Ultrasonography for Dating Pregnancies

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Learning Objectives

• After completing this presentation, the learner will be able to:
  1. Explain importance of accurate pregnancy dating
  2. Describe first trimester measurements and accuracy
  3. Describe second trimester measurements and accuracy
  4. Describe simple algorithm for assigning due date

Lecture Outline

• Menstrual dating
• First trimester ultrasound dating
  – measurements
  – accuracy
  – twins
• Second trimester dating
  – measurement
  – accuracy
  – twins
• Dating algorithm
• Case studies

Obstetrical Interventions and Procedures by Gestational Age

• All obstetrical care stems from accurate gestational age, including timing of
  – prenatal exams
  – screening tests
  – delivery
Traditional Pregnancy Dating – Last Menstrual Period (LMP)

- **Naegele’s Rule**
  - 1st day of LMP + 1 year – 3 months + 7 days = EDD
- **Wheel**

Wheel Accuracy

- **Findings**
  - 10/31 (35%) → 280 day EDD
  - largest single discrepancy = 4 days
  - largest interwheel difference = 7 days
  - 20/20 app → 280 day EDD
- **Conclusion**
  - replace wheels with electronic due date calculator

Ultrasound Dating – Assumptions

- **Size of embryo/fetus is consistent with its age**
  - measurements of IVF pregnancies = spontaneous conceptions
- **Measurements conform to nomograms**
- **Measurements are reliable both**
  - within and between examiners
- **Structures measured are normal**
- **US equipment is properly calibrated**

First Trimester Dating – Mean Sac Diameter (MSD)

- **Mean of 3 orthogonal measurements of the fluid filled space within the gestational sac**
  \[ MSD = \frac{1.22 + 0.83 + 0.71}{3} = 0.92 \text{ cm} \]

MSD – General Rules

- **Gestational age (d) = MSD (mm) + 25**
  - from 5 0/7 – 8 0/7 weeks
- **Grows ~1mm/day**
  - use to time dating and viability US for MSD ≥ 25mm or 7 weeks
- **Use only until embryo present, then use CRL**
  - greater interobserver variation vs. CRL
  - do not use to determine EDD
First Trimester Dating – Crown Rump Length (CRL)

- No standard technique until recently
  - transabdominal or transvaginal scan (equivalent) ≥ 6 weeks
  - mid-sagittal view
  - entire embryo/fetus fills screen
  - embryo oriented horizontally and 90° to US beam
  - neutral position
  - linear measurement
  - “best of 3” vs. “average of 3”

Wax, Papageorghiou, et al. USOG 2014
Insermou, et al. BJOG 2013
Grisolia, et al. USOG 1993
Lohr, et al. Contraception 2010
Pernot, et al. USOG 1993

Crown Rump Length – General Rules

- Use from 6 0/7 – 13 6/7 weeks (up to 84mm)
- Most accurate from 7 – 60mm
- Clinically insignificant (0.4d) difference males vs. females
- Gestational age (wks) = CRL (cm) + 6.5

<table>
<thead>
<tr>
<th>Accuracy (d)</th>
<th>Gestational Age (wks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 5</td>
<td>± 8 6/7</td>
</tr>
<tr>
<td>± 7</td>
<td>9 0/7 – 13 6/7</td>
</tr>
</tbody>
</table>

Wax

CRL Dating of Twins

- Which twin is used to date a pregnancy when LMP is uncertain?
  - discordant from CRL?
- Limited data = no consensus

Wax

CRL Dating of Twins

<table>
<thead>
<tr>
<th>Favor</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger</td>
<td>reduces chance of missing FGR</td>
</tr>
<tr>
<td></td>
<td>unlikely to have pathologically large fetus</td>
</tr>
<tr>
<td>Smaller</td>
<td>more accurate if △CRL &lt; 95% (&lt; 9.8mm)</td>
</tr>
<tr>
<td></td>
<td>no increased risk of discordance or adverse outcome</td>
</tr>
<tr>
<td>Average</td>
<td>as accurate as smaller twin dating</td>
</tr>
<tr>
<td></td>
<td>as similar to singleton CRL as small twin</td>
</tr>
</tbody>
</table>

Salomon, et al. USOG 2005
Chaudhuri, et al. JOG 2013
Dias, et al. BJOG 2010

CRL Dating of Twins

- Should twins be dated using twins-specific CRL nomograms?
  - not necessary
    - no clinically significant difference in CRL vs. singletons (1-2d)
    - no difference between mono- vs. dichorionic
    - best agreement when CRL 4-60mm

Kalish, et al. AJOG 2004
Wisser, et al. USOG 1994
Sebire, et al. OG 1998
Dias, et al. BJOG 2010

Second Trimester Dating

- Use either unweighted composite gestational age of measurements or
- Regression formula incorporating measurements vs. Nomograms
Second Trimester Dating – Biparietal Diameter (BPD), Head Circumference (HC)

