Controversies around antenatally detected PUJ syndrom

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Round table on the management of renal pelvic dilatation in children

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Newborn boy

History of prenatally diagnosed unilateral renal dilatation

Ultrasound postnatally: unilateral calyceal and pelvic dilatation

VCUG negative

PUJ syndrom
When and for which degree of dilatation would you evaluate this child with an isotope study?

What study would you use?
Pelvic diameter in the neonatal period

< 15 mm : radionuclide study not essential

15-30 mm : renogram around 1 month of age

30-40 mm : as early as 2 weeks

≥ 40 mm : within first days of life

Question readdressed to the urologist : pertinence of this attitude?
Study to be used: the renogram

Tracer with high extraction rate (MAG3, EC or Hippuran)

* in children below 1 yr

and

* on all subsequent controls
In children below 1 yr with antenatal hydronephrosis, are you performing renograms by means of Tc-99m DTPA?

1. Never
2. Sometimes
3. Systematically
How would you define obstruction in an asymptomatic child with unilateral dilatation?
PUJ is generally a \textbf{Partial Obstruction}

\textbf{Parameters supposed to define partial obstruction}:

* degree of dilatation on X-ray \hspace{0.5cm} no
* washout after furosemide \hspace{0.5cm} no
* differential renal function \hspace{0.5cm} no
In your final report to the referring clinician, do you suggest renal obstruction in case of

1. Poor renal washout after furosemide challenge
2. Low DRF on initial renogram
3. Combination of 1 and 2
4. I do not suggest the diagnosis of obstruction
Definition of obstruction is multifactorial

* Degree of dilatation US
* Parenchymal thinning US
* Heterogen echogenicity US
* Differential renal function renogram
* Renal curves, renal T1/2 renogram
S K

Definition of obstruction on serial imaging only

Any of the following events:

- Progressive increase of hydrenephrosis ultrasound
- Reduction of DRF (> 10 %) renograms
- No spontaneous improvement of DRF renograms
What value do you place on differential function (DRF) in management of asymptomatic unilateral dilatation?
Split function is a robust and reproducible parameter if criteria of quality are taken into account

* how to draw renal ROI

* how to draw the background ROI

* defining the time interval for measuring split function (less than 2 min in case of early furosemide injection)

* having identical results using integral and Rutland-Patlak methods
IG, AP

Usefulness of differential function

1. Presently the best instrument to estimate the level of function

- at entry

- during conservative or surgical follow up
Usefulness of differential function

2. Systematic surgery in case of low differential function?

With the hope
- to improve the split function sometimes
- to prevent further deterioration sometimes

→ Absence of controlled studies!

Low split function can be due to an associated dysplasia
Usefulness of differential function

* Simply one of many factors

* Values less than 30-35% heighten sensitivity for intervention
Usefulness of differential function

- Identify low function
- Monitor improvement in case of initial low DRF
- Monitor maintenance of function in case of persistent HN
In case of initial low DRF, do you see spontaneous improvement during further conservative follow up?

1. Very often
2. Uncommon
3. Never
If you decide to follow this child nonoperatively, how often do you perform the radionuclide test?
If initial DRF symmetrical (40-60 %)

follow up by ultrasound

scintigraphic control in case of increased dilatation

However

In most of the cases of increased dilatation,
DRF remains unchanged
In case of initial normal DRF, a later renographic control is requested

1. Systematically at fixed time intervals
2. Only if increase of hydrenephrosis on ultrasound
3. Is never requested
If initial DRF is low

* study should be repeated, during the first two years of life

but …..

* surgery often performed if persistence of low function
Depends on the degree of dilatation

* Grade III or more : low threshold to repeat the renogram

* Increase of dilatation : early renographic control
<table>
<thead>
<tr>
<th>Differential function</th>
<th>Interval between studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 40 %</td>
<td>3 months</td>
</tr>
<tr>
<td>30-40 %</td>
<td>2 months</td>
</tr>
<tr>
<td>20-30 %</td>
<td>1 month</td>
</tr>
<tr>
<td>&lt; 20 %</td>
<td>2 weeks</td>
</tr>
</tbody>
</table>
What are your criteria for recommending operative correction for asymptomatic unilateral dilatation?
IG, AP, JB, SK

Drop of split function = absolute criterion

- older children : 5% is significant
- infants : 10% is significant
Are presently unable to recommend surgery on the basis of the initial renogram findings (split function and/or drainage)
Surgery also when combination of

