ISUOG Basic Training
Assessing normal and abnormal findings from 4-10 weeks in singleton & twin pregnancies
Learning objectives

At the end of this session, you will:

• Recognise the typical ultrasound appearances of the normal pregnancy between 4 & 10 weeks of gestation

• Understand the role of measurements in early pregnancy

• Recognise the typical ultrasound appearances of ectopic & molar pregnancies
Key questions

1. What are the normal appearances of the gestation sac (GS), yolk sac (YS) & embryo?
2. How should the gestation sac & embryo be measured?
3. What criteria & terminology should be used to describe the non-viable intrauterine pregnancy?
4. What are the typical ultrasound features of an ectopic pregnancy?
5. What is the role of ultrasound in managing pregnancy of unknown location (PUL)?
6. What are the typical ultrasound features of a molar pregnancy?
Conception and implantation
Embryo from 0-8 weeks
Basic Training

Implantation ➞ gestation sac

1st evidence of pregnancy on US: completely embedded blastocyst 14d post conception

NEJM 2001,345:1400
Gestation sac

- Uniformly round fluid collection inside uterine cavity
- Normally positioned in mid-to upper uterine cavity
- Surrounded by a hyperechogenic rim
- Visible at approximately 4w gestation
Location of gestation sac within upper half of uterus
4 weeks – 2 mm
Gestation sac measurement: Mean sac diameter (MSD)

5w4d mean 3.9mm

6w4d mean 18.8mm

MSD = mean of 3 orthogonal planes
Growth in early pregnancy ≈ 1mm/day

Yolk sac

- First structure identified within gestational sac
- Confirms intrauterine pregnancy, 100% PPV
- Spherical
- Echogenic periphery
- Sonolucent center
- Attaches to embryo by vitelline duct
Yolk sac

- Imaged ~ 5 - 5.5w
- Imaged when MSD ~ 5-6mm
- Imaged 3-5d prior to embryo
- Diameter peaks at 6mm at 10w, then decreases
- Usually not visible after first trimester
- Number of yolk sacs usually = number of amnions
Yolk sac in multiple pregnancy

Dichorionic diamniotic

Monochorionic diamniotic

Monochorionic monoamniotic
Yolk sac measurement

- The yolk sac is measured “inner to inner” with the callipers placed at the inside of the yolk sac wall.
- The yolk sac diameter (YSD) is calculated as the average of 3 orthogonal diameters.
Amnion

• First seen at approximately 5.5w – small membranous structure continuous with the embryo
• Contains clear fluid
• Separates the embryo and amniotic space from the extraembryonic coelom
• Obliterates the coelomic cavity by 12-16w
Fetal heartbeat

Heartbeat visible from CRL > 2-4mm
Rapid frequency 5-9 weeks

Optional: Not a criteria for viability – do not need to document rate
Crown rump length (CRL)

ISUOG guideline:

- Midline sagittal section of whole fetus
- Ideal orientation: horizontal
- Magnification: fill most of screen
- Fetus in neutral position
- Endpoints clearly defined

*Between 6-9 weeks embryo = hyperflexed*

*Use neck-rump length instead of CRL*

ISUOG Practice Guidelines: performance of first-trimester fetal ultrasound scan UOG, 2013, 41:102-113
9 weeks 4 day embryos
**10 week fetus**

- At ten weeks and beyond the embryo is now referred to as a fetus
- The morphology begins to resemble that of the more familiar NT scan

Summary

We have covered the main developing structures in early intrauterine pregnancy:

- GS (MSD)
- YS
- Amnion
- Embryo (NRL/ CRL)

Let's move onto symptoms..
Pain and blood loss in early pregnancy

<table>
<thead>
<tr>
<th>Event</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain &amp; vaginal bleeding</td>
<td>1:5 pregnant women</td>
</tr>
<tr>
<td>Blood loss</td>
<td>50% continue into normal pregnancy</td>
</tr>
</tbody>
</table>

Gynecological causes:
- Miscarriage, ectopic, haemorrhage ruptured corpus luteum cyst, ovarian torsion

Non-gynecological causes:
- Cystitis, appendicitis, ureteric stones, constipation

Symptoms alone cannot reliably predict:
- Ectopic pregnancy
- Miscarriage

**Terminology: early pregnancy events**

<table>
<thead>
<tr>
<th>Terminology</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viable</td>
<td>Obstetric scan: results in liveborn baby (&gt;24w)</td>
</tr>
<tr>
<td></td>
<td>Early pregnancy scan: IUP + fetal cardiac activity</td>
</tr>
<tr>
<td>Non-viable</td>
<td>Cannot result in liveborn baby (failed intrauterine pregnancy, ectopic pregnancy)</td>
</tr>
<tr>
<td>Intrauterine pregnancy of uncertain viability (IPUV)</td>
<td>Neither a diagnosis of viable intrauterine pregnancy (VIUP) or non viable intrauterine pregnancy (NVIUP) can be confirmed</td>
</tr>
</tbody>
</table>

