ISUOG Basic Training

Assessing normal and abnormal findings from 4-10 weeks in singleton & twin pregnancies

Learning objectives

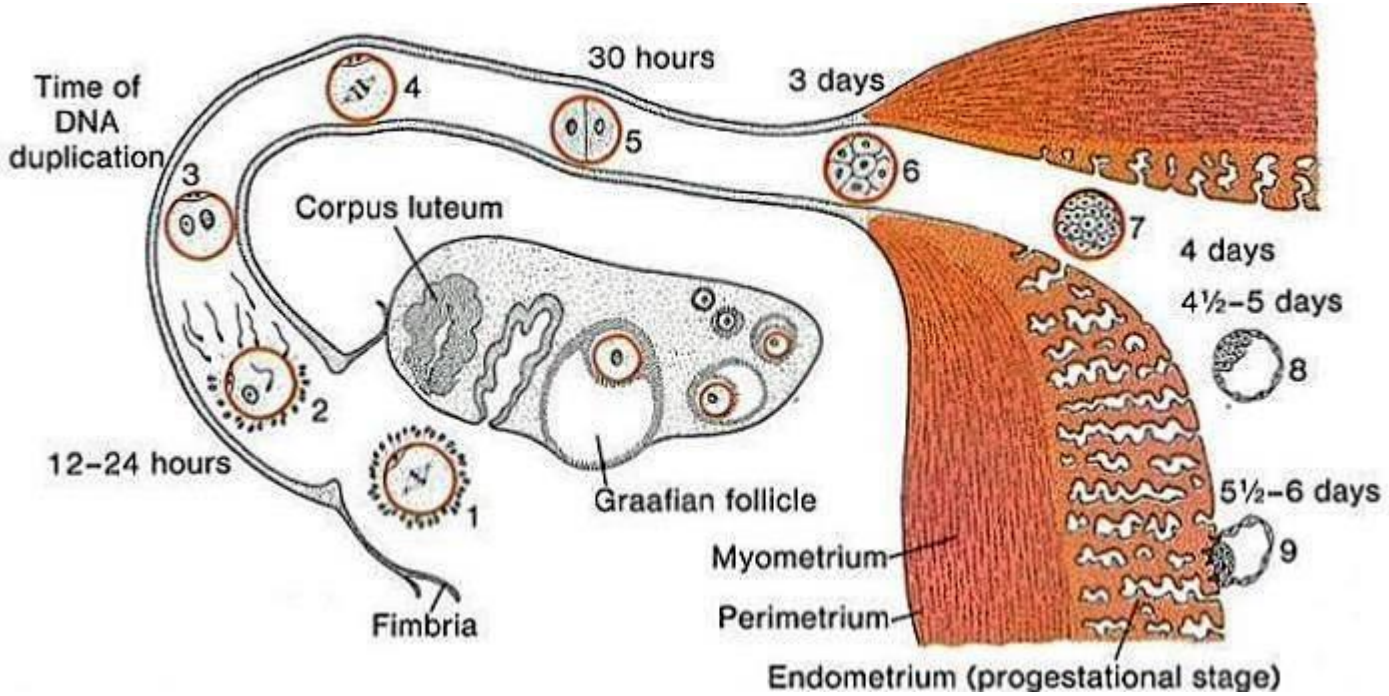
At the end of this session, you will:

- 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

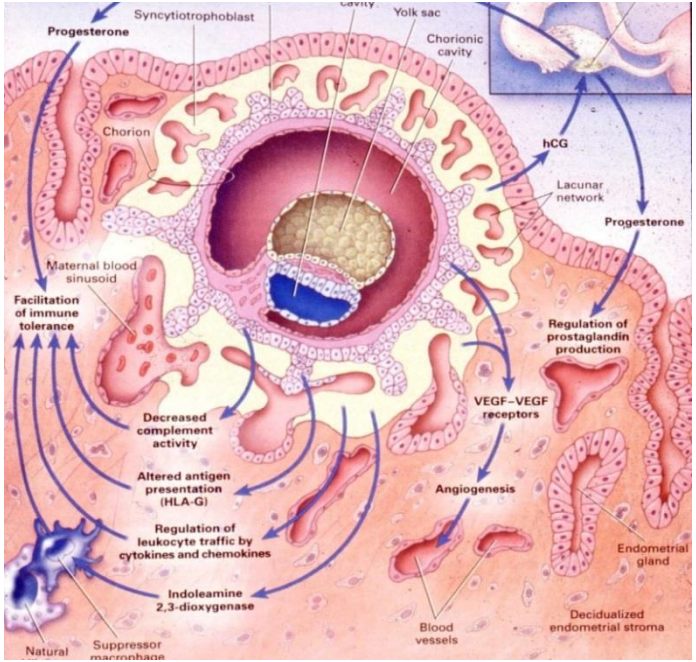
1. What are the normal appearances of the gestation sac (GS), yolk sac (YS) & embryo?
2. How should the gestation sac & embryo be measured?
3. What criteria & terminology should be used to describe the non-viable intrauterine pregnancy?
4. What are the typical ultrasound features of an ectopic pregnancy?
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

Implantation ➞ gestation sac



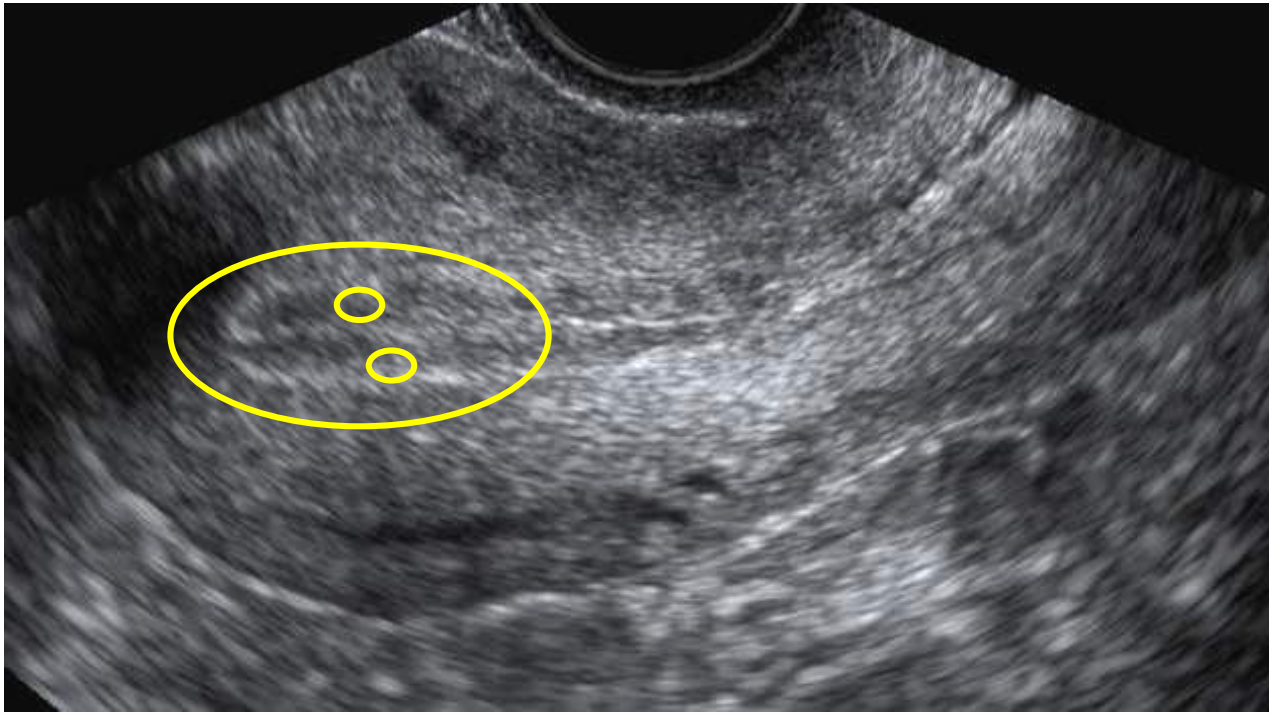
1st evidence of pregnancy on US: completely embedded blastocyst 14d post conception