* low function on initial renogram
* “significant” hydronephrosis
* thinning parenchyma
* prolonged T1/2
Surgery also

* when hydronephrosis increases “significantly”

or

* when function remains low

Underlying hypothesis : low function = obstruction
Is there a role for DMSA scan alone in the evaluation of asymptomatic unilateral hydronephrosis?
DMSA scintigraphy : the pro

* High signal to noise ratio
* The best tool for estimating split function in the absence of huge dilatation

IG, AP
**DMSA scintigraphy : the contra**

* Evaluation of drainage impossible

* In huge hydronephrosis, the trapped radioactivity in the collecting system is interfering with the activity taken up by the tubular cell
Cau .... 1 mo old boy

- posterior urethral valves

- cystostomy

- grade IV vesico-renal reflux

- moderately elevated plasma creatinine

 Injection of DMSA + Lasix

 Images at 6 hr
DMSA scan

Split function
Left : 60 %
Right : 40 %
## MAG3 renogram

<table>
<thead>
<tr>
<th>Time</th>
<th>0-2 minute</th>
<th>1-2 minutes</th>
<th>9-11 minutes</th>
<th>15-20 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 %</td>
<td>30 %</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DMSA  
MAG3 (1-2 min)
In case of major dilatation, do you measure DRF by means of Tc-99m DMSA?

1. Systematically
2. Sometimes
3. Never
What value do you place on the drainage curve in management of asymptomatic unilateral dilatation?
Problems related to renal drainage

- pitfalls related to the technique

- pitfalls related to the interpretation
Controversies around placing a catheter in the bladder

IG, AP

Bladder catheter can be replaced by late post-erect /mictur. views
Only in rare cases should bladder catheter be used

(eventually after unsuccessful voiding)

JB Disagrees entirely!

Pressures in the upper urinary system are markedly increased
in case of non-emptying of the bladder
An indwelling catheter is placed before starting the renogram

1. Systematically
2. Sometimes
3. Never
Left emptying at 20 min: stasis left after micturition and erect position: OK

Post-micturition, post-erect position image 50-60 min after tracer injection
If the washout at the end of the furosemide challenge is unsatisfactory

1. Do you acquire late images after micturition

2. Do you acquire late images after changing of position

3. Do you acquire late images combining 1 and 2

4. I do not perform late images
Quantitative parameters of drainage
IG, AP

Output Efficiency (OE), Normalized Residual Activity (NORA)

\[
OE_{20} = \frac{\text{Integral } P(t) dt - R_{20}}{\text{Integral } P(t) dt}
\]

\[
NORA_{20} = \frac{R_{20}}{R_2}
\]
OE and NORA

* Both are independent of ipsilateral function

* Both are only slightly dependent on overall function (OE less than NORA)

* Both can be quantified on the late PM images
Are you quantifying the renal washout after furosemide

1. By means of T ½
2. By means of OE and/or NORA
3. By means of other formulae (GAD, ....)
4. I do not quantify
Colin F et al. Bases expérimentales d’une interprétation quantitative du rénogramme
Acta Cardiologica, Brussels, 1964
Quantitative parameters of drainage

Are they useful?
Lasix
### Relative Function

<table>
<thead>
<tr>
<th>Relative Function</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRF (Area)</td>
<td>93 %</td>
<td>7 %</td>
</tr>
<tr>
<td>DRF (Patlak)</td>
<td>93 %</td>
<td>7 %</td>
</tr>
</tbody>
</table>

### Transit Parameter

<table>
<thead>
<tr>
<th>Transit Parameter</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tmax (minutes)</td>
<td>3.0</td>
<td>7.5</td>
</tr>
<tr>
<td>OE 20 min.</td>
<td>95 %</td>
<td>58 %</td>
</tr>
<tr>
<td>OE PM</td>
<td>99 %</td>
<td>82 %</td>
</tr>
<tr>
<td>NORA 20 min.</td>
<td>0.21</td>
<td>1.50</td>
</tr>
<tr>
<td>NORA PM</td>
<td>0.08</td>
<td>0.40</td>
</tr>
</tbody>
</table>

