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Section 1: Knobology (Understanding the machine) and safety of ultrasonography

The ultrasound imaging investigation plays an important role in the diagnosis and monitoring of several diseases in various clinical areas, especially in the gynaecology and obstetrics. Its advantages of being portable, safe and relatively cheaper make the ultrasound imaging even more appropriate for the examination of the foetus and the mother.

1. MACHINE BASICS



A. Transducers

The device attached to the machine and used on the patient is called **transducer** (or probe) which basic function is to produce sound waves and receive echoes. There are different types of transducer based on the shape, size and frequency. The field, depth and resolution of an image is greatly impacted by the type of the transducer.

For the obstetrical imaging study, the ultrasound machine should have at least the abdominal transducer. The other probe which may be used is the transvaginal probe, especially in the early pregnancy.

TYPE	SHAPE	FREQUENCY
Abdominal	Curvilinear	3.5 – 7 MHz (Low)
Vaginal	Curvilinear (90 – 180°)	5 – 12 MHz (High)

The main advantage of the transvaginal transducer is the close contact with the structures under evaluation which provides higher resolution images and accurate anatomy compared to the transabdominal transducer.

B. Control Panel Operating Area



① Power/running indicator lights	② Power on/off key	③ Acoustic power adjusting knob and TGC sliders
④ PC keyboard	⑤ Function controls	

To operate the machine, there is a panel with buttons and knobs for various functions such as:

- **Powering on/off** the machine
- The multi-function **knob Depth/Zoom**: this selection determines how far into the body from the skin/probe is displayed on the screen (Depth). By pressing twice, it switches to Zoom function.
- The **Gain** : influences the overall brightness of the image.
- The **Freeze** : this option allows to stop on an image the operator judges useful and to be saved (**Save**)/printed(**P1/P2**).

- **Measure, Caliper:** useful for measurements of the structures of interest. The measurement can be updated (**Update**) before validating the value and saving the image.
- **ABC/Comment:** important for adding annotations either from the list on the screen or by typing on the keyboard.
- **BodyMark:** indicate the examine position and the scan direction.
- **Set:** to confirm the selection of a specific function or command. Used also to anchor calipers, select a menu item or image graphic.
- **Clear:** serves to delete from the screen the last or all measurements/annotations done.
- **Probe:** selection of a connected probe.
- **TGC sliders :** Glide the slide controls to adjust the TGC (Time Gain Control).

C. Ultrasound Modes

- **B-Mode (Brightness mode):** Commonly used mode which displays anatomy in different shades of grey on a 2D image.
- **M-Mode (Motion mode):** in addition to the B-Mode, it displays movement as it is related to time. One application of the M-Mode is to assess the foetal cardiac activity.
- **Doppler Mode:** used for the detection of blood flow, its direction and velocity.



2. Safety Concerns and Infection prevention

- While the ultrasound is generally safe for use in children and foetal imaging, there are few safety concerns to know regarding the first trimester of pregnancy.
- High sound energies, such the one produced in Color Doppler Studies, have the potential of chromosome damage by heat deposition in tissues when the ultrasound

is aimed to the embryo. That is the reason the M-Mode is preferred to the Doppler Mode to document the foetal cardiac rate.

- The transducers must be cleaned after every use and the exterior of the ultrasound machine should be cleaned at least at the end of each working day because they are potential source of microbial transmission.
- Specific products such Hexanios and Surfanios are used for cleaning the probes and the exterior of the machine, respectively. Alcohol, oil or any other fluids should never be used as they can damage the transducers.

