Ultrasound Detection of Macrosomia

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Los Angeles, CA

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DETECTION OF MACROSOMIA

Normal Term Birth Weight Distribution

<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>50th Percentile</th>
<th>90th Percentile</th>
<th>95th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>3,117</td>
<td>3,755</td>
<td>3,959</td>
</tr>
<tr>
<td>38</td>
<td>3,263</td>
<td>3,867</td>
<td>4,027</td>
</tr>
<tr>
<td>39</td>
<td>3,400</td>
<td>3,980</td>
<td>4,107</td>
</tr>
<tr>
<td>40</td>
<td>3,495</td>
<td>4,060</td>
<td>4,185</td>
</tr>
<tr>
<td>41</td>
<td>3,527</td>
<td>4,094</td>
<td>4,217</td>
</tr>
<tr>
<td>42</td>
<td>3,522</td>
<td>4,098</td>
<td>4,213</td>
</tr>
</tbody>
</table>


DETECTION OF MACROSOMIA

ACOG Definition of Macrosomia

ACOG: 5,000 grams (No Diabetes)
ACOG: 4,500 grams (Diabetes)
DETECTION OF MACROSOMIA

Accuracy of Ultrasound To Predict Weight

<table>
<thead>
<tr>
<th>% Difference Between US and Birth Weight</th>
<th>Hadlock</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>5.9</td>
</tr>
<tr>
<td>&lt;2000 g</td>
<td>4.9</td>
</tr>
<tr>
<td>2000-4000 g</td>
<td>4.3</td>
</tr>
<tr>
<td>&gt;4000 g</td>
<td>8.6</td>
</tr>
</tbody>
</table>

DETECTION OF MACROSOMIA

Accuracy of Ultrasound To Predict Weight

<table>
<thead>
<tr>
<th>% Difference Between US and Birth Weight</th>
<th>Hadlock I</th>
<th>Hadlock II</th>
<th>Hadlock III</th>
<th>Hadlock IV</th>
<th>Hart</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>9</td>
<td>10.3</td>
<td>8.5</td>
<td>10.4</td>
<td>3.7</td>
</tr>
</tbody>
</table>

DETECTION OF MACROSOMIA

Thigh Volume Equation for EFW

\[
\ln(BW) = -0.8237 + (4.0344 \times \ln(BPD)) - (0.7820 \times (\ln(BPD))^2) + (0.7853 \times \ln(AC)) + (0.0528 \times (\ln(TVol))^2)
\]

DETECTION OF MACROSOMIA

ESTIMATING FETAL WEIGHT - Soft Tissue Analysis -
DETECTION OF MACROSOMIA

Accuracy of Ultrasound To Predict Weight

Hadlock
3D Leg Volume

% Difference Between US and Birth Weight

-0.4 0.4 1.5 4.3 4.9 5.9 8.6

All <2000 g 2000-4000g >4000 g

Ultrasound Obstet Gynecol 2003;43:198-203

DETECTION OF MACROSOMIA

Predicting Birth Weight At Term
From EFW Obtained Between 34 and 37 Weeks

PROBLEM: DIFFICULT TO MEASURE FETAL HEAD AND ABDOMEN AT TERM TO ACCURATELY PREDICT FETAL WEIGHT

Gestation-adjusted projection of estimated fetal weight. Mongelli M1, Gardosi J.


Forward Extrapolation of Sonographic Estimates of Fetal Weight to the Time of Delivery
Using Gestation-Adjusted Projection Method -Hypothesis-

Ratio of the Estimated Fetal to the Median Fetal Weight For Gestational Age Remains Constant in the Third Trimester


DETECTION OF MACROSOMIA

ESTIMATING DELIVERY WEIGHT REMOTE FROM TERM

DETECTION OF MACROSOMIA

Predicting Birth Weight At Term

STEP 1: IDENTIFY MEDIAN WEIGHT

A standard of fetal growth for the United States of America.