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



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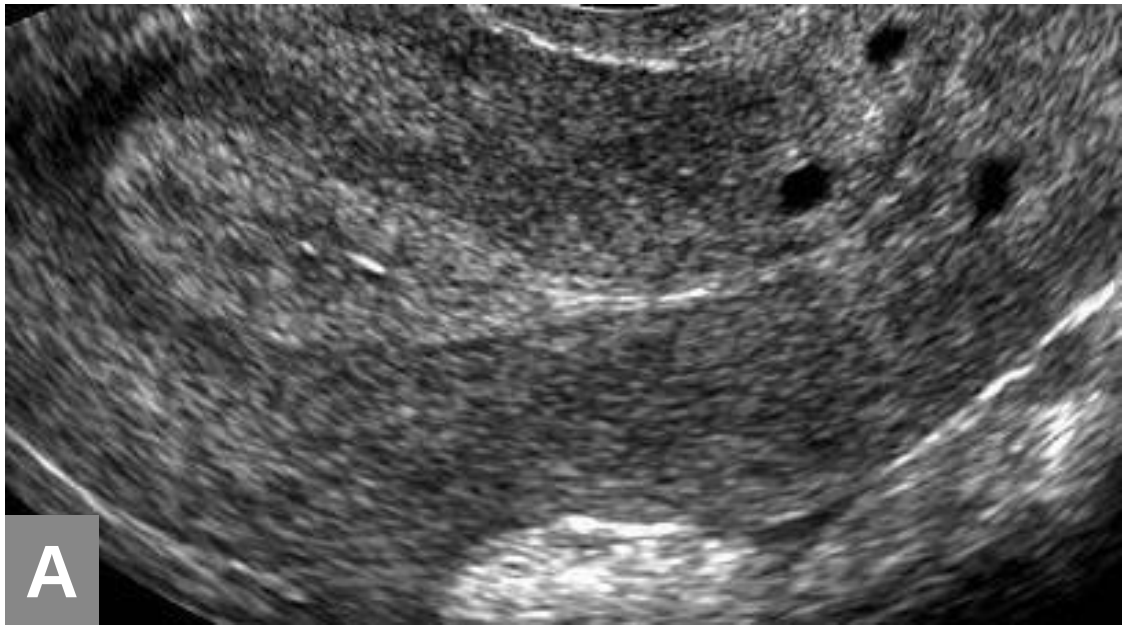
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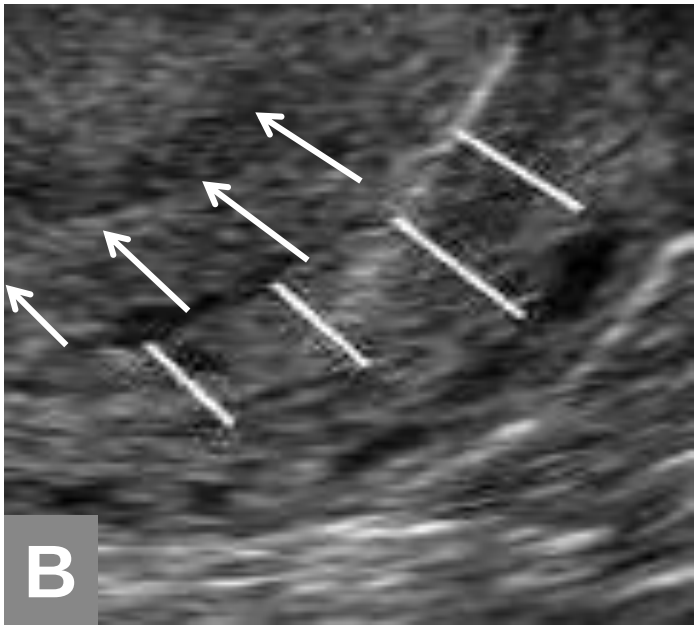
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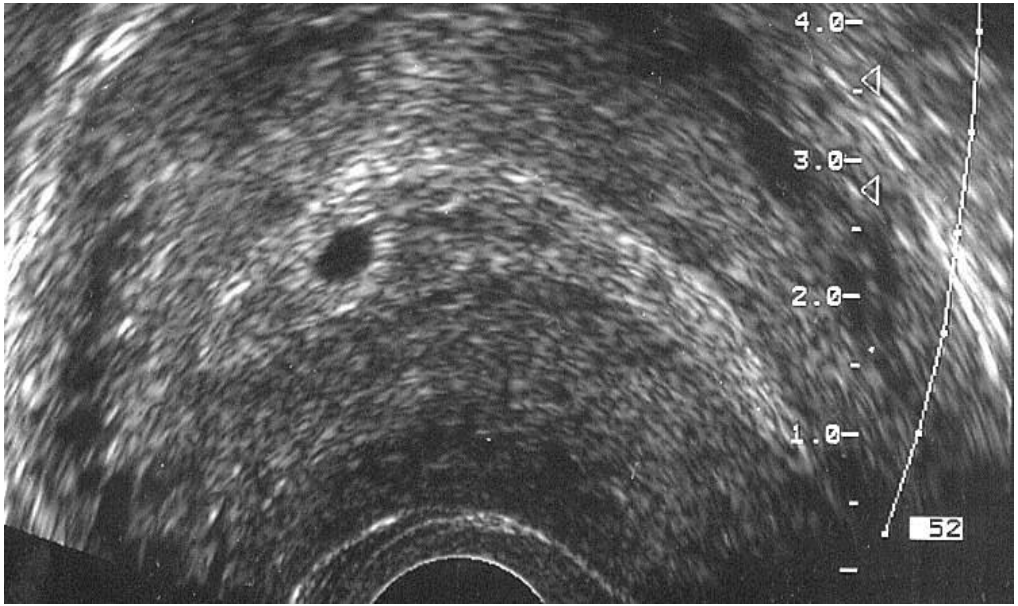
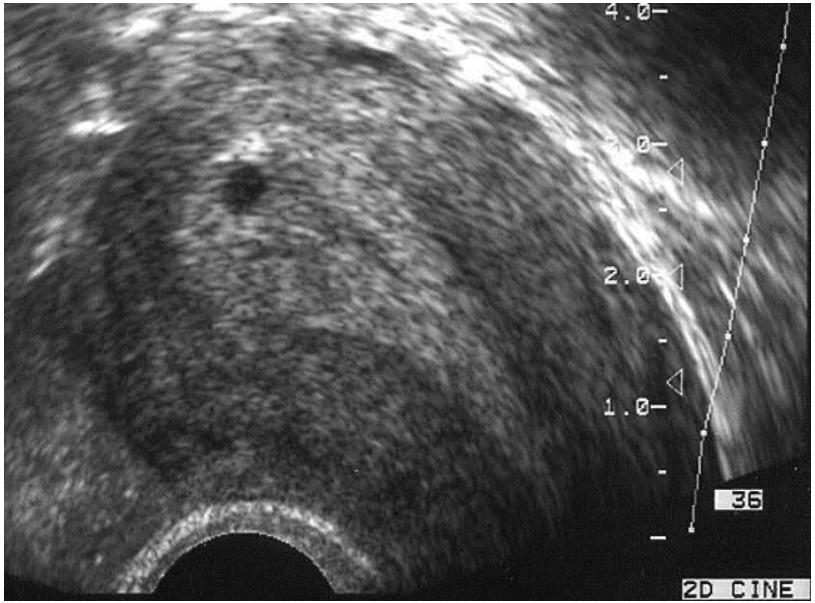
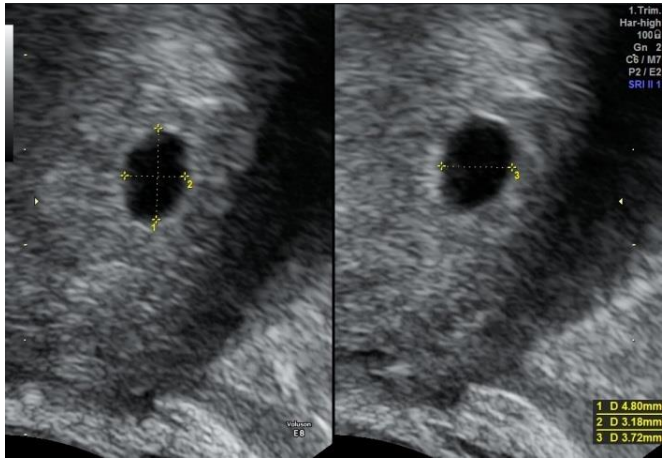
4 weeks – 2 mm



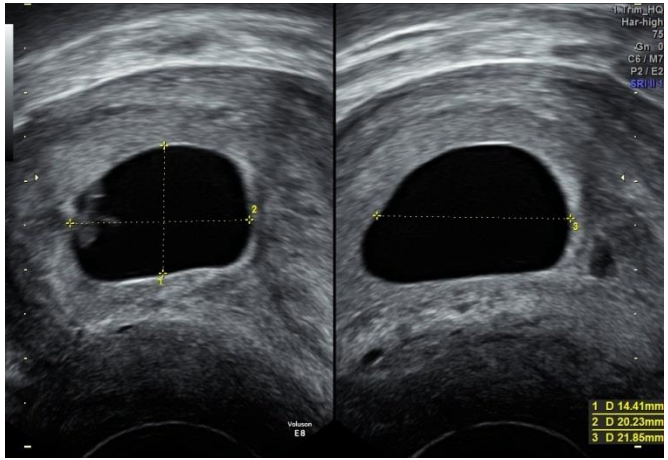


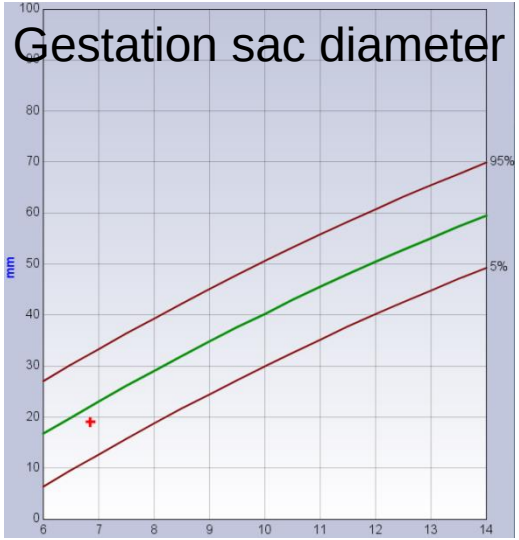
Gestation sac measurement: Mean sac diameter (MSD)

