Outline

- Approach to fetal renal evaluation
- Define “severe” GU anomalies
- Uropathies versus nephropathies
- Amniotic fluid overview
- Pulmonary hypoplasia
- Examples
- Renal replacement therapy
- Future directions

Top 5 most important areas to evaluate in assessing fetal GU well-being:

1. Amniotic fluid: (AFI or DVP)
2. Bladder: presence and appearance
3. Kidney: number, position, structure
4. Ureters: number, size, origin, insertion
5. Fetal genitalia: external + internal

How should we define “severe” renal anomalies?

- Renal pathology leading to poor renal function
- Poor renal function → decreased fetal urine production
- Low urine = low amniotic fluid
- Low amniotic fluid → diminished lung development
- Pulmonary hypoplasia, cannot live outside womb

Severe fetal GU anomalies

- Life threatening bilateral cystic disease, obstruction or renal agenesis
- Obstructive but repairable uropathies:
  - UPJ obstruction
- Complex but repairable anomalies:
  - Hypospadias
  - Vaginal atresia
  - Bladder and cloacal exstrophy

Less severe renal anomalies

- Affect only one kidney
- May threaten it’s function
- May or may not be fixable after birth
- Even if no function of one kidney, condition still compatible with life
Uropathies vs Nephropathies

Definitions

- **Uropathy**: any pathology of the urinary tract (plumbing)
  - Obstruction
  - Reflux

- **Nephropathy**: disease or abnormality of the renal tissue
  - Ex: cystic kidney disease (ARPKD)
  - Renal function

Artificial distinction

Uropathy ↔ Nephropathy

Amniotic fluid overview

- **Amniotic fluid volume**
  - Increases logarithmically first half of pregnancy
    - < 10 mL @ 8 weeks gestation
    - 630 mL @ 22 weeks gestation
    - 770 mL @ 28 weeks gestation
    - Peaks at about 32 weeks
  - > 36 weeks: volume decreases
  - 41 weeks: 515 mL
  - Decreases 33% each week after 41 weeks

- **AFI: Amniotic Fluid Index**
  - **Definition**:
    Summation of the deepest vertical pocket (DVP) in 4 cord-and-extremity-free quadrants of the gravid uterus
  - **Oligohydramnios**: < 5 cm
  - **Polyhydramnios**: > 24 cm
**Polyhydramnios**

- **Definition:** Excessive accumulation of amniotic fluid at some time during pregnancy
- Greater than 1500-2000 mL
- Deepest vertical pocket > 8 cm

**Polyhydramnios: Causes**

- CNS: anencephaly
- GI: esophageal or duodenal atresia
- Respiratory: CDH
- GU: mesoblastic nephroma
- CV: Ebstein anomaly
- MSK: fetal akinesia syndrome

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**Oligohydramnios**

- **Definition:** Condition in which the amniotic fluid volume (AFV) is decreased relative to gestational age.

- Or: AFI < 300-500 mL in 2nd trimester
  - DVP < 1-2 cm
  - AFI < 5 cm
  - AFI < 5% of expected

**Oligohydramnios: Causes**

- Renal: agenesis, obstruction, dysplasia
- Uteroplacental insufficiency ⇒ IUGR
- PPROM: prolonged premature rupture of membranes
- Post term pregnancy

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**Oligohydramnios**

- Almost always associated with an increased risk of fetal morbidity and mortality
- Fetus at risk for:
  - Pulmonary hypoplasia
  - Cord compression
  - Untoward fetal outcome

**Pulmonary hypoplasia**
Reid’s Rules of Lung Development

- The bronchial tree is developed by the 16th week of intrauterine life
- Alveoli develop after birth, increasing in number until the age of 8 years and in size until growth of the chest wall finishes with adulthood

Case 1:

- Referred at 26w1d for severe unilateral hydronephrosis
Fetal-neonatal course

- Fetal drainage 450 cc
- Just before term delivery
- Dx: severe right UPJ
- Normal renal function
- Open reduction pyeloplasty at 4 mo
- Last f/u: age 6, thriving
- Scan: scarred RK: 29%; nl LK 71%

Case 2

- 38 weeks 3 days
- Large pelvic cyst
- Female fetus
Born via NSVD at 40 weeks

10 cm complex pelvic fluid collection

Hydrocolpos

Distal vaginal atresia
Outcome

- Hydrocolpos diminished by 6 months
- No vaginal opening
- Plan: repair vaginal atresia as teen
- An example of a serious, but not life-threatening GU anomaly

Case 3

- Male fetus at 20 weeks gestation
- Moderate oligohydranmios
- Bilateral hydronephrosis, large bladder with “keyhole”, ?PUV
- Referred for possible bladder shunt

Moderate oligohydranmios

Bilateral hydronephrosis, no macrocycts
Clinical Course
- Bladder tap: favorable indices
- Vesico-amniotic shunt placed at 21w3d: amniotic fluid volume normalized
- Shunt dislodged after 23 days
- Amniotic fluid decreased, hydronephrosis increased

Followup
- Second shunt placed 2 days later (25 w)
- Migrated out of bladder next day
- Decision made NOT to place further shunts
- Conservative management from 25-32 w

Outcome
- Born at 32 weeks, 6 days
- 2175 grams
- On hi-fi ventilator with nitric oxide
- Foley catheter placed: no urine output
**Outcome**

- Bilateral pneumothoraces at 15 hours
- Died one hour later

Lung Volume, 42 mL (expected, 85 mL)
Bilateral hydroureteronephrosis, renal cystic dysplasia, bladder hypertrophy.

