Evaluation and Management of Fetal Lower Urinary Tract Obstruction (LUTO)

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The Children’s Hospital of Philadelphia
Perelman School of Medicine
University of Pennsylvania
No financial disclosures
Lower Urinary Tract Obstruction (LUTO)
Prune Belly Phenotype
Fetal Sheep Models

* Early obstruction by ureteral ligation
  -> produced renal fibrocytic dysplasia

* Earlier the onset and longer the duration
  -> greater the renal damage

* Early midgestation relief of obstruction
  -> prevented dysplastic changes
In Utero Vesicoamniotic Shunt Therapy
In Utero Surgical Treatment of Fetal Obstructive Uropathy: A New Comprehensive Approach to Identify Appropriate Candidates for Vesicoamniotic Shunt Therapy.

Fetal Obstructive Uropathy

Prenatal Evaluation:

1. High resolution sonographic evaluation
   - amnioinfusion

2. Rapid karyotype analysis
   - chorionic villus sampling, fetal urine FISH screen

3. Renal evaluation by serial bladder drainage
   - Na, Cl, Osm, Ca, Total protein, B2-microglobulin
Step 1: Sonographic evaluation
II. Evaluation of existing renal injury & fetal karyotype

III. Fetal urine: karyotype & renal function information
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Good</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>&lt; 90 mmol/L</td>
<td>&gt; 100 mmol/L</td>
</tr>
<tr>
<td>Chloride</td>
<td>&lt; 80 mmol/L</td>
<td>&gt; 90 mmol/L</td>
</tr>
<tr>
<td>Osmolality</td>
<td>&lt; 180 mOsm/L</td>
<td>&gt; 200 mOsm/L</td>
</tr>
<tr>
<td>Calcium</td>
<td>&lt; 7 mg/dL</td>
<td>&gt; 8 mg/dL</td>
</tr>
<tr>
<td>B2-microglobulin</td>
<td>&lt; 6 mg/L</td>
<td>&gt; 10 mg/L</td>
</tr>
<tr>
<td>Total protein</td>
<td>&lt; 20 mg/dL</td>
<td>&gt; 40 mg/L</td>
</tr>
</tbody>
</table>
Sequential Fetal Urine Analysis

* Note decreasing values.

* Note increasing values.
Instruments for fetal shunt placements

3mm

2.3mm
Shunt Insertion Technique
Complications depend on where you place the shunt!
Vesicoamniotic Shunt Complications

Review of 40 consecutive shunt placements by single operator

* 16/40 (40 %) of the shunts became physically displaced

- 14 intraamniotic
- 2 intraperitoneal
Multicenter Cook Harrison Shunt Study (SPO 1998)

16 centers, 52 procedures in 42 fetuses

18 (34.6%) successful

3 (5.7%) failed placement

31 (58.8%) complications within 2 weeks

- 11 shunt dislodgements (21.2%)
- 8 shunt obstructions (15.4%)
- 5 shunts migrated into bladder (9.6%)
- 1 shunt migrated into abdomen (1.9%)
- 6 preterm deliveries within 2 weeks

48 %
Survival rate (21/23*) = 91%

Mean gestational age at delivery = 34.5 wks.

Mean birth weight = 2573.5 gms.

(No IUGR; 3 large for GA; 1 Macrosomia)

Mean days from shunt to delivery = 84.4 days

* From original outcome cohort of the 33/84 LUTO survivors
Long Term Outcomes: Obstet Gynecol 2005

• Mean age at follow-up (years) 5.83

• Final diagnosis:
  - Posterior urethral valves (PUV) 7/18 (39%)
  - Urethral atresia (UA) 4/18 (22%)
  - Prune Belly syndrome (PBS) 7/18 (39%)

• Failure to thrive:
  - < P5 for age
    - Weight 3/18 (17%)  
    - Height 4/18 (22%)
  - < P25 for age
    - Weight 9/18 (50%)  
    - Height 9/18 (50%)
  - Special diet 10/18

• Normal pulmonary function 10/18 = 55%

  Asthma 7/18; Recurrent pulmonary infections 5/18; Limitations in daily activities 2/18; Sleep apnea 2/18
• Following successful prenatal VAS:
  – 45% have normal renal function
  – 61% have normal bladder function

• Role of obstruction type on renal and bladder function:
  – 50% UA have been transplanted at an early age, but 75% have normal bladder function
  – 43% PBS have been transplanted, and 43% have normal bladder function
  – Only 14% PUV have been transplanted, and 72% have normal bladder function

Long Term Outcomes: Obstet Gynecol 2005
Urethral atresia

Posterior urethral valves

Prune Belly variant (TRIAD)
### Long Term Outcomes: Obstet Gynecol 2005

**Renal outcomes**

<table>
<thead>
<tr>
<th>Normal renal function</th>
<th>8/18 = 45%</th>
</tr>
</thead>
<tbody>
<tr>
<td>- PUV</td>
<td>3/7 (43%)</td>
</tr>
<tr>
<td>- UA</td>
<td>1/4 (25%)</td>
</tr>
<tr>
<td>- PBS</td>
<td>4/7 (57%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mild renal insufficiency</th>
<th>4/18 = 22%</th>
</tr>
</thead>
<tbody>
<tr>
<td>- PUV</td>
<td>3/7 (43%)</td>
</tr>
<tr>
<td>- UA</td>
<td>1/4 (25%)</td>
</tr>
<tr>
<td>- PBS</td>
<td>0/7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dialysis</th>
<th>6/18 = 33%</th>
</tr>
</thead>
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<table>
<thead>
<tr>
<th>Transplanted</th>
<th>6/18 = 33%</th>
</tr>
</thead>
<tbody>
<tr>
<td>- PUV</td>
<td>1/7</td>
</tr>
<tr>
<td>- UA</td>
<td>2/4</td>
</tr>
<tr>
<td>- PBS</td>
<td>3/7</td>
</tr>
</tbody>
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**Mean delay to transplant (months)**

- PUV: 120 months
- UA: 25.5 months
- PBS: 51.3 months
Long Term Outcomes: Obstet Gynecol 2005

<table>
<thead>
<tr>
<th>Method</th>
<th>Ratio</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Spontaneous voiding</td>
<td>12/18</td>
<td>67%</td>
</tr>
<tr>
<td>• PUV</td>
<td>6/7</td>
<td>86%</td>
</tr>
<tr>
<td>• UA</td>
<td>3/4</td>
<td>75%</td>
</tr>
<tr>
<td>• PBS</td>
<td>3/7</td>
<td>43%</td>
</tr>
<tr>
<td>Intermittent catheterisation</td>
<td>3/18</td>
<td>33%</td>
</tr>
<tr>
<td>• PUV</td>
<td>1/7</td>
<td></td>
</tr>
<tr>
<td>• UA</td>
<td>0/4</td>
<td></td>
</tr>
<tr>
<td>• PBS</td>
<td>2/7</td>
<td></td>
</tr>
<tr>
<td>Catheterisation only</td>
<td>3/18</td>
<td></td>
</tr>
<tr>
<td>• PUV</td>
<td>1/7</td>
<td></td>
</tr>
<tr>
<td>• UA</td>
<td>0/4</td>
<td></td>
</tr>
<tr>
<td>• PBS</td>
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Other considerations

- Serial amnioinfusions for restoring lung growth
- Renal replacement
- Importance of team approach – ripple effect