5w4d mean 3.9mm



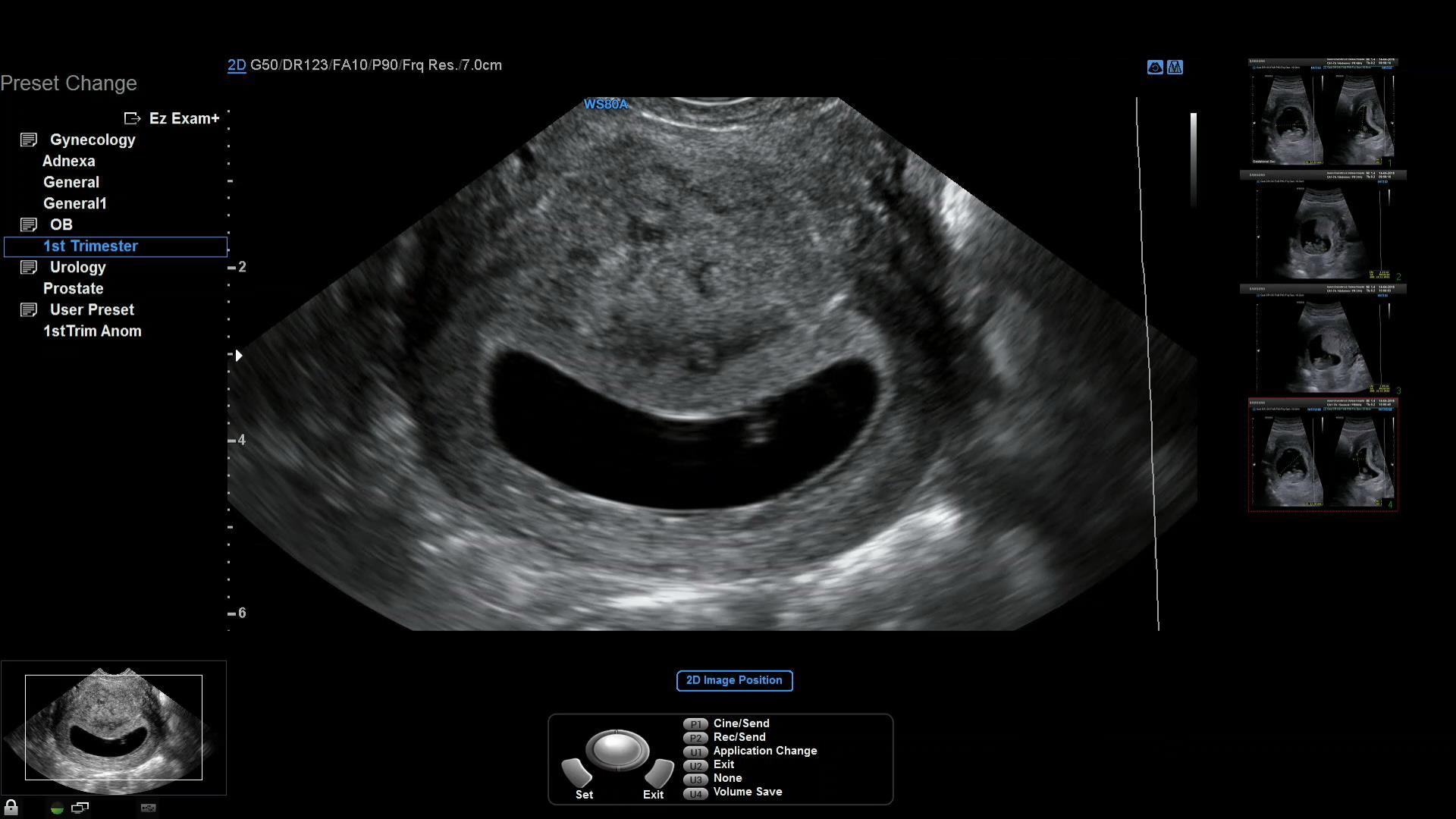
6w4d mean 18.8mm





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

Abdallah et al. Ultrasound Obstet Gynecol. 2011, **38(5)**:503-9
Bottomley et al. Hum Reprod. 2009, **24(2)**:284-90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Urology
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U3 None
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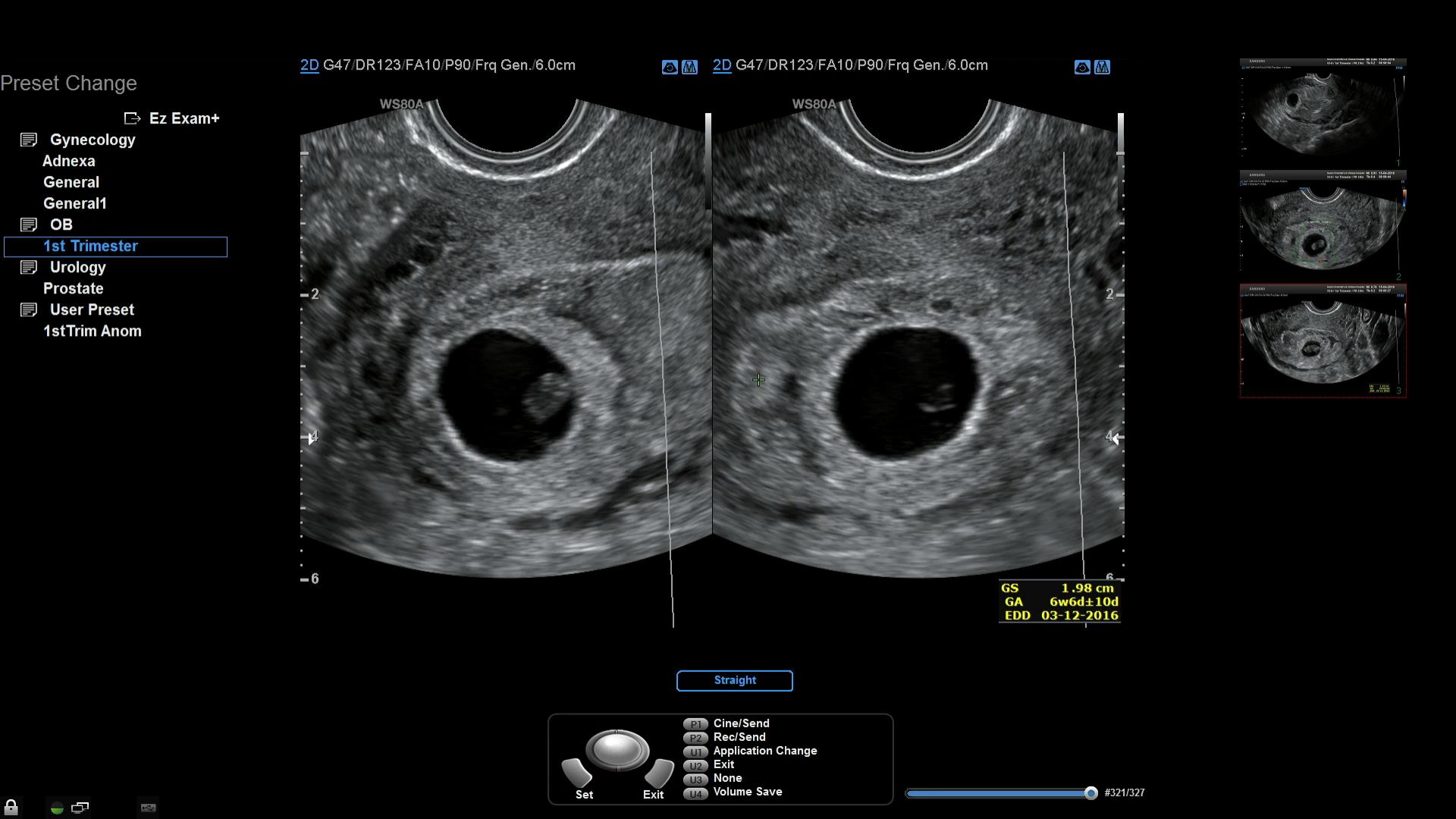
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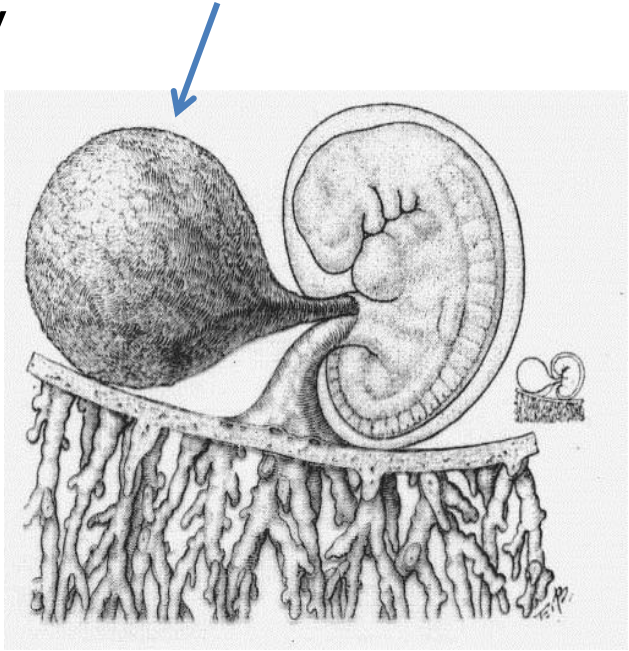
2D G47/DR123/FA10/P90/Frq Gen./6.0cm
WS80A
2D G47/DR123/FA10/P90/Frq Gen./6.0cm
WS80A
GS 1.98 cm
GA 6w6d±10d
EDD 03-12-2016
Straight
Set
Exit
P1 Cine/Send
P2 Rec/Send
U1 Application Change
U2 Exit
U3 None
U4 Volume Save
#321/327

Yolk sac

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

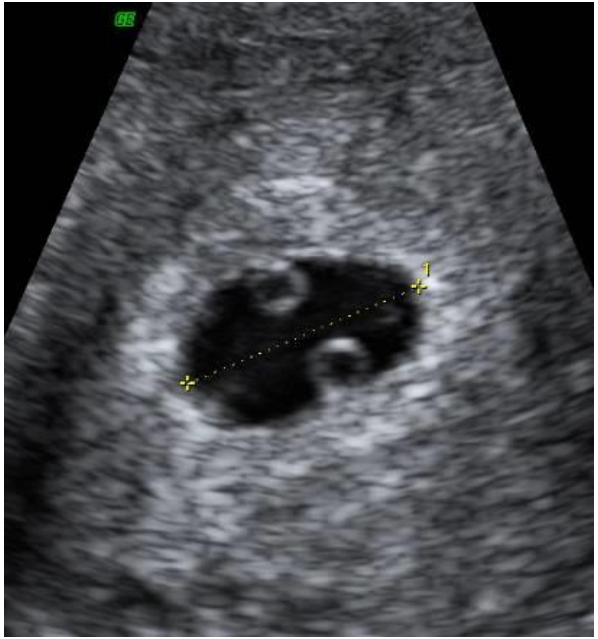


Yolk sac

- 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

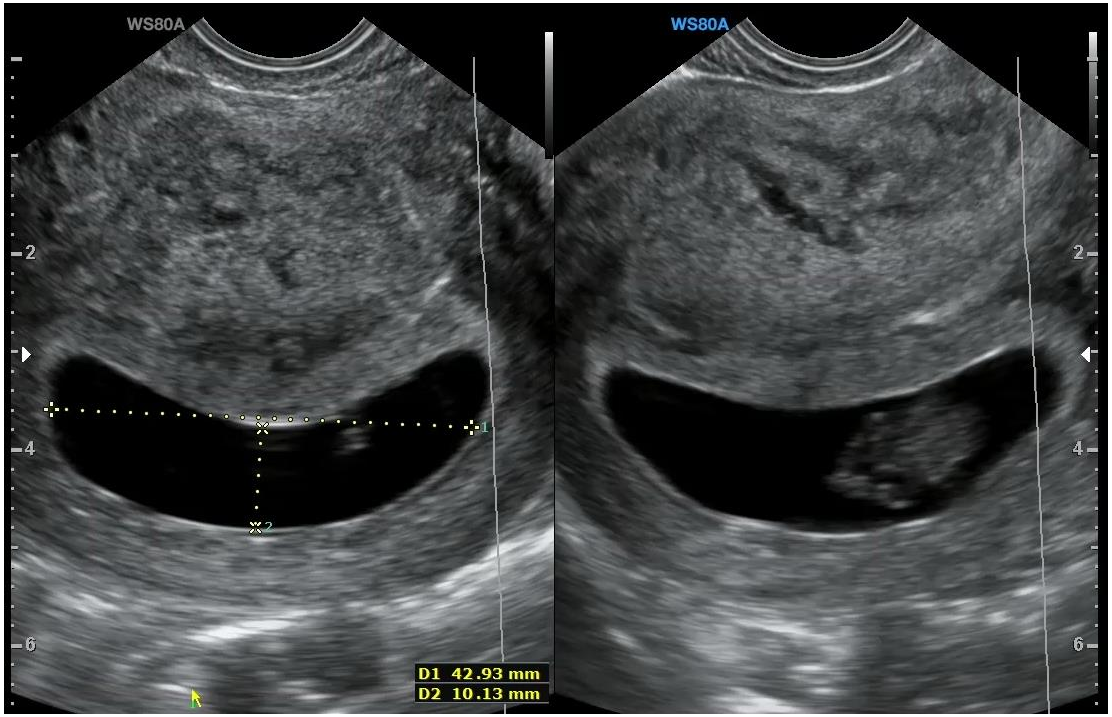
Dichorionic diamniotic



Monochorionic diamniotic

Monochorionic monoamniotic

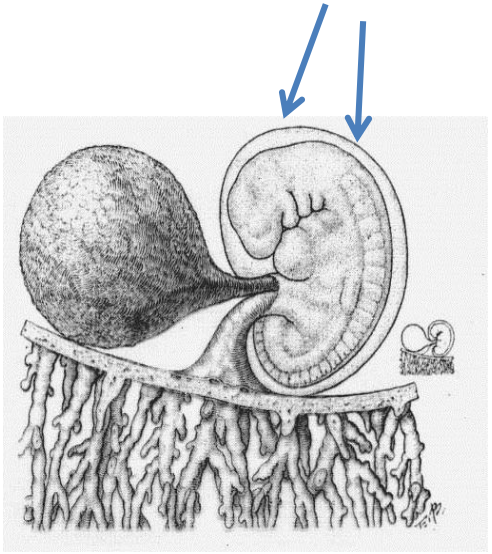
Yolk sac measurement



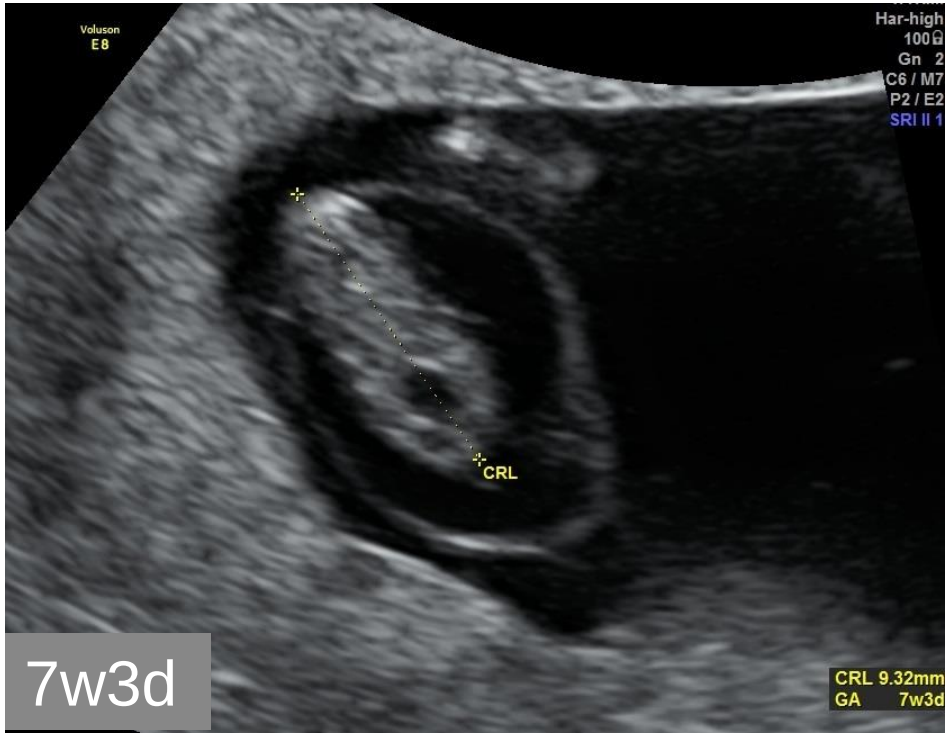
- The yolk sac is measured “inner to inner” with the callipers placed at the inside of the yolk sac wall
- The yolk sac diameter (YSD) is calculated as the average of 3 orthogonal diameters

