Use of Ultrasound to Improve Care in Diabetes in Pregnancy

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What is diabetes?

...a melting down of the flesh and limbs into sweet urine” (Aretaeus of Cappadocia)
Ultrasound and Diabetes

Overview

- Prevalence
  - 10.8% of all women >19yo have diabetes
    - 12.6 million women (8 million of these are reproductive age)
      - Nearly half of these are undiagnosed
  - Pregestational: 1% of all pregnancies
  - Gestational: 2-5% of all pregnancies

National Diabetes Information Clearinghouse, 2011
ACOG Bulletin #60, 2005
Ultrasound and Diabetes

- Adverse outcomes: maternal
  - Nephropathy
    - Progression to end stage renal failure if cr >1.5mg/dL or proteinuria >3g
    - Preeclampsia 50%
  - Chronic hypertension (5-10% of all pregnant pregestational diabetics)
    - Preeclampsia develops in 10-25%
    - Exacerbations may cause end organ disease
  - Retinopathy
    - Progression may occur, especially with rapid glucose control
  - Coronary artery disease
    - Serious illness (eg MI) in patients with longstanding CAD and/or comorbidities
  - Neuropathy
    - Not well studied
  - DKA
  - Primary C/S

ACOG Bulletin #60, 2005
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**Adverse outcomes: fetal**

- **SAB**
  - 10-20% (pregestational)

- **Birth defects**
  - 5-10% (pregestational)
  - HgA1c
    - 5-6%: probably no increased risk (2-3%)
    - Values more than 1% above normal have increased risk
    - >10%: 20-25% anomaly risk
    - Usually cardiac or CNS (spina bifida, anencephaly, sacral agenesis)

- **Prematurity**
  - Spontaneous PTB
  - Iatrogenic PTB

- **Abnormal growth**
  - Fetal overgrowth (GDM)
    - Birth injury
  - Uteroplacental insufficiency
    - Growth restriction
    - IUFD
Ultrasound and Diabetes

- Adverse outcomes: neonatal/childhood/lifetime
  
  o **Neonatal**
    - RDS
    - Metabolic disturbances
      - Hypoglycemia
      - Hyperbilirubinemia
      - other
    - Polycythemia
    - Organomegaly
  
  o **Childhood/lifetime**
    - Obesity
    - Glucose intolerance/ type 2 diabetes
Ultrasound and Diabetes

• GDM Screening & Treatment

  ▪ Hyperglycemia and adverse pregnancy outcome
    • Associations are continuous with no obvious thresholds at which risk is increased: a consensus is needed to translate into clinical practice

  ▪ Benefit of treatment
Ultrasound and Diabetes

Role of ultrasound

- Establish accurate dating (early gestation)
- Screen for anomalies
- Monitor growth
- Antenatal testing
- Inform mode/timing of delivery

Vink, AJOG, 2006
Nizard, Sem Fetal Neonat Med, 2009
Ultrasound and Diabetes

- Monitor growth
  - Detection of macrosomia
    - Utility
    - Feasibility
Ultrasound and Diabetes

• Monitor growth

  o Utility & Feasibility

  o Shoulder dystocia cannot be predicted or prevented because accurate methods for identifying which fetuses will experience this complication do not exist.

ACOG, 2002
Ultrasound and Diabetes

- Monitor growth
  - Gregory, Obstet Gynecol 1998
    - 50% of dystocia in normal weight babies
    - Birth injuries happen in the absence of dystocia
    - No significant difference in overall birth injury in macrosomic v. non-macrosomic babies
      - Except brachial plexus injury
        - BUT, in normal weight babies, most brachial plexus injury occurs without dystocia

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**Table 4. Incidence Rates and Adjusted Relative Risks for Infant Complications of Shoulder Dystocia**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Macrosomic infants*</th>
<th>Normal weight infants†</th>
<th>Adjusted relative risk (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 712)</td>
<td>(n = 690)</td>
<td></td>
</tr>
<tr>
<td>Asphyxia</td>
<td>23</td>
<td>24</td>
<td>1.2 (0.6, 2.3)</td>
</tr>
<tr>
<td>Birth trauma</td>
<td>10</td>
<td>13</td>
<td>0.6 (0.2, 1.6)</td>
</tr>
<tr>
<td>Clavicular injury</td>
<td>42</td>
<td>34</td>
<td>1.3 (0.8, 2.1)</td>
</tr>
<tr>
<td>Facial palsy</td>
<td>2</td>
<td>3</td>
<td>2.2 (0.2, 44.4)</td>
</tr>
<tr>
<td>Long-bone injury</td>
<td>21</td>
<td>22</td>
<td>1.2 (0.6, 2.4)</td>
</tr>
<tr>
<td>Erb palsy</td>
<td>42</td>
<td>12</td>
<td>3.5 (1.8, 7.5)</td>
</tr>
<tr>
<td>Seizures</td>
<td>1</td>
<td>1</td>
<td>1.0 (0.0, 25.0)</td>
</tr>
</tbody>
</table>