Section 2: Introduction to Ultrasound Scanning in First Trimester

First Trimester Pregnancy: the period of pregnancy extending from conception up to 13 weeks and 6 days of gestation

The introduction of transvaginal ultrasound and quantitative serum β -hCG testing since the 1980s has significantly improved early pregnancy diagnosis and contributed to more than a 50% reduction in ectopic pregnancy–related maternal mortality through earlier detection and timely management. This reduction is largely attributed to:

- Earlier diagnosis using transvaginal ultrasound
- Quantitative β -hCG monitoring
- Earlier detection of ectopic pregnancy before rupture
- Improved medical management (e.g., methotrexate)
- Advances in minimally invasive surgery

Role of Ultrasound and β -hCG

- Pelvic ultrasound and serum β -hCG testing are fundamental tools in early pregnancy evaluation. They help diagnose pregnancy and guide management of early pregnancy complications.
- Serial β -hCG measurements and follow-up ultrasound are often needed in uncertain cases.
- In proly stable patients, avoid diagnosing ectopic pregnancy or pregnancy failure based on one scan alone.

Preferred Imaging Technique

- Endovaginal (transvaginal-Frequency 7-14MHz) ultrasound is the primary imaging method in early pregnancy.
- Transabdominal ultrasound (Frequency 3-5MHz) is complementary and useful for:
 - ✓ Adnexal masses located high in the pelvis
 - ✓ Assessment of free intraperitoneal fluid

The main Objectives of Ultrasound and β -hCG is to differentiate:

- To recognize Normal and abnormal findings in First Trimester
- To identify patients requiring urgent referral or further evaluation

Specific Goals

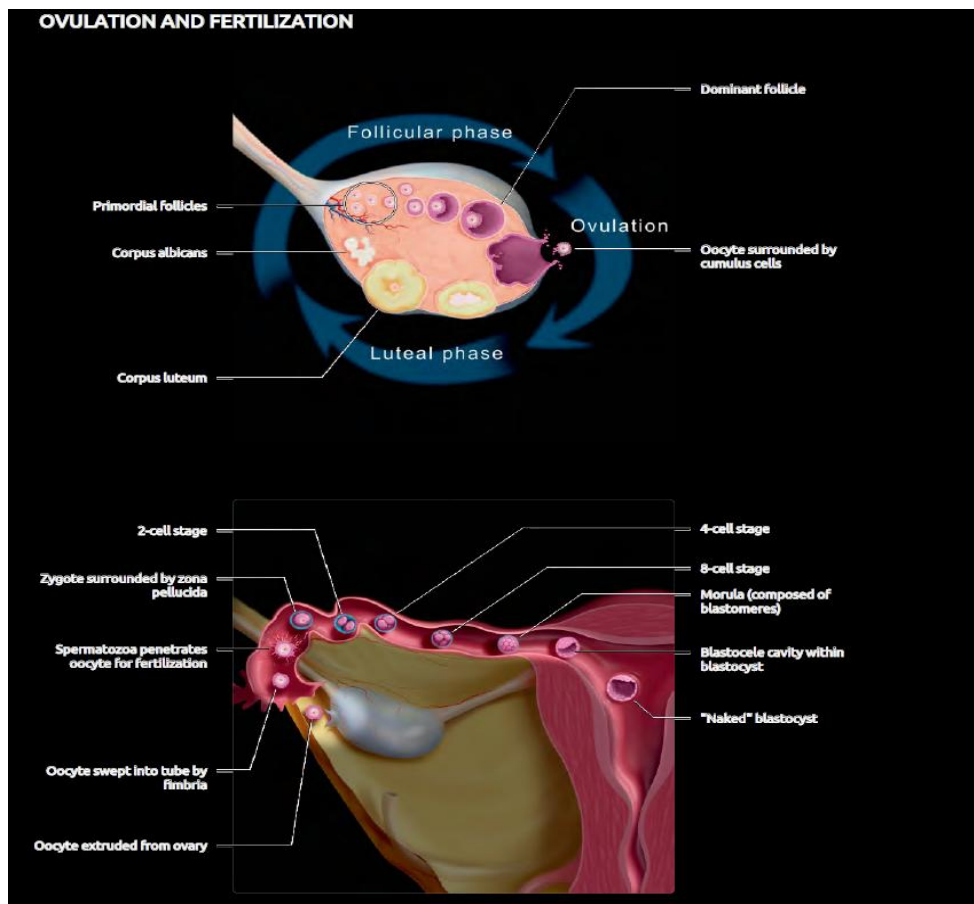
- To confirm the occurrence of normal pregnancy
- To assess the normal appearance gestational sac (GS), yolk sac (YS) and embryo
- Assessment of mean sac diameter (MSD) and CRL
- Analyzing viability criteria and terminology in non-viable pregnancy
- Recognition of ectopic, principles of pregnancy of unknown location (PUL)