Amnion

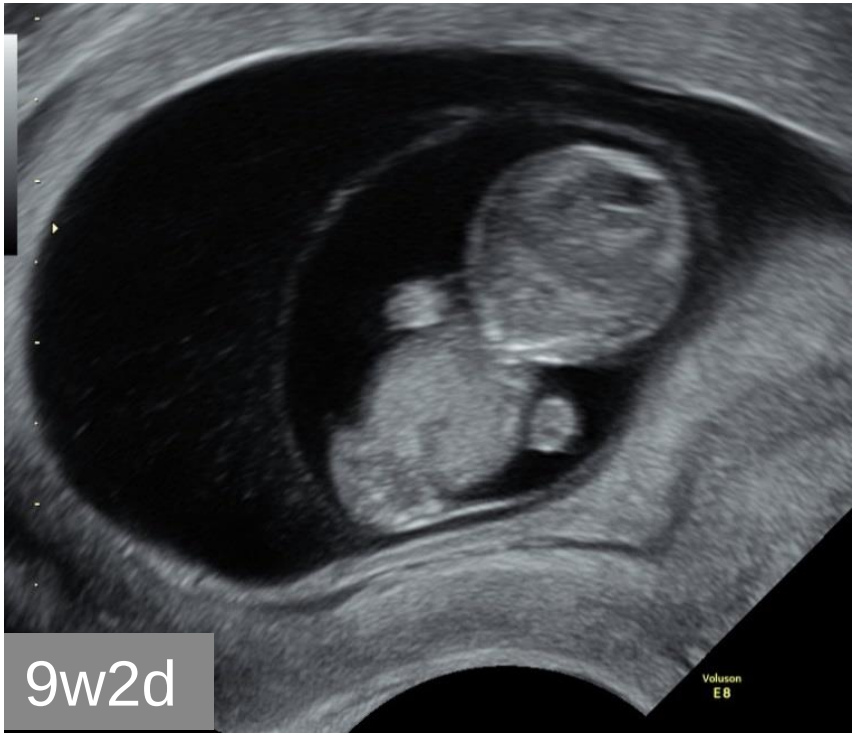
- First seen at aproximately 5.5w – small membranous structure continuous with the embryo
- Contains clear fluid
- Separates the embryo and amniotic space from the extraembryonic coelom
- Obliterates the coelomic cavity by 12-16w



Amnion

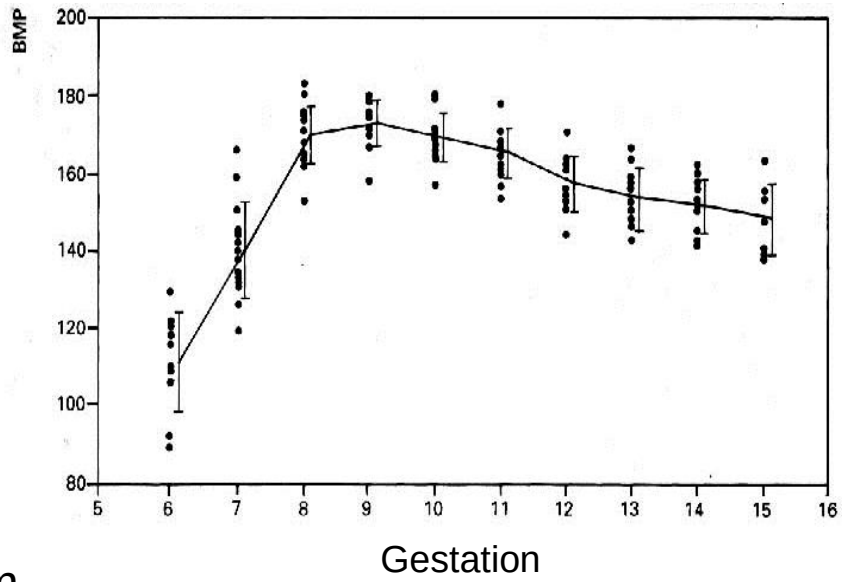


7w3d



9w2d

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:

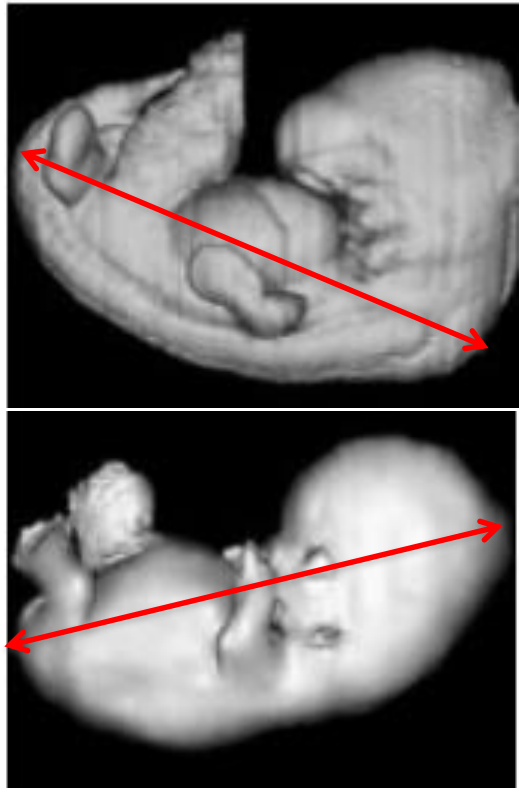
- Midline sagittal section of whole fetus
- Ideal orientation: horizontal
- Magnification: fill most of screen
- Fetus in neutral position
- Endpoints clearly defined

Between 6-9 weeks embryo = hyperflexed

Use neck-rump length instead of CRL

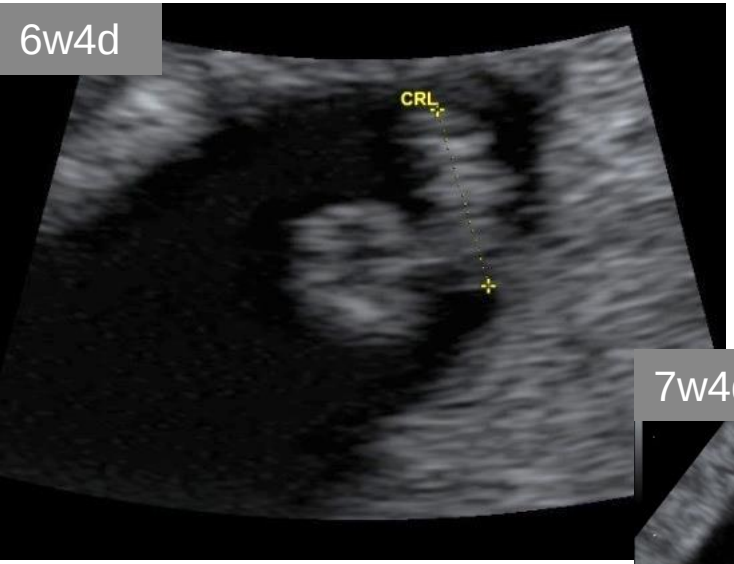
NRL

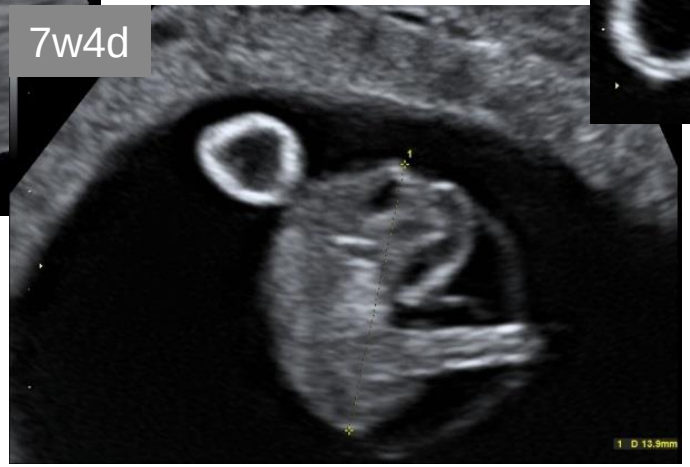
CRL

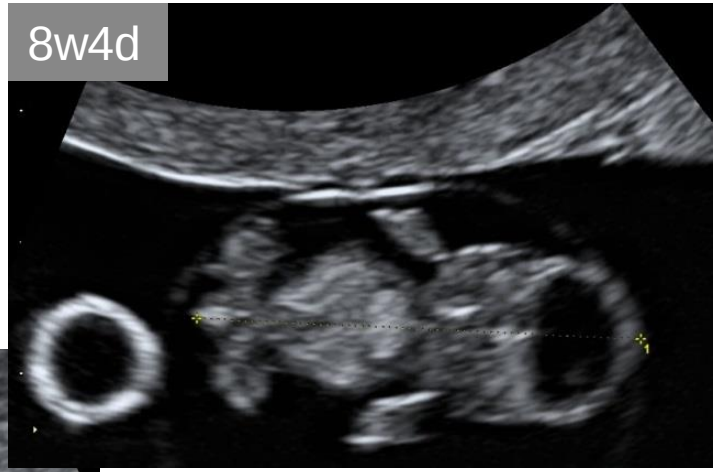


ISUOG Practice Guidelines: performance of first-trimester fetal ultrasound scan UOG, 2013, **41**:102-113

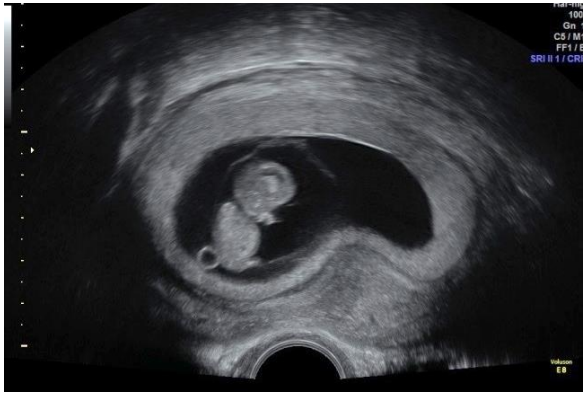
Embryo 6-8 weeks

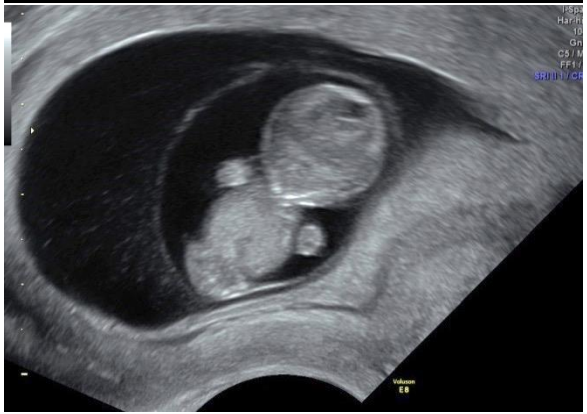




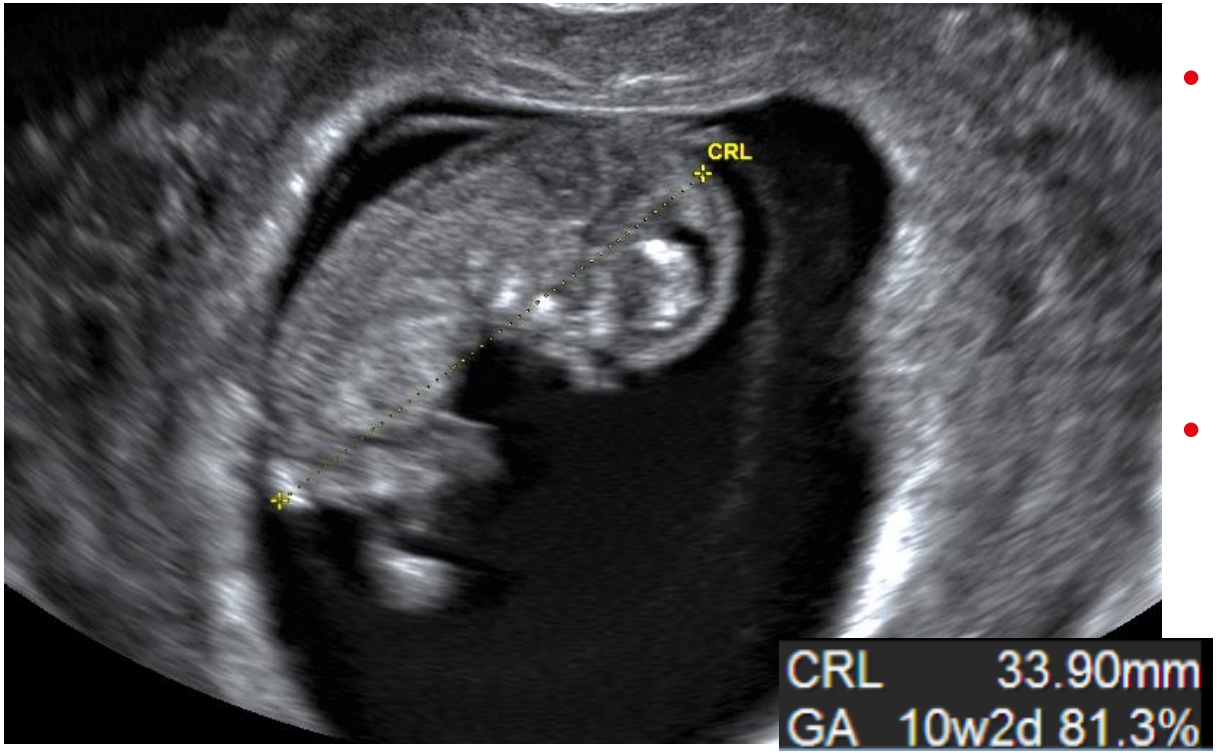


9 weeks 4 day embryos





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

Pexsters et al. Ultrasound Obstet Gynecol. 2010, **35(6)**:650-5

Summary

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

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

Lets move onto symptoms..