* Macrosomic infants weighed at least 4000 g.
† Infants less than 4000 g.
Ultrasound and Diabetes

- **Monitor growth**
  - Macrosomic babies of diabetics are at higher risk than macrosomic babies of non-diabetics

  - Langer, AJOG, 1991
    - 75,000 deliveries (>1500 diabetics)
    - Diabetics: 3.2% dystocia
      - 84% weighed >4kg
    - Non-diabetics: 0.5% dystocia
      - 60% weighed >4kg
    - Similar rates of injury (asphyxia, fracture, seizures)
    - *3x higher dystocia rate in macrosomic babies of diabetic mothers than macrosomic babies of nondiabetic mothers*

  - Conway, AJOG, 1998
    - 2604 deliveries (all diabetic)
    - Overall 1.5-2.8% dystocia; 7.4% with birthweight >4kg
    - *3.6x higher rate if macrosomic*
Ultrasound and Diabetes

- Monitor growth
  - Accuracy of sonographic predictors of macrosomia
Ultrasound and Diabetes

• Monitor growth

- Improved prediction in diabetics?

  - Best, Obstet & Gynecol, 2002
    • 2023 pregnancies (1690 control, 133 diabetes)
      • 80/189 babies predicted >4kg had birthweights >4kg
        • 27/31 diabetics

  - Conway, AJOG, 1998
    • 2604 diabetic pregnancies
      • Ultrasound identified presence/absence of macrosomia in 87%
Monitor growth

Buchanan, Diabetes Care 1994 & 1998

- 303 GDM
  - AC <75%ile: diet
    - 24/171 LGA (14%)
  - AC ≥75%ile: diet
    - 9/24 LGA (38%)
  - AC ≥75%ile: randomized to diet
    - 13/29 LGA (45%)
  - AC ≥75%ile: randomized to insulin
    - 4/30 LGA (13%)

USN identified babies at higher risk for macrosomia in absence of glycemic criteria
Ultrasound and Diabetes

- Monitor growth

- Rossi, Acta Obstet Gynecol 2000
  - RCT
  - n=141
    - 73 had AC at 28w
    - 68 had AC at 32w

- Macrosomia reduced in babies identified at 28w (but not at 32w)
Ultrasound and Diabetes

- **Monitor growth**
  - **Kjos, Diabetes Care, 2001**
    - Randomized
    - 98 women (FBG 105-120)
      - Standard
        - Insulin, goal 90/120
      - Experimental
        - Insulin, goal 80/110
        - If AC >70%ile or any FPG >120
  
  - Birthweights, LGA, neonatal morbidity did not differ
    - 38% of Experimental group did not require insulin
      - Would have required in Study group
Ultrasound and Diabetes

- Monitor growth

- Schaefer-Graf, Diabetes Med, 2004
  - Randomized
  - 199 women
  - Standard: n=100
    - 30% received insulin
    - fasting >90/postprandial>120
  - Ultrasound-guided: n=99
    - 40% received insulin
    - AC >75%ile or fasting >120/postprandial>200

- 121 women (32 pregestational, 89 GDM)
  - AC >75th correlated to AF insulin >16
  - No cases of severe fetal hyperinsulinism with AC <75th
Ultrasound and Diabetes

• Monitor growth

- Bonomo, Diabetes Metab, 2004
  - Prospective
  - 229 gestational diabetics
    - Conventional: n=78
      - Goal 90/120
      - Insulin 16.7%
    - Modified: n=151
      - AC ≥75%ile: goal 80/100
      - AC <75%ile: goal 100/140
      - Insulin in 30.5%
• Monitor growth

- Fetal AC in 2nd & early 3rd trimester, repeated every 2-4w, can provide useful information to guide management

- Evidence reviewed from RCTs indicates that modification of metabolic management based on fetal growth measurements may improve perinatal outcome or at least be equivalent to standard intensified management.
  - Less intensified management may be allowed with normal growth (fetal abdominal circumference <75th percentile for gestational age), although the consensus was that some SMBG should be continued.

Fifth International Workshop-Conference on Gestational Diabetes Mellitus, Diabetes Care 2007; 30(2): S251-60
Ultrasound and Diabetes