- Understand and analyze the role Beta-hCG and management of PUL
- Understand indicators of poor prognosis in early pregnancy
- Evaluate causes of first trimester bleeding like Molar pregnancy
- Avoid inadvertent harm to potentially viable pregnancies

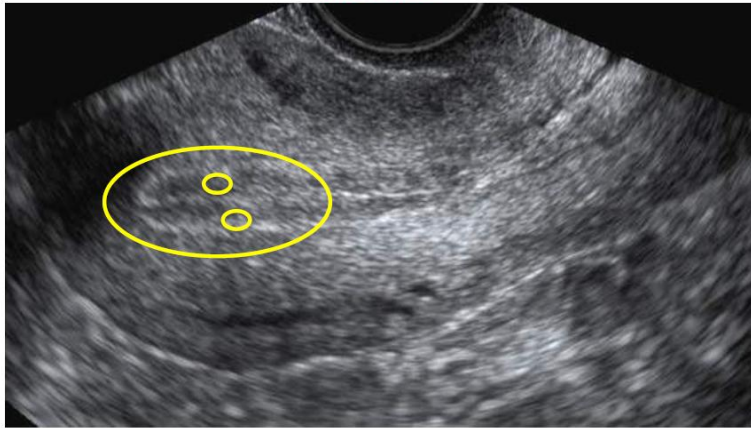
Table 1: Timeline of Normal Early Pregnancy Development

Time Period	Developmental Milestone (Threshold)
Week 0	Patient has last menstrual period
Week 2	Conception occurs
Week 4.5–5.0	Gestational sac appears
Week 5.0–5.5	Yolk sac appears
Week 6.0	Embryo appears; cardiac pulsation begins, with lower limit of 100 beats/min
Week 6.5–7.0	Amniotic membrane appears; cardiac pulsation lower limit is 120 beats/min
Week 7–8	Spine develops
Week 8	Head curvature separates from the body; four limb buds appear
Week 8.0–8.5	Intrinsic motion of the embryo occurs
Weeks 8–10	Rhombencephalon develop

Ovulation and fertilization



Location of gestational sac within upper half of uterus



Basic Training

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Figure 2: Ultrasound illustration related to Slide 12

Interdecadal sac sign: 4-4.5 weeks

INTRADECIDUAL SAC SIGN

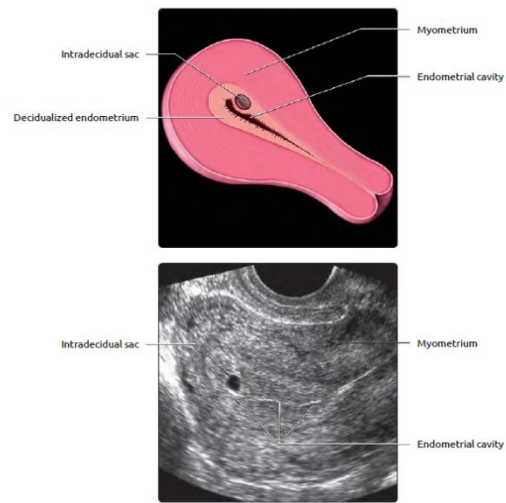


Figure 3: Ultrasound illustration related to Intradecidual sac sign (4-4.5wks).