Preisler J et al. BMJ. 2015, **23**: 351
## Terminology: early pregnancy events 2

<table>
<thead>
<tr>
<th>Terminology</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ectopic pregnancy (EP)</td>
<td>Pregnancy outside endometrial cavity</td>
</tr>
<tr>
<td>Heterotopic pregnancy</td>
<td>Intrauterine + ectopic pregnancy at the same time</td>
</tr>
<tr>
<td>Pregnancy of unknown location (PUL)</td>
<td>+ve urine/serum hCG, no evidence of IUP or EP on TVS</td>
</tr>
<tr>
<td>Human chorionic gonadotropin (hCG)</td>
<td>Positive urine pregnancy test = hCG &gt;25 IU/L</td>
</tr>
<tr>
<td></td>
<td>Positive serum pregnancy test = hCG &gt;5 IU/L</td>
</tr>
</tbody>
</table>

Miscarriage

Spontaneous loss of a pregnancy before it would be able to survive independently (before 23rd week gestation/ fetal weight $\geq 500$g)

Fundamental principle: First do no harm
Misdiagnosis of miscarriage is unacceptable as it may lead to inadvertent termination of a viable pregnancy
Thus:
- Strict cut-offs for diagnosis; allow for inter- & intra-observer variability
- Strict time intervals before repeating scans when initial scan inconclusive
Features diagnostic of a miscarriage on transvaginal* scanning:

- MSD $\geq 25\text{mm}$ (with no obvious yolk sac or fetal pole)
- Embryo with CRL $\geq 7\text{mm}$ without evidence of fetal heart activity
- MSD $\geq 18\text{mm}$ without embryo, more than 70 days after LMP
- Embryo $\geq 3\text{mm}$ without fetal heart activity, more than 70 days after LMP

*Close to decision boundaries, a second operator should check the findings or repeat the scan 7 days later.
Scan repeated at interval

Features diagnostic of a miscarriage on follow-up transvaginal scanning:

- No embryo with fetal heart activity \( \geq 14 \text{ days} \) after a scan that showed a gestational sac without a yolk sac
- No embryo with fetal heart activity \( \geq 11 \text{ days} \) after a scan that showed a gestational sac with a yolk sac
- No embryo with fetal heart activity 7 days after a scan:
  - In which embryo was visualised
  - In which a gestation sac \( \geq 12\text{mm MSD} \) (with or without yolk sac) was visualised
- MSD less than doubled 14 days after scan in which empty sac with MSD <12mm was seen

Diagnosing miscarriage

≥ 25.0mm

≥ 7.0mm
### Intrauterine pregnancy of uncertain viability

#### Features suggestive of a miscarriage

| Findings close to decision boundaries | Crown-rump length of <7mm and no heartbeat  
Mean sac diameter of 16-24mm and no embryo  
Absence of an embryo ≥6 weeks after last menstrual period |

Doubilet et al NEJM, 2013, **369**:1443-51
# Intrauterine pregnancy of uncertain viability

<table>
<thead>
<tr>
<th>Features <strong>suggestive</strong> of a miscarriage</th>
</tr>
</thead>
</table>
| **Findings close to decision boundaries** | Crown-rump length of <7mm and no heartbeat  
  Mean sac diameter of 16-24mm and no embryo  
  Absence of an embryo >=6 weeks after last menstrual period |
| **Discordant growth** | Enlarged yolk sac >7mm  
  Empty amnion sign  
  <5mm difference between MSD and CRL |

Doubilet et al NEJM 2013, **369**:1443-51
Intrauterine pregnancy of uncertain viability

<table>
<thead>
<tr>
<th>Features suggestive of a miscarriage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Findings close to decision boundaries</strong></td>
</tr>
<tr>
<td>Crown-rump length of &lt;7mm and no heartbeat</td>
</tr>
<tr>
<td>Mean sac diameter of 16-24mm and no embryo</td>
</tr>
<tr>
<td>Absence of an embryo &gt;=6 weeks after last menstrual period</td>
</tr>
<tr>
<td><strong>Discordant growth</strong></td>
</tr>
<tr>
<td>Enlarged yolk sac &gt;7mm</td>
</tr>
<tr>
<td>Empty amnion sign</td>
</tr>
<tr>
<td>&lt;5mm difference between MSD and CRL</td>
</tr>
<tr>
<td><strong>Other concerning features</strong></td>
</tr>
<tr>
<td>GS low in cavity (NB care to exclude cervical or C/S scar ectopic)</td>
</tr>
<tr>
<td>Irregular outline to GS</td>
</tr>
<tr>
<td>Subchorionic haematoma</td>
</tr>
</tbody>
</table>
Intrauterine pregnancy of uncertain viability