### Images:

- **0-1 minute**
- **1-2 minutes**
- **9-10 minutes**
- **19-20 minutes**

**Post-Medication Image**

*Lasix*
<table>
<thead>
<tr>
<th>Time Activity</th>
<th>Relative Function</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DRF (Area)</td>
<td>78 %</td>
<td>22 %</td>
</tr>
<tr>
<td></td>
<td>DRF (Patlak)</td>
<td>78 %</td>
<td>22 %</td>
</tr>
<tr>
<td>Transit Parameter</td>
<td>Tmax (minutes)</td>
<td>3.2</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>OE 20 min.</td>
<td>95 %</td>
<td>66 %</td>
</tr>
<tr>
<td>OE PM</td>
<td>97 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NORA 20 min.</td>
<td>0.33</td>
<td>2.12</td>
<td></td>
</tr>
<tr>
<td>NORA PM</td>
<td>0.14</td>
<td>1.32</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
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<tbody>
<tr>
<td>0-1 minute</td>
<td></td>
</tr>
<tr>
<td>1-2 minutes</td>
<td></td>
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<tr>
<td>5-10 minutes</td>
<td></td>
</tr>
<tr>
<td>10-20 minutes</td>
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**Lasix**

**Post-Micturition Image**
Problems related to renal drainage

- pitfalls related to the technique
- pitfalls related to the interpretation
Washout and obstruction

**Good renal emptying:**
obstruction and consequences practically excluded

**Poor renal emptying:**
one should NOT conclude that
obstruction is present or likely

- reservoir effect
- poor overall clearance
- immature infant’s kidney
Drainage curve is the least important aspect of renogram but …. it helps for the diagnosis of obstruction
Does the emphasis on split relative function and drainage change if dilatation is bilateral?
Same conservative attitude as in unilateral hydronephrosis


….but many urologists disagree!
Can cortical transit time detect those kidneys

* at risk of deterioration of split function if no surgery performed?

* improvement of split function postoperatively?

Is there a role for MRI in the evaluation of dilatation?
IG, AP

* Need for deep sedation
* Availability of the machine
* What is the present state of accuracy of differential function?
Different time interval for each kidney!!

Grattan-Smith JD et al MR urography in children: how we do it
Pediatric Radiology (2008) 38 (suppl) S3-S17, fig 8
SK

No role for MRI in PUJ syndrom
In case of ureteropelvic junction “obstruction”

* which studies to use to follow the child postoperatively

* when to perform them?
After uneventful surgery, a renogram is traditionally performed one year postoperatively.

Sometimes, nasty surprises:
- complete and irreversible loss of unilateral function!

**A more reasonable attitude (JB, SK, IG, AP):**

- early postoperative ultrasound (1-3 months)
  - still important dilatation ➔ early renogram: loss of function ➔ early successful surgery
Criteria for nephrectomy rather than pyeloplasty?
Complete silent kidney

No recovery of function after any drainage procedure

Very low split function ( < 10%)

Nephrectomy traditionally recommended

…..but not necessary the good attitude !
Neonate

Palpable mass occupying the entire right flank corresponding to a huge right hydronephrosis

Antenatally, pelvic transverse diameter:

- 22 weeks  27 mm
- 27 weeks  41 mm
- 33 weeks  87 mm
- 36 weeks  78 mm
<table>
<thead>
<tr>
<th>Time</th>
<th>Preoperative - day 2</th>
<th>Postoperatively - day 35</th>
<th>Postoperative one year later</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1 minute</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>1-2 minutes</td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td>9-10 minutes</td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
</tr>
<tr>
<td>15-20 minutes</td>
<td><img src="image10.png" alt="Image" /></td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
</tr>
<tr>
<td>Posterior view</td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td><img src="image15.png" alt="Image" /></td>
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**Percentages:**
- Preoperative - day 2: 100% 0%
- Postoperatively - day 35: 80% 20%
- Postoperative one year later: 82% 18%
Looking into the future, what evolutionary changes do you foresee with renography that would be helpful in the management of ureteropelvic junction “obstruction”? 
Responsibility of the nuclear medicine physician

Need for standardization

* acquisition procedure

* processing procedure (cortical transit ?)

* report

Need for a comprehensive processing program on PC, independent of the gamma camera systems
Responsibility of the urologist

15-20% of the antenatally detected PUJ syndromes are considered by the urologist to be at risk and therefore operated on the basis of simple statements.

Need for prospective controlled studies.
Early identification of patients at risk?

- he does not foresee significant advancements in imaging
- cellular and molecular markers of nephron dysfunction?

but….

“It is tough to make predictions, especially about the future”