Pain and blood loss in early pregnancy

Event	Frequency
Pain & vaginal bleeding	1:5 pregnant women
Blood loss	50% continue into normal pregnancy

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**

Bottomley C et al. Ultrasound Obstet Gynecol. 2011, **37(5)**:588-95
Ayim et al. Ultrasound Obstet Gynecol 2016, **48(5)**:656-662

Terminology: early pregnancy events 1

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

Preisler J et al. BMJ. 2015, **23**: 351

Terminology: early pregnancy events 2

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

Kirk E, Bottomley C, Bourne T. Hum Reprod Update. 2014, **20(2)**:250-61

Miscarriage

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

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

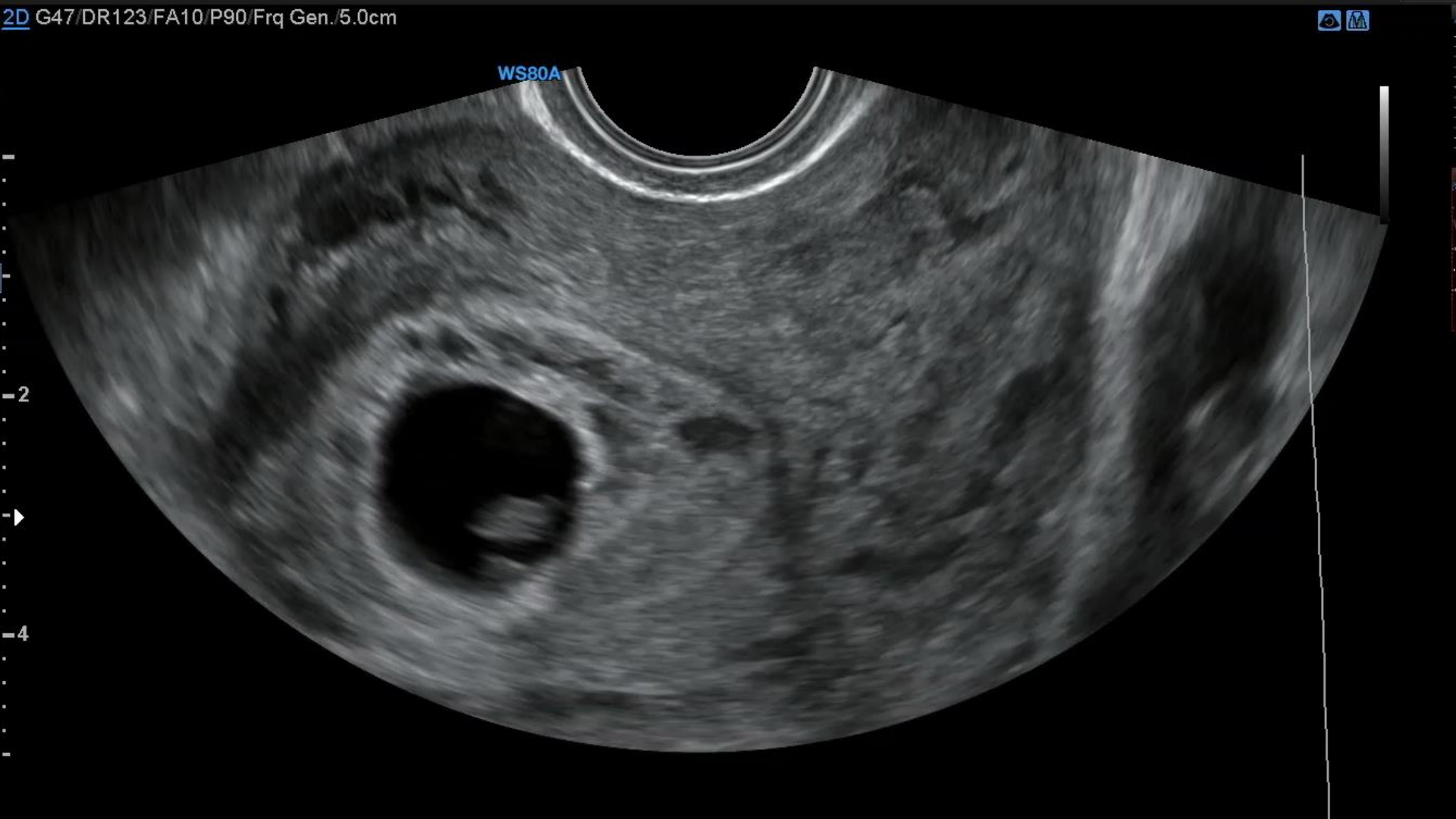
Initial scan

Features diagnostic of a miscarriage on transvaginal* scanning:

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

Preisler J et al. BMJ. 2015, **23**: 351; Abdallah Y et al. UOG, 2011, **38(5)**: 497-502.


2D G47/DR123/FA10/P90/Frq Gen./5.0cm
WS80A
2
4

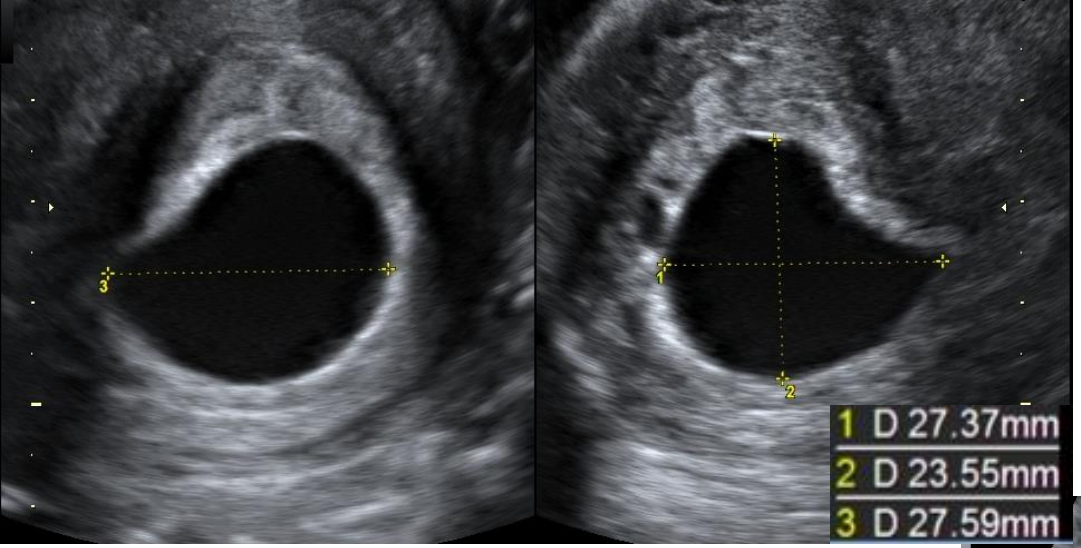
Scan repeated at interval

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

- No embryo with fetal heart activity ≥**14 days** after a scan that showed a gestational sac without a yolk sac
- No embryo with fetal heart activity **≥11 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 ≥12mm 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

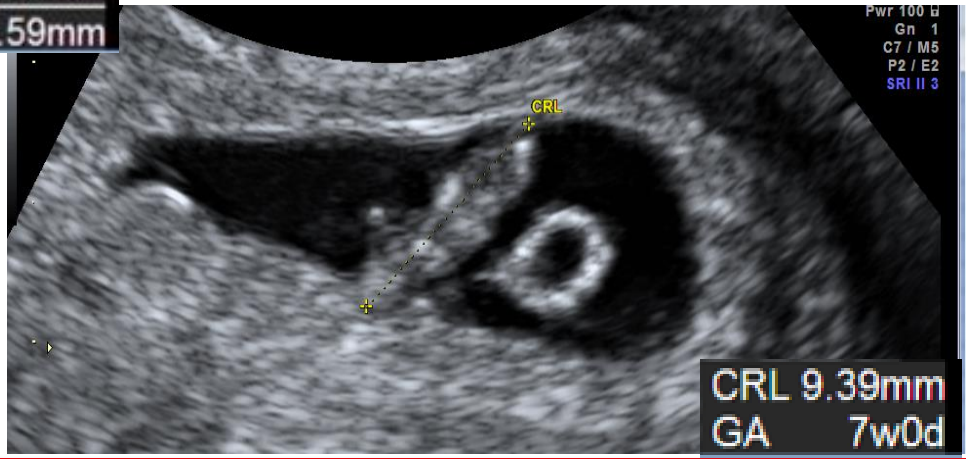
Preisler J et al. BMJ. 2015, **23**: 351; Doubilet et al NEJM 2013, **369**:1443-51.

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

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Discordant growth	Enlarged yolk sac >7mm Empty amnion sign <5mm difference between MSD and CRL

Doubilet et al NEJM 2013, **369**:1443-51

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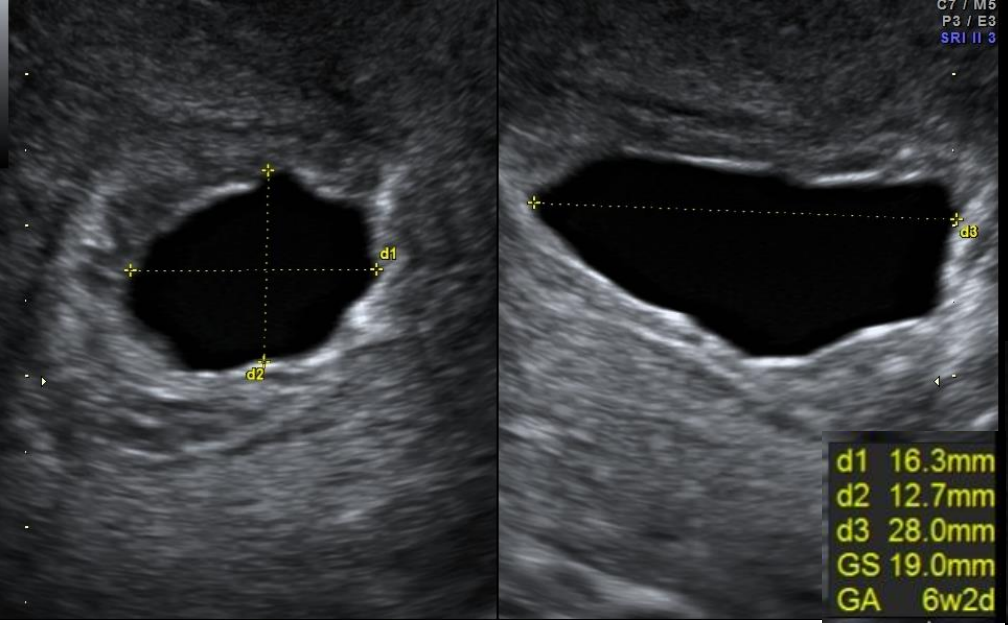
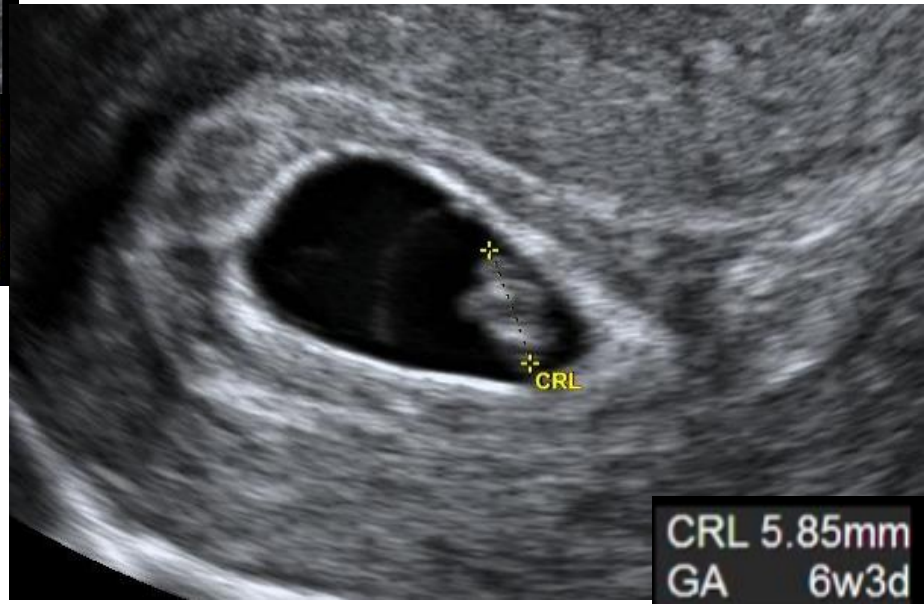
Discordant growth	Enlarged yolk sac >7mm Empty amnion sign <5mm difference between MSD and CRL
Other concerning features	GS low in cavity (NB care to exclude cervical or C/S scar ectopic) Irregular outline to GS Subchorionic haematoma