- Monitor growth
  - Schaefer-Graf, Diab Care 2011
    - n = 1914 subjects (avg 2.3 per pregnancy)
      - 518 women with AC >90%ile
        - 74% dx with the first USN exam
        - 13% with the 2nd
    - ~86% of the fetuses were born non-LGA when AC was <90%ile at 24-27w and 28-32w (if both, 88%)
  - Predictive ability did not increase with more than 2 normal scans
  - Accuracy for predicting non-LGA
    - 90% (BMI >30)
    - 89.5% (hx macrosomia)
    - 95.2% (FBG >100)

| Table 3—Ability of an abdominal circumference measurement <90th percentile to predict a normally grown neonate depending on the gestational age at performance of the scan and the absence or presence of maternal risk factors for LGA birth weight |
|-----------------------------------------------|----------------|----------------|----------------|
| Gestational age at abdominal circumference <90th percentile | Total population | No maternal risk factor | With maternal risk factor |
| All US (n = 944 subjects) | 88.9 | 92.2 | 83.2* |
| 24-27 weeks (n = 313) | 85.9 | 90.0 | 81.0* |
| 28-31 weeks (n = 365) | 83.9 | 88.5 | 75.7* |
| 32-33 weeks (n = 97) | 87.9 | 92.5 | 81.0* |
| 36-38 weeks (n = 703) | 89.8 | 93.7 | 81.0* |
| In both, 24-27 and 28-32 weeks (n = 209) | 88.0 | 92.5 | 84.0* |

*Significantly different from percentage in pregnancies without maternal risk factors.

| Table 2—Independent risk factors for LGA birth weight in pregnancies with abdominal circumference <90th percentile at first ultrasound (n = 389 women with at least one risk factors of 1,443 subjects with maternal data) |
|-----------------------------------------------|----------------|----------------|
| | OR (95% CI) | P value |
| History of LGA newborn | 2.2 (1.2–3.9) | 0.004 |
| Pre-pregnancy BMI >30 kg/m² | 1.6 (1.04–2.5) | 0.032 |
| Mean fasting glucose at profile at entry >100 mg/dl (5.5 mmol/l) | 2.1 (1.2–3.3) | 0.003 |
Ultrasound and Diabetes

• Antepartum testing

  - Issues
    - No RCTs compare tests
      - The outcome is too rare
      - Most case series report good outcomes with a given testing protocol and conclude the protocol used is appropriate
    - High false-positive rates
      - Unnecessary interventions
    - No consensus regarding surveillance in GDM
      - Most authorities agree that women with GDM requiring insulin or glyburide, poor metabolic control, and/or cormorbid conditions undergo fetal surveillance.
      - The degree, if any, of excess perinatal mortality associated with mild GDM has not been established.

ACOG PRACTICE BULLETIN #30, 2001
Ultrasound and Diabetes

• **Antepartum testing**
  - Fetal kick counts
  - Nonstress test
  - Contraction stress test
  - Biophysical profile
  - Modified biophysical profile
  - Amniotic fluid index
Ultrasound and Diabetes

• Antepartum testing
  ○ Type & frequency of antenatal testing should be determined by the severity of maternal hyperglycemia or presence of other adverse clinical factors.
  ○ All women with GDM should monitor fetal movements during the last 8-10w of pregnancy
  ○ NSTs should be “considered” after 32 weeks’ gestation in women on insulin and “at or near” term in those who are diet controlled
  ○ BPP & Doppler to assess umbilical blood flow “may be considered” if there is excessive or poor growth

Fourth/Fifth International Workshop-Conference
Ultrasound and Diabetes

- Delivery
  - Mode
  - Timing
Ultrasound and Diabetes

- **Delivery: Mode**

- **C/S to avoid birth injury**
  - Crowther, NEJM, 2005
    - Number of C/S needed to prevent 1 brachial plexus injury: 34
  - Alsunnari, JOGC, 2005
    - Increase in C/S to prevent 10 dystocias out of 49 births if EFW >5kg: negligible
  - Conway, AJOG 1998
    - Increase in C/S rate using cutoff of 4250g in diabetics: 1%
  - Gregory, Obstet & Gynecol, 1998
    - C/S would not avoid all cases of shoulder dystocia or birth injury
  - Ecker, Obstet & Gynecol, 1997
    - Number of C/S to prevent 1 shoulder dystocia in non-diabetics: 19-162
    - Number of C/S to prevent 1 shoulder dystocia in diabetics: 5-48
  - Rouse, JAMA, 1996
    - Number of C/S needed to prevent 1 brachial plexus injury in non-diabetics: 2345
    - Number of C/S needed to prevent 1 brachial plexus injury (4.5kg) in diabetics: 443

- “Very difficult to find data that elective prelabor cesarean delivery at term is any riskier than vaginal delivery for the mother.”
  - Conway, Diab Care 2007
Ultrasound and Diabetes

- Delivery: Timing
  - No data to support induction for prevention of birth injury with suspected macrosomia
  - No data to support delivery before 38 weeks in absence of objective evidence of fetal compromise
Ultrasound and Diabetes

Conclusions

- Is ultrasound useful?
  - YES
    - Accurate dating (<20 weeks)
    - Anomaly screening (especially preexisting)
    - Avoidance of complications
      - Growth (~28 & ~34 weeks nominally enough)
      - Antenatal testing/AFI (twice weekly)
      - Delivery (related to growth)
Ultrasound and Diabetes

- Thank you!