Gestation-adjusted projection of estimated fetal weight.
Predicting Birth Weight At Term

**STEP 2: ULTRASOUND ESTIMATED WEIGHT DETERMINED BETWEEN 34-36.9 WEEKS USING HADLOCK FORMULA**

**DIABETIC**

**N=133**

**CONTROL**

**N=1690**

The ratio between the estimated fetal weight and the median fetal weight for the gestational age (Brenner) was calculated:

1. **CALCULATION 1**
   
   The ratio was multiplied by the median birth weight at the gestational age of delivery to give the predicted birth weight:

2. **CALCULATION 2**

Birth Weight Errors were determined by the difference between the predicted birth weight and the actual birth weight:

3. **CALCULATION 3**

**DETECTION OF MACROSOMIA**

**Computing Birth Weight**

1. 37 wk US EFW: 3,700

**ABSOLUTE ERROR:**

**CONTROL 10.1%**

**DIABETIC 68%**

**DETECTION OF MACROSOMIA**

**Birth Weight**

<table>
<thead>
<tr>
<th>Birth Weight (Grams)</th>
</tr>
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<tbody>
<tr>
<td>1000</td>
</tr>
<tr>
<td>1500</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>2500</td>
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<td>3000</td>
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<td>3500</td>
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<tr>
<td>4000</td>
</tr>
<tr>
<td>4500</td>
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<tr>
<td>5000</td>
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<table>
<thead>
<tr>
<th>Weeks Gestation</th>
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<tbody>
<tr>
<td>34</td>
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<tr>
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<tr>
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**ABSOLUTE ERROR:**

**CONTROL 10.1%**

**DIABETIC 68%**

**DETECTION OF MACROSOMIA**

**Computing Birth Weight**

1. 37 wk US EFW: 3,700
2. 37 wk Median Wt: 2,870
3. 

**ABSOLUTE ERROR:**

**CONTROL 10.1%**

**DIABETIC 68%**
DETECTION OF MACROSOMIA

Computing Birth Weight

1. 37 wk US EFW: 3,700
2. 37 wk Median Wt: 2,870
3. $3,700 \div 2,870 = 1.29$
4. 40 wk Median Wt: 3,280

5. Est Wt 40 wk: $3,280 \times 1.29 = 4,231$

ABSOLUTE ERROR: CONTROL 10.1%
ABSOLUTE ERROR: DIABETIC 68%

DETECTION OF MACROSOMIA

FINDINGS: PREDICTING MACROSOMIA

DIABETIC
N=31

SENSITIVITY: 68%
SPECIFICITY: 96%
POSITIVE PREDICTIVE VALUE: 97%
NEGATIVE PREDICTIVE VALUE: 87%

CONTROL
N=155

SENSITIVITY: 52%
SPECIFICITY: 95%
POSITIVE PREDICTIVE VALUE: 52%
NEGATIVE PREDICTIVE VALUE: 95%

Ultrasonographic prediction of birth weight in diabetic pregnancies.

Predicting Birth Weight At Term
PREDICTING ADVERSE OUTCOME

- FAILURE TO PROGRESS IN LABOR REQUIRING C/S -

Cheek-to-Cheek Diameter

The cheek-to-cheek diameter in the ultrasonographic assessment of fetal growth.

**Reference Ranges**

**Table 1. Cheek-to-cheek diameter predicted by gestational age (mean ± 2 SD)**

<table>
<thead>
<tr>
<th>Gestational age</th>
<th>Cheek-to-cheek diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>7.8 ± 2.2</td>
</tr>
<tr>
<td>32</td>
<td>8.4 ± 2.4</td>
</tr>
<tr>
<td>36</td>
<td>9.0 ± 2.6</td>
</tr>
<tr>
<td>40</td>
<td>9.6 ± 2.8</td>
</tr>
</tbody>
</table>