Intrauterine pregnancy of uncertain viability

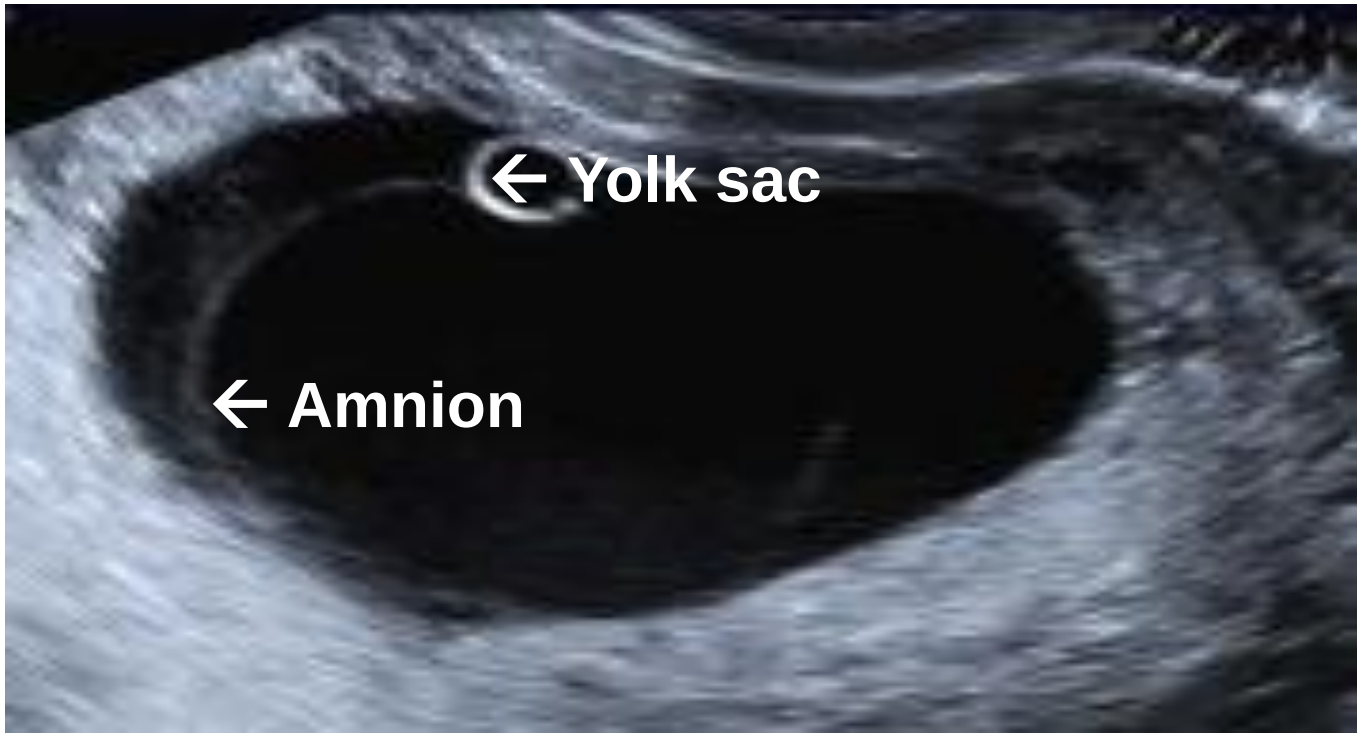
<7mm



<25mm

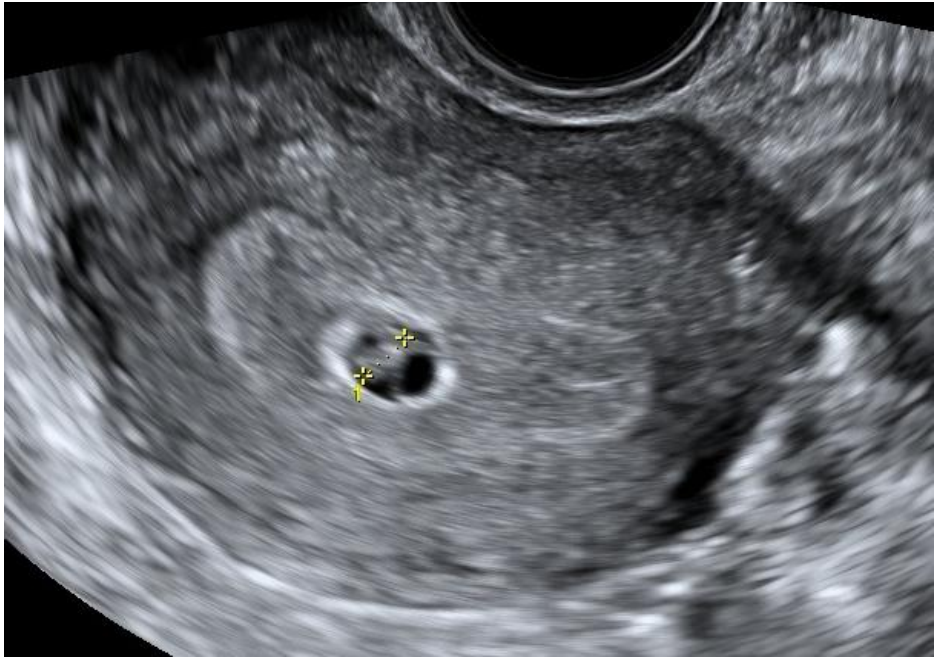


IPUV: empty amniontic cavity sign – ***not diagnostic***

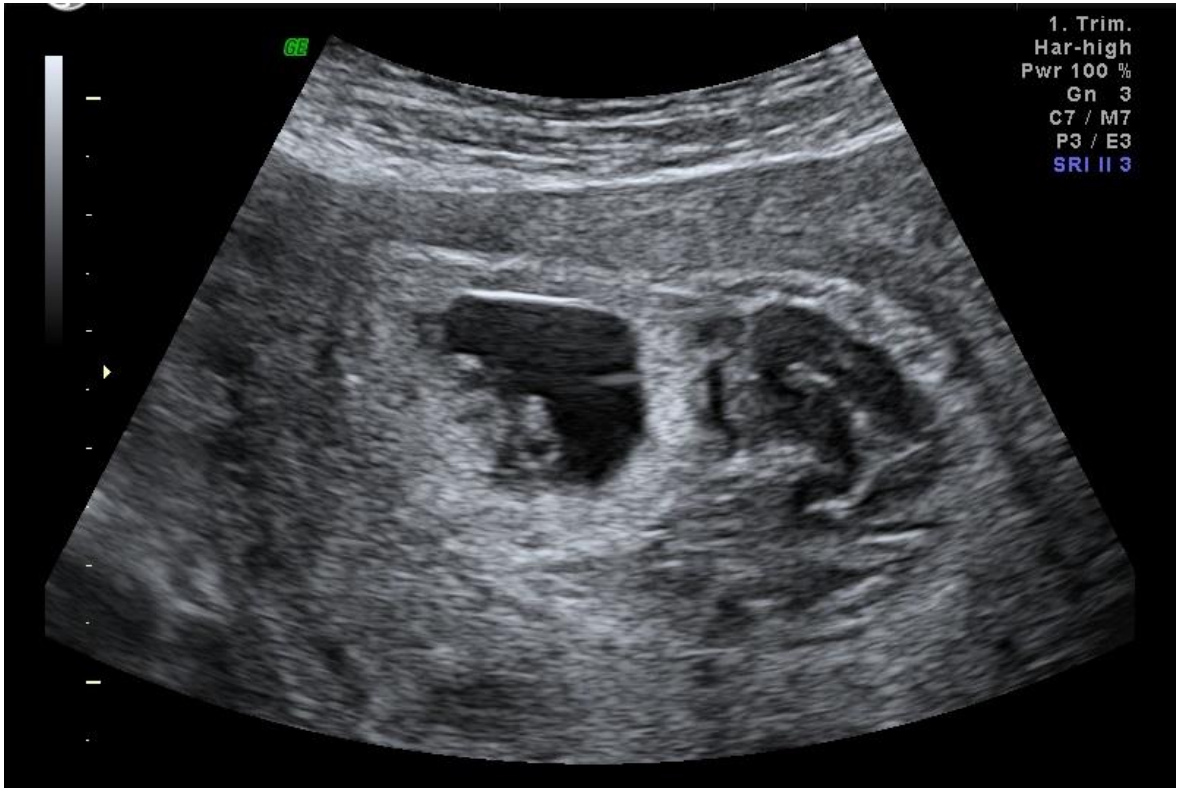


Intrauterine pregnancy of uncertain viability

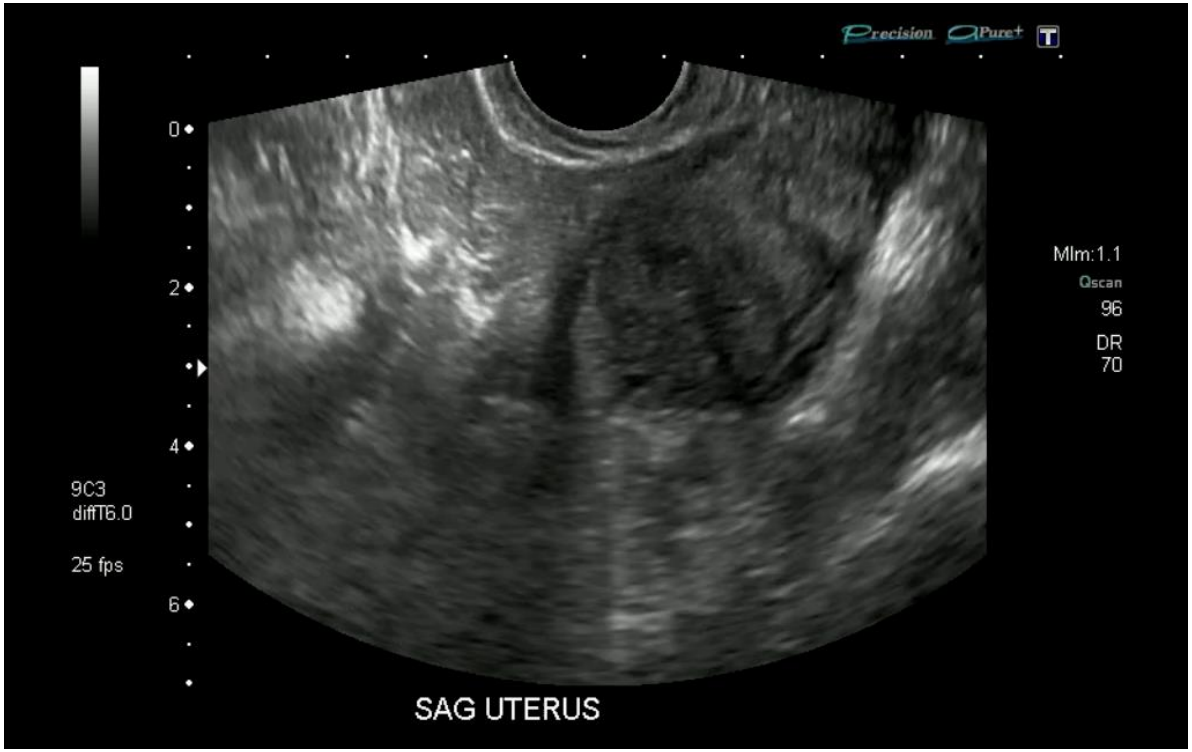
Small gestation sac in relation to embryo:
<5.0mm difference between CRL and MSD