<7mm

<25mm
IPUV: empty amniontic cavity sign – *not diagnostic*
Intrauterine pregnancy of uncertain viability

Small gestation sac in relation to embryo:
<5.0mm difference between CRL and MSD
Subchorionic haematoma
Subchorionic haematoma
Ectopic pregnancy

- Tubal 95–96%
- Interstitial and cornual 2–3%
- Isthmic 12%
- Ampullary 70%
- Fimbrial 11%
- Ovarian 3%
- Cervical <1%
- Abdominal 1%
- Cesarean scar <1%
## Ectopic pregnancy

<table>
<thead>
<tr>
<th>Sonographic findings</th>
<th>% of ectopics seen on US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhomogenous adnexal mass (‘blob sign’)</td>
<td>60%</td>
</tr>
<tr>
<td>Empty extrauterine gestation sac (‘bagel sign’)</td>
<td>20%</td>
</tr>
<tr>
<td>Extrauterine GS +/- YS +/- embryo +/- fetal cardiac activity</td>
<td>20%</td>
</tr>
</tbody>
</table>

*Kirk E et al, Hum Reprod. 2007, 22(11):2824-8*
Ectopic pregnancy

- ‘Blob’ sign
- ‘Bagel’ sign
- GS & YS +/- FHR
- Haemoperitoneum

Basic Training
Ectopic pregnancy: Blob sign

[Image: Ultrasound scan showing an ovary and an ectopic pregnancy.]
Ectopic pregnancy: Bagel Sign
Ectopic pregnancy: GS & YS +/- FHR
Ectopic pregnancy: haemoperitoneum
# Ectopic pregnancy: management

<table>
<thead>
<tr>
<th></th>
<th>Expectant</th>
<th>Medical</th>
<th>Surgical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure</td>
<td>(None)</td>
<td>Methotrexate: dose = 50 mg/m²</td>
<td>Laparoscopy v. laparotomy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Salpingectomy v. salpingotomy</td>
</tr>
<tr>
<td>Success rates</td>
<td>48-100%</td>
<td>65-95% : 1 dose: 68%; 2 doses: 84%</td>
<td></td>
</tr>
<tr>
<td>Advantages</td>
<td>• Can be performed on outpatient basis</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• Avoids risks of surgery</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• Avoids risks of MTX</td>
<td>• Definitive 1-stop management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Can be performed on an outpatient basis</td>
<td>• No prolonged follow-up</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Avoids the risks of surgery</td>
<td>• Avoids risks of rupture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• &lt;10% require surgical intervention</td>
<td>• Potentially shortens the time until</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>next conception can occur</td>
<td></td>
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<tr>
<td>Disadvantages</td>
<td>Side effects: abdominal pain (75%), conjunctivitis, stomatitis, GI upset</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7% experience tubal rupture during follow-up; 14% require &gt;1 dose</td>
<td>Potential surgical complications –</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Higher risk of unplanned admission and intervention compared to surgical management</td>
<td>including bowel/ bladder / ureteric injury or adhesions</td>
<td></td>
</tr>
</tbody>
</table>

Management protocols: Pregnancy of Unknown Location (PUL)

- PUL

  - Progesterone ≤ 10

  - Discharge with a UPT in 2/52

  - Likely failing PUL: hCG ratio <0.87
  - Likely ectopic: hCG ratio ≥0.87 - ≤1.66
  - Likely ongoing IUP: hCG ratio >1.66

M4 model (logistic regression):
- Initial hCG
- hCG ratio

Management protocols: Pregnancy of Unknown Location (PUL)

**M6 model**
- Initial hCG
- Initial progesterone
- hCG ratio

**App**: search ‘early pregnancy Leuven’ in the app store
**Free website**: [www.earlypregnancycare.com/m6](http://www.earlypregnancycare.com/m6)

Hydatiform mole

Incidence = 1:1500 pregnancies
Hydatiform mole

**Complete**
46, XX only paternal
Classic ‘snowstorm’ or ‘bunch of grapes’ appearance
95% diagnosed via US

**Partial**
69 XXX or 69 XXY (triploidy)
Paternal & maternal (dispermic fertilisation)
Often has embryo
20% diagnosed via US

Key points

1. The first evidence of an intrauterine pregnancy can be seen at around 4 weeks, using the transvaginal approach
2. At 4 weeks, the mean sac diameter is 2mm
3. The normal gestation sac grows at ~1mm/day
4. The correct terminology should be used when describing early pregnancy events
5. The strict criteria used to diagnose miscarriage should always be followed
6. The most common ultrasound appearance of an ectopic pregnancy is of a heterogenous mass