**Table 2. Cheek-to-cheek diameter predicted by biparietal diameter (BPD) (mean ± 2 SD)**

<table>
<thead>
<tr>
<th>BPD (mm)</th>
<th>Cheek-to-cheek diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>7.8 ± 2.2</td>
</tr>
<tr>
<td>84</td>
<td>8.4 ± 2.4</td>
</tr>
<tr>
<td>88</td>
<td>9.0 ± 2.6</td>
</tr>
<tr>
<td>92</td>
<td>9.6 ± 2.8</td>
</tr>
</tbody>
</table>

**Reference Ranges**

**Table 3. Cheek-to-cheek diameter predicted by gestational age (mean ± 2 SD)**

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<td>36</td>
<td>9.0 ± 2.6</td>
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<td>40</td>
<td>9.6 ± 2.8</td>
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</table>

**Prediction of Need for Cesarian Section For Failure to Progress in Labor**

- **Sensitivity:** 97%
- **Specificity:** 40%

Increased Cheek-to-Cheak Diameter (>7.9 mm)

**Detection of Macrosomia - Shoulder Dystocia**

- Abnormal CCD (>2SD above previously published norms for each GA) was closely associated with cesarean delivery, regardless of EFW. At term, risk of C/S with a CCD >7.9 cm was 94%
“Shoulder dystocia is most often an unpredictable and unpreventable obstetric emergency. Failure of the shoulders to deliver spontaneously places both the pregnant woman and fetus at risk for injury.”
Risk Factors Associated With Shoulder Dystocia

(79,781 Vaginal Deliveries)

Management of Shoulder Dystocia: Trends in Incidence and Maternal and Neonatal Morbidity
MacKenzie, I. Z.; et al
Obstetrics & Gynecology

Increase in Adult Obesity

Obesity Trends* Among U.S. Adults
BRFSS, 1985
(*BMI ≥ 30, or ~ 30 lbs. overweight for 5’ 4” person)

Source: Behavioral Risk Factor Surveillance System, CDC.

Risk for Shoulder Dystocia

Risk for Shoulder Dystocia

BMI > 30

Relative Risk 1.64
p < 0.001

MacKenzie, I. Z.; Shah, Mutayyab; Lean, Katie; Dutton, Susan; Newdick, Helen; Tucker, Danny E.

Risk for Shoulder Dystocia

Birth Weight > 4 kg

Relative Risk 5.42
p < 0.001

MacKenzie, I. Z.; Shah, Mutayyab; Lean, Katie; Dutton, Susan; Newdick, Helen; Tucker, Danny E.
Risk for Shoulder Dystocia

Birth Weight > 4.5 kg

Risk for Shoulder Dystocia

Relative Risk 15.8
p<0.001

Other Clinical Factors

<table>
<thead>
<tr>
<th>Clinical Findings</th>
<th>Relative Risk</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiparas 1st Stage 8 hours or more</td>
<td>1.64</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nulliparas 2nd Stage 4 hours or more</td>
<td>2.30</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Multiparas 2nd Stage 2 hours or more</td>
<td>2.30</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Assisted Delivery</td>
<td>2.11</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Neonatal Acidosis</td>
<td>2.17</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>


Risk Factors Associated With Shoulder Dystocia

(175,886 Vaginal Deliveries of Infants > 3,500 g)

Shoulder dystocia and associated risk factors with macrosomic infants born in California

- 175,886 Women Delivered Babies > 3,500 grams
- 6,238 Cases of Shoulder Dystocia
- INCIDENCE: 3%

**Risk Factors Associated With Shoulder Dystocia**

- Hispanic: 0.8
- Induction of Labor: 1.3
- Diabetes: 1.7
- BW 4000-4500 g: 3.6
- BW >4500 g: 10

**Rate of Shoulder Dystocia: SUMMARY**

<table>
<thead>
<tr>
<th>Birth Weight in Grams</th>
<th>4000-4250</th>
<th>4250-4500</th>
<th>4500-4750</th>
<th>4750-5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Shoulder Dystocia</td>
<td>12.2</td>
<td>12.2</td>
<td>16.7</td>
<td>16.7</td>
</tr>
<tr>
<td>Unassisted Birth: No Diabetes</td>
<td>8.4</td>
<td>8.4</td>
<td>12.3</td>
<td>12.3</td>
</tr>
<tr>
<td>Assisted Delivery (Diabetes)</td>
<td>19.9</td>
<td>23.5</td>
<td>29</td>
<td>34.8</td>
</tr>
</tbody>
</table>