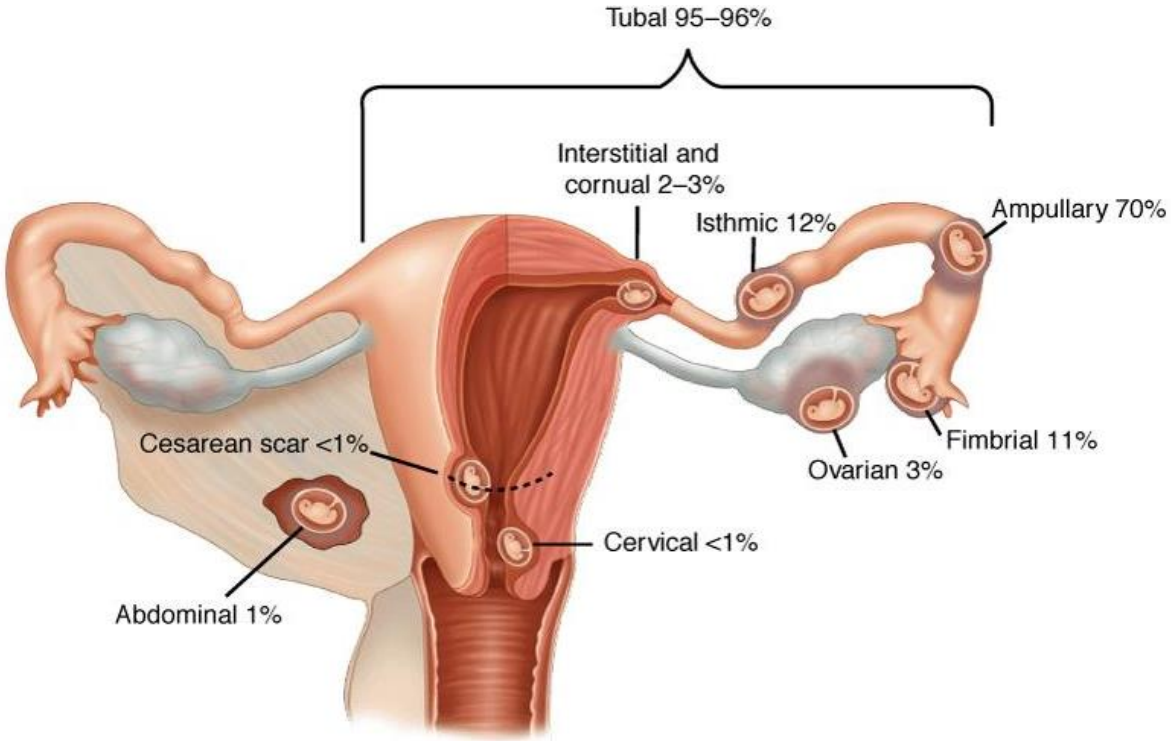
Subchorionic haematoma



Subchorionic haematoma



Ectopic pregnancy

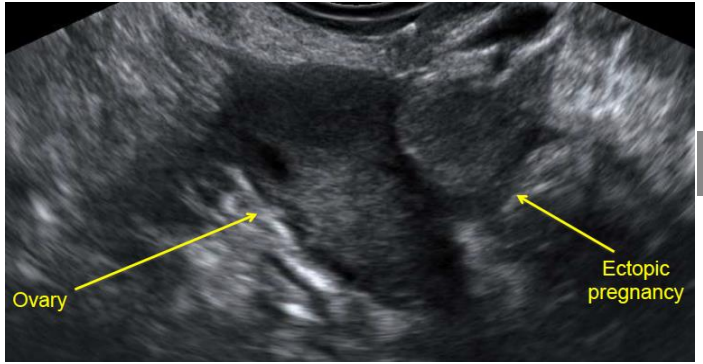


Ectopic pregnancy

Sonographic findings	% of ectopics seen on US
Inhomogenous adnexal mass ('blob sign')	60%
Empty extrauterine gestation sac ('bagel sign')	20%
Extrauterine GS +/- YS +/- embryo +/- fetal cardiac activity	20%

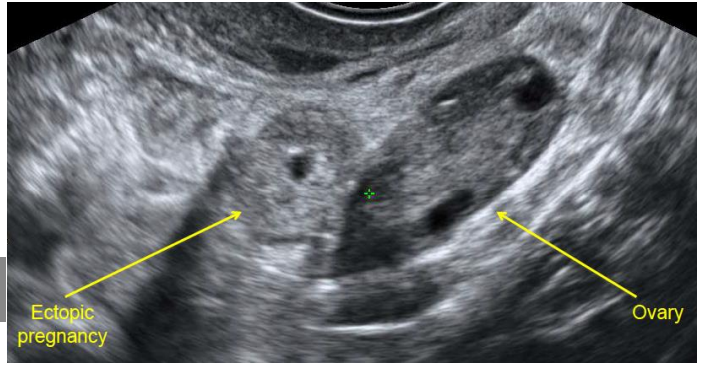
Kirk E et al, Hum Reprod. 2007, **22(11)**:2824-8

