agreement
Conclusion
Conclusion

VUS has the following characteristics:

1. Higher detection rate of reflux than MCU
2. Reliable
3. Simple & technically feasible
4. Safe
5. Radiation free

- *Important to children*
Conclusion

- Can VUS be an alternative to MCU?

Remember: Posterior Urethral Valve in boys

Study of urethra is not a limitation ... in VUS (Duran et al 2009)
Implications of our study

VUS = Alternative to MCU

VUS = One-stop examination with US of urinary tract
  • Save time and resources

VUS = Future trend in reflux imaging
  • Cluster Technology Committee in KCC
  • Adopted in KCC this year
References


4. Routh JC, Lee RS, Chow JS. Letters to Editor: Radiation Dose and Screening for Vesicoureteral Reflux. DOI:10.2214/AJR.09.3384

Remarks

- Special thanks to
  Dr. Kassa Darge (Children Hospital of Philadelphia)
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