- Terminology
  - Gestational age (GA)
    - Refers to the length of pregnancy counting from the LMP and is usually expressed in weeks and days
  - Conceptional age
    - True fetal age and refers to the length of pregnancy from the time of conception
  - Expected date of delivery (EDD)
    - Only 4% of babies are born precisely on the EDD
    - Median length of pregnancy is 280 days (40 weeks) from the LMP
    - In women with regular cycles and certain LMP, EDD is calculated by adding 7 days to the first day of LMP and adding 9 months
  - Trimesters
    - First trimester is from week 1 to the end of week 12
    - Second trimester is from week 13 to the end of week 26
    - Third trimester is from week 27 to the end of the pregnancy
  - Preterm and postterm
    - Infants born before 37 weeks are deemed preterm
    - Infants born after 42 weeks are termed postterm

- Menstrual history
  - Gestational age is traditionally estimated from the LMP
  - Conception is assumed to occur on day 14 of the cycle
  - 10-45% of pregnant women cannot provide useful information about their LMP
  - 18% of women with certain menstrual dates have significant differences between menstrual and sonographic dating

- Combining menstrual and sonographic dates
  - A common practice is known as the 10-day or 7-day rule
  - If LMP dates and ultrasound dates are in agreement within 10 or 7 days, LMP dates are accepted
  - If the discrepancy exceeds 10 or 7 days, the ultrasound dates are used

- Ultrasound dating
  - First trimester crown-rump length is the most accurate means for sonographic dating of pregnancy, with 95% confidence interval (2 standard deviations) of approximately 1 week
    - Early fetal growth is spontaneous and not affected by secondary factors as is growth in the 2nd and 3rd trimesters
    - Dating established at this time is used as reference for later age and percentile determinations
    - It is important that the gestational age assigned at the time of the first examination is carried through all future examinations
Fetal Biometry

- After the first trimester, a variety of sonographic parameters (e.g. biparietal diameter, head circumference, abdominal circumference, femoral diaphysis length) are used to estimate gestational age.
  - Variability of gestational age estimations increases with advancing pregnancy.
  - 95% confidence interval of approximately 2 weeks in the 2nd trimester, approximately 3 weeks in the 3rd trimester.

- Biparietal diameter (BPD)
  - Measured at the level of the thalami and cavum septum pellucidum.
  - Cerebellar hemispheres should not be visible.
  - Measurement is taken from the outer edge of the proximal skull to the inner edge of the distal skull.

- Head shape
  - BPD may not accurately reflect dates or head growth in fetuses with abnormal head shapes.
  - HC may be more accurate in these cases.
  - Cephalic index
    - Elongation of the head (dolicocephaly) is present if BPD/OFD < 0.70.
      - Most commonly seen with oligohydramnios, breech position, or engaged head in the 3rd trimester.
    - Abnormally round head (brachycephaly) is present if BPD/OFD > 0.86.
      - May indicate genetic anomaly.
      - In post-natal life it is well recognized that children with T21 have brachycephaly.
      - However, several studies have found no difference in cephalic index between 2nd trimester fetuses with T21 and normal controls.

- Corrected BPD has been proposed to correct for head shape.
  - Occipitofrontal diameter (OFD) is measured in the same plane as the BPD.
Fetal Biometry

- Calipers are placed on the outer skull table


- Head circumference (HC)
  - Measured at the same level as the BPD, around the outer perimeter of the calvarium
  - This measurement is not affected by head shape

- Femur length (FL)
  - Make sure the entire bone is imaged
  - Image should show two blunted ends
  - Don’t include “spike” that appears at the end of the femur
  - Imaging from a slightly different direction will usually eliminate the spike

- Abdominal circumference
Fetal Biometry

- The least accurate measurement
- Abdomen should be as round as possible
  - Avoid distorting the fetal abdomen by pushing too hard
- Umbilical vein is seen passing through the liver
- Stomach is visible
- Spine is in sharp cross section
- Ribs are symmetric