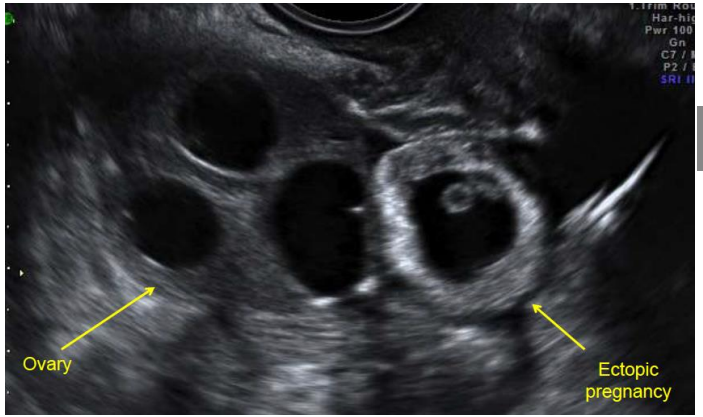
Ectopic pregnancy



‘Blob’ sign

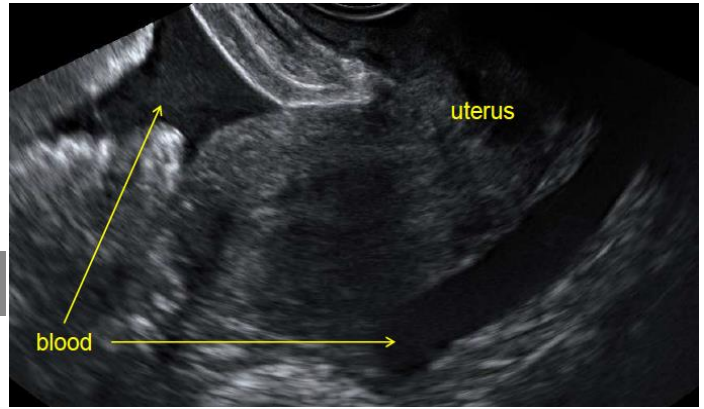
‘Bagel’ sign



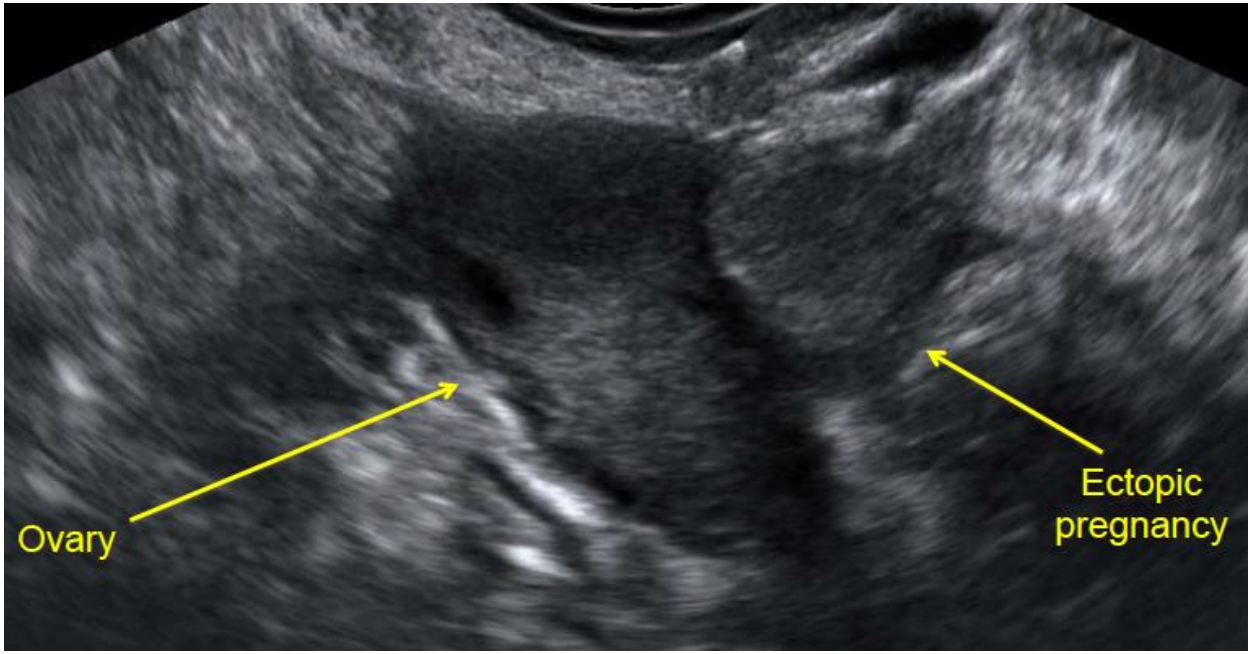


GS & YS +/- FHR

Haemoperitoneum

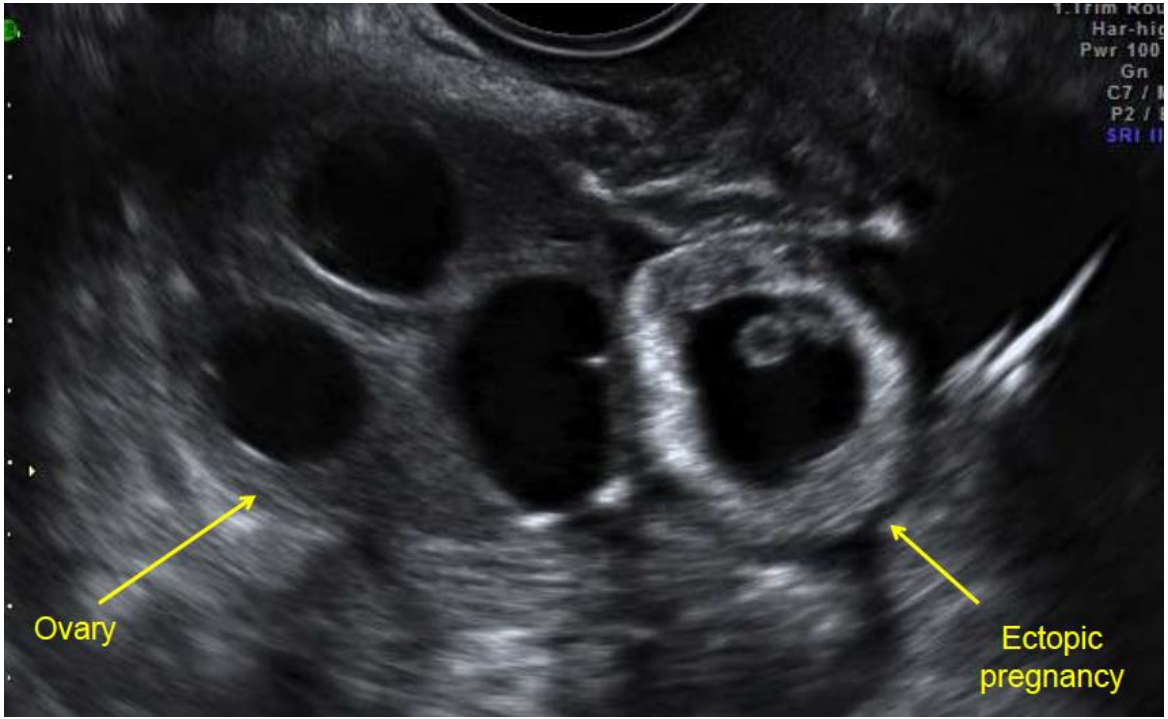


Ectopic pregnancy: Blob sign



Ectopic pregnancy: Bagel Sign

Ectopic pregnancy: GS & YS +/- FHR



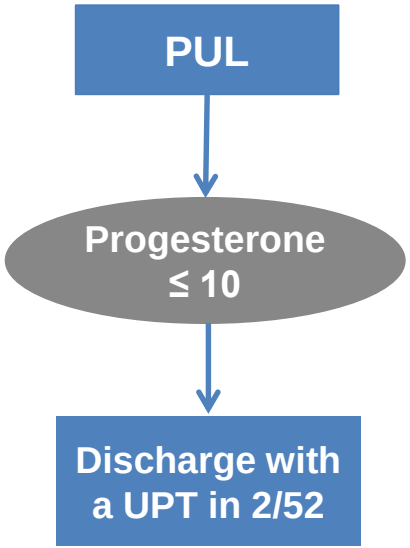
Ectopic pregnancy: haemoperitoneum

Ectopic pregnancy: management

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

Kirk E et al, HRUpdate. 2014, **20(2)**:250-61. Kirk E et al, Hum Reprod, 2007.

Management protocols: Pregnancy of Unknown Location (PUL)



hCG 48 hours/ hCG 0 hours

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

M4 model
(logistic regression)

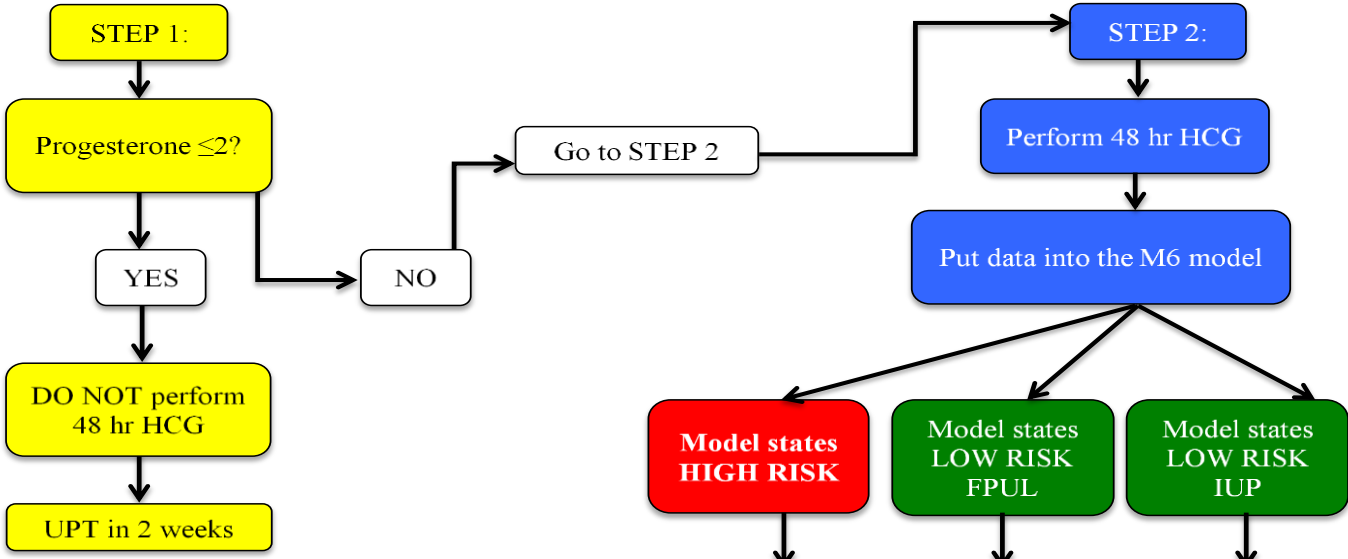
- Initial hCG
- hCG ratio

Bobdiwala S. et al. Hum Reprod. 2016, **31(7)**:1425-35.

Management protocols: Pregnancy of Unknown Location (PUL)

M6 model

- Initial hCG
- Initial progesterone
- hCG ratio

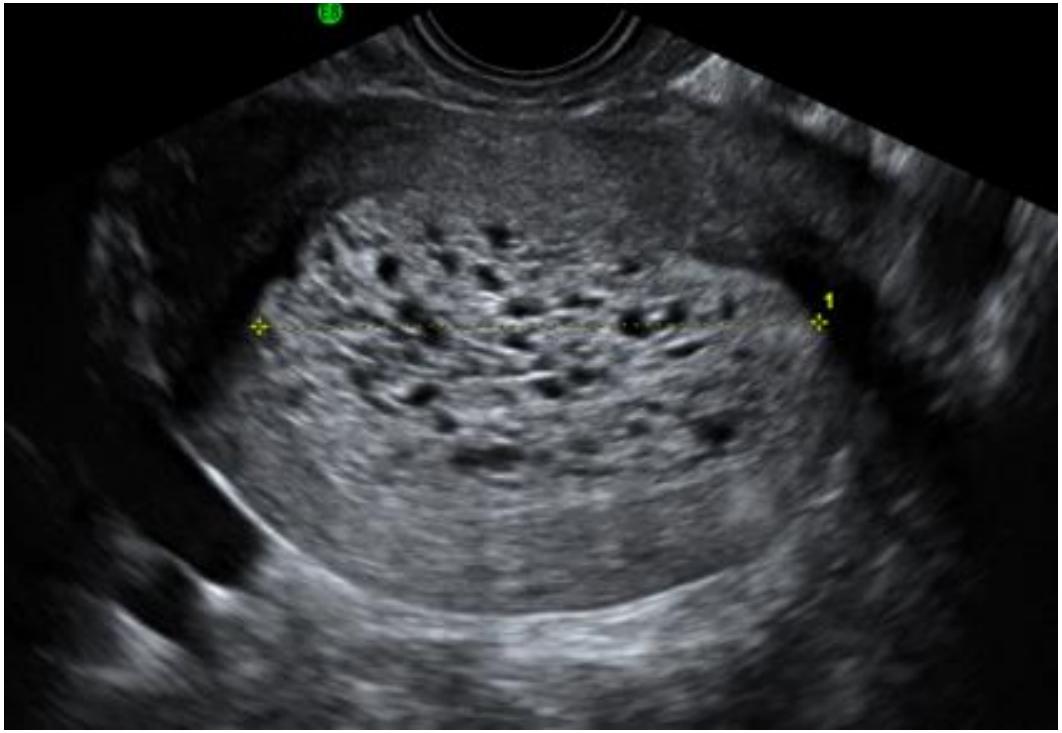


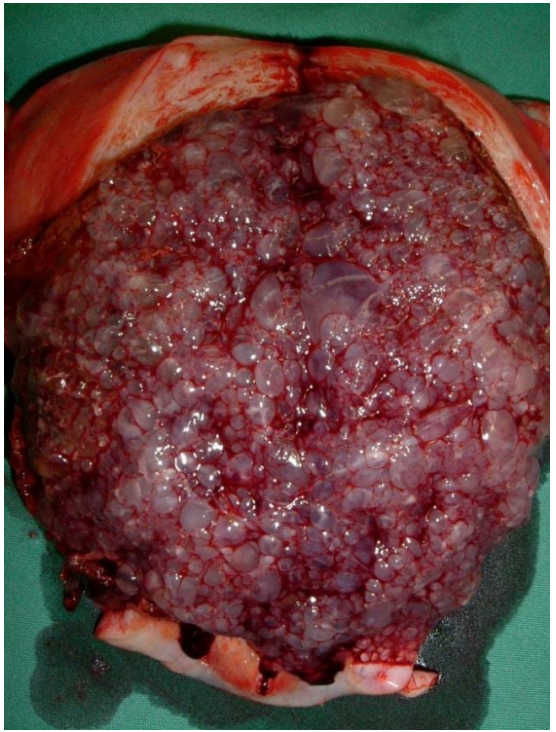
App: search 'early pregnancy Leuven' in the app store

Free website: www.earlypregnancycare.com/m6

Van Calster B. et al UOG, 2016, **48(5)**:642-649

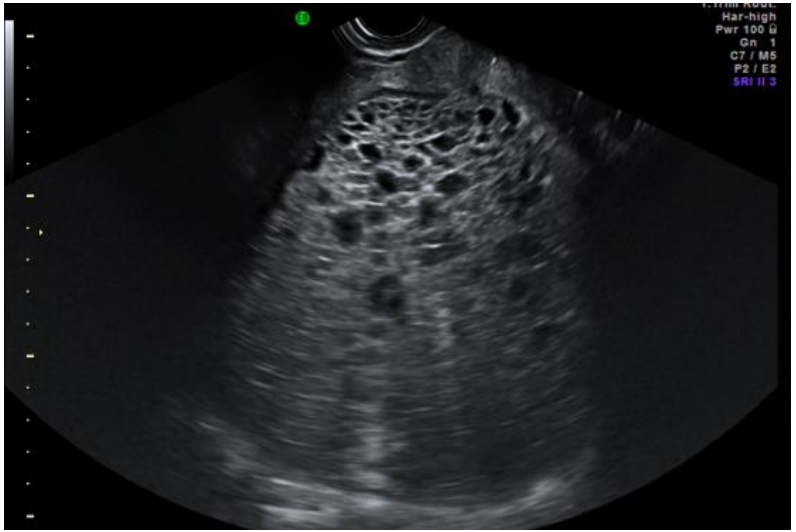
Hydatiform mole





Incidence = 1:1500 pregnancies

Hydatiform mole

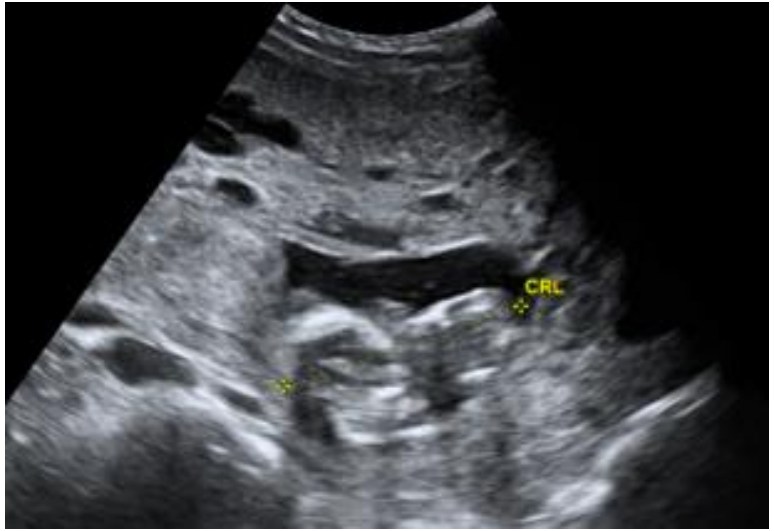


Complete

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

Kirk E et al. Ultrasound Obstet Gynecol. 2007;29(1):70-5

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