- Level of thalami and cavum septi pellucidi
- No cerebellum seen
- Midline echo horizontal and perpendicular to US beam
- Symmetrical hemispheres
- BPD – calipers on outer edge near field parietal bone, inner edge far field parental bone*
- HC – outer perimeter of bony skull

*BMUS: outer–outer, use appropriate nomogram

Second Trimester Dating – Abdominal Circumference (AC)

- True axial section at level of umbilical vein and portal sinus
- Stomach seen
- Kidneys not visible
- Measure along skin

Second Trimester Dating – Femur Length (FL)

- Measure only diaphyseal length of bone
- Femur horizontal and perpendicular to US beam

Second Trimester Dating – Caveats

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Comment</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPD</td>
<td>Slightly less accurate than HC</td>
<td>± 7-12 d</td>
</tr>
<tr>
<td>HC</td>
<td>Most accurate single measurement 14-22 wks</td>
<td>± 7-12 d</td>
</tr>
<tr>
<td>AC</td>
<td>Most variable measurement • fetal growth factors • borders hard to discern • shape distortion</td>
<td>± 7-15 d</td>
</tr>
<tr>
<td>FL</td>
<td>May vary with • aneuploidy • ethnicity • skeletal dysplasia</td>
<td>± 7-17 d</td>
</tr>
</tbody>
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Second Trimester Dating – General Rules

- Clinically as accurate (18-22 wks) as first trimester dating (11-14 wks) using IVF-dated pregnancies
- Do not redate if earlier reliable exam available

<table>
<thead>
<tr>
<th>Accuracy (d)</th>
<th>Gestational Age (wks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 7</td>
<td>14 0/7 – 15 2/7</td>
</tr>
<tr>
<td>± 10</td>
<td>16 0/7 – 21 6/7</td>
</tr>
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Second Trimester Dating – Twins

- May use singleton nomograms up to 26 weeks
- HC of larger twin – most accurate measurement

Kalish, et al. ACOG 2004

Dias, et al. USOG 2011
Should All Women Undergo 1st Trimester Ultrasound?

<table>
<thead>
<tr>
<th>Organization</th>
<th>Recommendation (and timing, wks)</th>
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<tbody>
<tr>
<td>U.K. NICE (2008)</td>
<td>offer at 10 0/7 – 13 6/7</td>
</tr>
<tr>
<td>ISUOG (2013)</td>
<td>• 11 0/7 – 13 6/7 if indicated</td>
</tr>
<tr>
<td></td>
<td>• offer at 10 0/7 – 13 6/7</td>
</tr>
<tr>
<td>SOGC (2014)</td>
<td>offer/perform, where available</td>
</tr>
<tr>
<td>ACOG (2009)</td>
<td>if indicated</td>
</tr>
<tr>
<td>NIH Consensus (2014)</td>
<td>if indicated, 7-10 wks (dating)</td>
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Simplified Dating Algorithm

- If pregnancy resulted from ART, use ART dating
- If pregnancy resulted from spontaneous conception, and LMP is unknown or uncertain
  - date by CRL up to 84 mm (13 6/7 wks), preferably ≥ 10 mm
  - if CRL unavailable, date by composite of BPD, HC, AC, FL up to 24 weeks, preferably 18-20 weeks or earlier

Case Studies in Dating – ART Conception

- 36-year old with IVF conception
- 5 days between fertilization and transfer on 7/20/15
- What is her EDD?
  - egg retrieval and fertilization assigned “day 14”
  - fertilization + 5 days = 19 days since “LMP”
  - “LMP” = 7/20/15 – 19 days = 7/1/15
  - EDD = 4/6/16
Case Studies in Dating – First Trimester

- 39-year old LMP 7/8/15 EDD 4/13/16 at 7 5/7 weeks
- CRL = 6 4/7 weeks
- What is her EDD?
  - US – LMP difference = 8 days
  - 8 days > 5 day US – LMP threshold
  - date by CRL
  - EDD = 4/21/16

Case Studies in Dating – Second Trimester

- 28-year old LMP 7/16/15 EDD 4/21/16 at 19 5/7 weeks
- Biometry
  - BPD 17 2/7
  - HC 17 0/7
  - AC 17 2/7
  - FL 17 4/7
- What is her EDD?
  - composite EGA = 17 2/7
  - US – LMP difference = 16 days
  - 16 days > 10 day US – LMP threshold
  - date by US
  - EDD = 5/8/16

Case Studies in Dating

- 34-year old, unknown LMP
- US on 8/31/15 shows monochorionic diamniotic twins
  - Biometry
    - CRL A 12 0/7
    - CRL B 11 3/7
- What is her EDD?
  - by larger twin = 3/14/16
  - by smaller twin = 3/18/16
  - by average = 3/16/16

Conclusion

- Use ART dating, if applicable
- First and second trimester biometry are accurate EDD determinants
  - Do not use MSD to determine EDD
- Perform followup growth study if dated by third trimester ultrasound
- Twins may be dated by singleton nomograms

References

References