**Identification of the Fetus at Risk for Shoulder Dystocia**

**PREDICTING ADVERSE OUTCOME**

**- PREDICTING SHOULDER DYSTOCIA -**

**Abdominal Diameter - Biparietal Diameter**

**Sonographic Fetal Asymmetry Predicts Shoulder Dystocia**

- **Hypothesis**
  Asymmetric distribution of fetal weight may predispose to fetal shoulder dystocia.
Predicting Adverse Outcome: Shoulder Dystocia

Abdominal Diameter - Biparietal Diameter

**Study Population**
- 322 patients
- 23 of 322 (6.9%) had shoulder dystocia

**Requirements for Positive Screen Results**
- Abdominal Diameter - Biparietal Diameter
- EFW > 97th Percentile
- Abdominal circumference > 95th percentile

**Risk Factors**

<table>
<thead>
<tr>
<th>Percent</th>
<th>Shoulder Dystocia</th>
<th>No Shoulder Dystocia</th>
</tr>
</thead>
<tbody>
<tr>
<td>39.1%</td>
<td>39.1%</td>
<td>39.1%</td>
</tr>
<tr>
<td>17.5%</td>
<td>17.5%</td>
<td>17.5%</td>
</tr>
<tr>
<td>39.1%</td>
<td>39.1%</td>
<td>39.1%</td>
</tr>
<tr>
<td>39.1%</td>
<td>39.1%</td>
<td>39.1%</td>
</tr>
<tr>
<td>39.1%</td>
<td>39.1%</td>
<td>39.1%</td>
</tr>
</tbody>
</table>

Birth Weight

<table>
<thead>
<tr>
<th>Percent</th>
<th>Shoulder Dystocia</th>
<th>No Shoulder Dystocia</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,880</td>
<td>3,880</td>
<td>3,880</td>
</tr>
<tr>
<td>3,714</td>
<td>3,714</td>
<td>3,714</td>
</tr>
</tbody>
</table>

p < 0.05
Sonographic fetal asymmetry predicts shoulder dystocia.

**Risk Factors**

![Mean Abdominal Diameter-Biparietal Diameter](chart)

- **AD-BPD > 2.6 cm**
  - Sensitivity: 44%
  - Specificity: 90%
  - Odds Ratio (95% CL): 7.15 (2.9-17.7)
- **AC > 95%**
  - Sensitivity: 36%
  - Specificity: 79%
  - Odds Ratio (95% CL): 1.95 (0.6-6.1)
- **EFW > 97%**
  - Sensitivity: 13%
  - Specificity: 95%
  - Odds Ratio (95% CL): 1.95 (0.5-6.1)
- **EFW > 4000 g**
  - Sensitivity: 17%
  - Specificity: 85%
  - Odds Ratio (95% CL): 1.15 (0.4-3.5)

**Clinical Protocols**

- **High-Risk Patient**
  - Predicting Birth Weight
  - Cheek-to-Cheek Diameter (>2 SD)
  - PeriCalm Shoulder Screen to Predict Risk for Permanent Erb's Palsy
  - Gestation-Adjusted Projection Method
  - Hadlock Equation
  - Limb-Volume Equation
  - Macrosomia

- **Increased Risk of Cesarean Section for Failure to Progress in Labor**
  - AD-BPD (>2.6 cm)

- **Increased Risk for Shoulder Dystocia**
  - 34w-37w at Term

- **Increased Risk for Shoulder Dystocia At Term**

**Ultrasound Findings**

- **Parameter**
- **Likelihood Ratio**
- **Positive Predictive Value**
- **Negative Predictive Value**