- Proportions
  - HC/AC ratio

**Table I**

<table>
<thead>
<tr>
<th>Menstrual age (weeks)</th>
<th>Number of measurements</th>
<th>5th centile</th>
<th>Mean</th>
<th>95th centile</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-14</td>
<td>18</td>
<td>1.14</td>
<td>1.23</td>
<td>1.31</td>
</tr>
<tr>
<td>15-16</td>
<td>39</td>
<td>1.05</td>
<td>1.22</td>
<td>1.39</td>
</tr>
<tr>
<td>17-18</td>
<td>77</td>
<td>1.07</td>
<td>1.18</td>
<td>1.29</td>
</tr>
<tr>
<td>19-20</td>
<td>54</td>
<td>1.09</td>
<td>1.18</td>
<td>1.26</td>
</tr>
<tr>
<td>21-22</td>
<td>41</td>
<td>1.06</td>
<td>1.15</td>
<td>1.25</td>
</tr>
<tr>
<td>23-24</td>
<td>22</td>
<td>1.05</td>
<td>1.13</td>
<td>1.21</td>
</tr>
<tr>
<td>25-26</td>
<td>18</td>
<td>1.04</td>
<td>1.13</td>
<td>1.22</td>
</tr>
<tr>
<td>27-28</td>
<td>31</td>
<td>1.05</td>
<td>1.13</td>
<td>1.22</td>
</tr>
<tr>
<td>29-30</td>
<td>23</td>
<td>0.99</td>
<td>1.10</td>
<td>1.21</td>
</tr>
<tr>
<td>31-32</td>
<td>31</td>
<td>0.96</td>
<td>1.07</td>
<td>1.17</td>
</tr>
<tr>
<td>33-34</td>
<td>42</td>
<td>0.96</td>
<td>1.04</td>
<td>1.11</td>
</tr>
<tr>
<td>35-36</td>
<td>49</td>
<td>0.93</td>
<td>1.02</td>
<td>1.11</td>
</tr>
<tr>
<td>37-38</td>
<td>67</td>
<td>0.92</td>
<td>0.98</td>
<td>1.05</td>
</tr>
<tr>
<td>39-40</td>
<td>47</td>
<td>0.87</td>
<td>0.97</td>
<td>1.06</td>
</tr>
<tr>
<td>41-42</td>
<td>4</td>
<td>0.93</td>
<td>0.96</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Campell S, Thoms A. Ultrasound Measurement of the Fetal Head to Abdomen Circumference Ratio in the Assessment of Growth Retardation. BJOG 1977;84:165-174

- HC/AC ratio is used to identify asymmetric growth retardation
- Suspect nutritional growth retardation (i.e. with brain sparing) if HC/AC is >1 after 34 weeks (some authors use 36 weeks as cutoff)
  - Note that the study by Campbell et al used HC/AC ratio of >95th percentile for gestational age as cutoff

- FL/BPD ratio
  - FL/BPD is normally 71-87% from 23 weeks to 40 weeks (Hohler et al)

-Suspect microcephaly if increased
-Suspect short-limb dysplasias or macrocephaly if decreased

-FL/AC ratio

-Constant value of 0.20-0.24 after 21 weeks (Hadlock et al)
  -Suspect growth retardation if >0.24
  -Suspect macrosomia if <0.20

Hadlock FP, Deter RL, Harrist RB. A Date-Independent Predictor of Intrauterine Growth Retardation: Femur Length/Abdominal Circumference Ratio. AJR 1983;141:979-984

-Composite gestational age
Fetal Biometry

- Gestational age formula that incorporates multiple parameters is more accurate than any single parameter, especially in the 3rd trimester

-Intrauterine growth restriction
  - Perinates with a weight at or below the 10th percentile for gestational age and sex
  - Implies a pathologic process that affected normal fetal growth
    - May be due to fetal, placental, maternal disorders (alone or in combination)
  - The definition is similar to that of small for gestational age (SGA)
    - Defined as perinates with a weight at or below the 10th percentile for gestational age and sex, without reference to the etiology

<table>
<thead>
<tr>
<th>Normally small fetus (80-95%)</th>
<th>Intrinsically abnormally small fetus (10-15%)</th>
<th>Dysmature small fetus (10-15%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>* No restraint of growth potential.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Weight &lt;10th centile due to lower growth potential.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Asphyxia risk no greater than an appropriate age fetus.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Small/symmetrical.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Normal amniotic &amp; fat distribution.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Intervention not indicated.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Growth restriction due to a genetic/structural anomaly or infection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* May be severely IUGR.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Perinatal outcome related to defect rather than size.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Perinatal mortality high</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Symmetric IUGR + normal or increased amniotic fluid.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Intervention rarely improves outcome.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Extrinsic restriction of normal growth potential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Compromised placental function.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Asphyxial complications common and careful surveillance required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Perinatal mortality high.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Asymmetric growth failure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Oligohydramnios.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Abnormal biophysical profile.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Intervention can improve outcome.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

http://www.fetalultrasound.com/online/

References:

6) Doubleit PM, Greenes RA. Improved Prediction of Gestational Age from Fetal Head Measurements. AJR 1984;142:797-800
8) http://www.fetalultrasound.com/online/
11) Hadlock FP, Deter RL, Harrist RB. A Date-Independent Predictor of Intrauterine Growth Retardation: Femur Length/Abdominal Circumference Ratio. AJR 1983;141:979-984
13) Campell S, Thoms A. Ultrasound Measurement of the Fetal Head to Abdomen Circumference Ratio in the Assessment of Growth Retardation. BJOG 1977;84:165-174