Bilateral renal cortical cystic dysplasia, L>R

Why did this infant die?

- Had some AF until 20 weeks
- Had normal AF from 21-24 wks
- Severe oligo from 24-33 weeks

- Was it simply the lack of AF?
- Was surfactant deficiency + pulmonary hypoplasia impossible to overcome?
- Or were kidneys irreparably damaged too early?

Case 4

History

- Normal US studies @ 9, 12, 19 weeks
- Oligohydramnios @ 21 weeks
- MFM referral @ 22w: AFI 4, nl kidneys
- 23, 24 weeks: same findings
- Referral at 26 weeks 1 day
Summary at 26w1d

- Severe oligohydramnios
- Normal appearing kidneys

Possible Dx

- Leaking amniotic fluid
- Kidneys look normal, but making urine
Outcome
• No amniotic fluid from 26 weeks on
• Delivered at 36w @ Level III NICU

Outcome
• CXR: low lung volumes, surfactant deficiency
• CPAP x 24 hours
• Weaned to room air!
• Transferred to local hospital near home
• Has done well, now 4 years of age: WHY?
  – ? Normal AFI until 19 weeks
  – ? Intrinsically normal kidneys

History
• 31 y/o G2P0 woman
• Normal NT at 12w
• Echogenic kidneys at 17w
• Self referred at 24 weeks
Dx: Posterior Urethral Valves

Delivered at 35w3d by C-section by for worsening oligohydramnios.

Born at 35 weeks. Very little urine output in the first 36 hours of life. His creatinine rose to about 5mg/dl and then plateaued ~4mg/dl

- Prenatal Dx: PUV
Clinical Course
- 4 weeks: Bilateral cutaneous ureterostomies
- 6 months: Gastrostomy tube placement for FTT and CRF
- 12 months:
  - Transurethral ablation of posterior urethral valves
  - Bilateral ureteroureterostomy (takedown and closure of loop cutaneous ureterostomies)
  - Insertion of peritoneal dialysis catheter

Followup
- 12 months: began peritoneal dialysis
- 15 months
  - Living related donor renal TX#1 (father)
- 3 years:
  - Living related donor renal TX #2 (mother)
- Age 8:
  - Doing well, ADHD

IFMSS 2012:
Queenstown, NZ
- Panel on obstructive uropathy
- Mike Harrison: first open fetal vesicostomy in 1982
  "We are no further along now than we were 30 years ago."
Percutaneous vesicoamniotic shunting versus conservative management for fetal lower urinary tract obstruction (PLUTO): a randomised trial

• Goal: recruit 200 patients with LUTO over 3 years
• Randomize to shunt or no shunt
• End point: survival with intact renal function
• Trial stopped after 5 years (2012): slow and low recruitment
• 31 patients randomized: 16 to shunt, 15 to conservative treatment
  - 10% of non-shunted patients terminated
  - 6% miscarried
  - 30% alive at 28 days
• Results: “Survival seemed to be higher in the fetuses receiving vesicoamniotic shunting, but the size and direction of the effect remained uncertain, such that benefit could not be conclusively proven. Our results suggest that the chance of newborn babies surviving with normal renal function is very low irrespective of whether or not vesicoamniotic shunting is done.”


Amniopert

• Indwelling catheter for chronic replacement of amniotic fluid
• Maintain normal volume of fluid → adequate pulmonary function after birth
• Proceed to RRT → increased survival
• Preliminary results are promising
• Potential use for other fetal conditions

William Polzin, MD, MFM, Director Fetal Center at Cincinnati Children’s Hospital, IFMSS, April 2012

The Bottom Line

• Can’t reliably predict outcome based on how kidneys look
• Can’t reliably predict outcome by amount of amniotic fluid
• What DO we know?
• How should we counsel?

What we know

• Amniotic fluid aids in pulmonary development
• Traditional vesicoamniotic shunts don’t work well
  - A different kind of shunt: Amniopert
  - More aggressive fetal bladder shunting
  - More aggressive neonatal care
• If the lungs are developed, we can use Renal Replacement Therapy (RRT) to keep babies alive

Renal Replacement Therapy (RRT) Strategy

• RRT = Peritoneal Dialysis + Transplant
  - Medical management (meds/diet) as long as possible
  - Peritoneal Dialysis until large enough for transplant
  - Transplant
• RRT dramatically increases survival

Retrospective study 1997 – 2008
• All CRF started on RRT < 1yr (dialysis or transplant) (n=29)
• Followed up median of 7.2 years
• 27 received PD (mean starting age 112d) (median duration prior to transplant 320 days)
• 21 underwent transplant (median age 1.4 years, weight 9.6 kg)
• 2 underwent early transplant, 6 died @ < 1 year of life (all deaths)
• 5 yr patient survival rate 79%
Future Directions: A Quiet Revolution

- Acceptance of Renal Replacement Therapy as standard of care
  - While understanding risks and costs to individual and society

- Plan to conserve fetal lung function by shunting bladder
  - Some efficacy: vesicoamniotic shunts
  - Amniopent: constant replacement of amniotic fluid

Thank you!