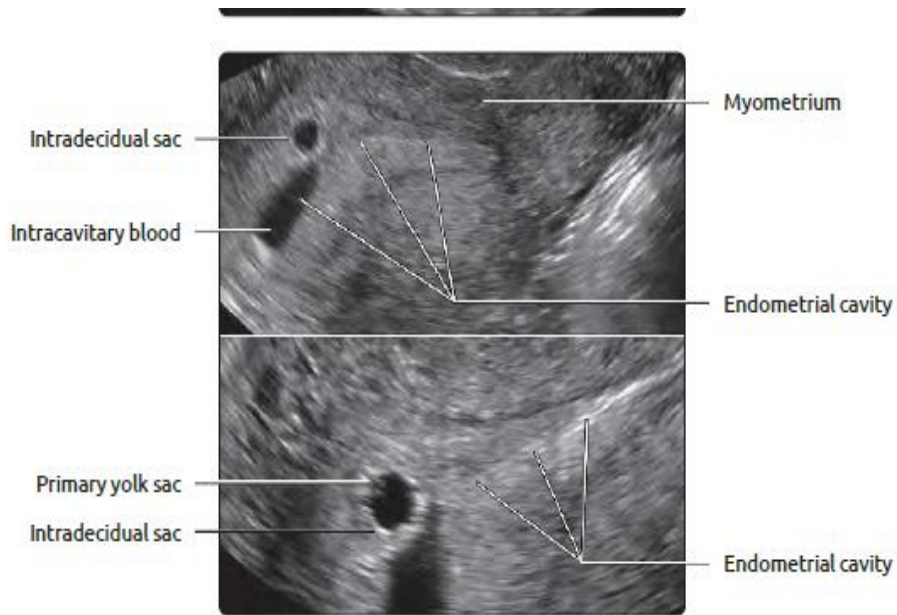


Figure 5 and 6: Ultrasound illustration related to Intradecidual sac sign (4-4.5wks)

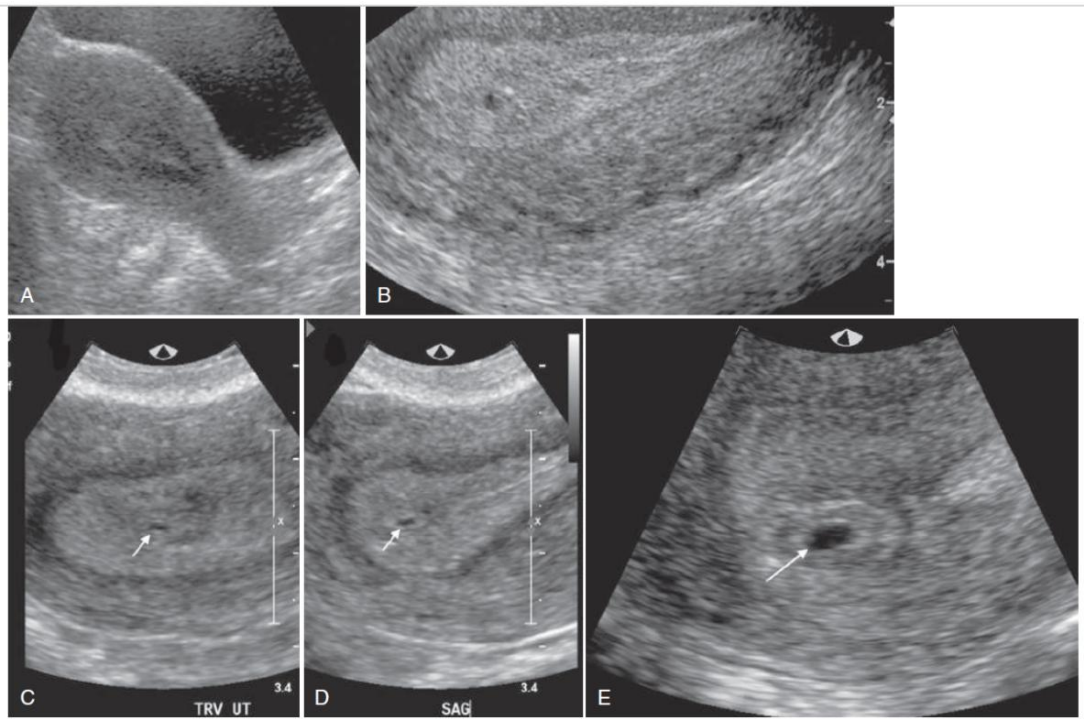
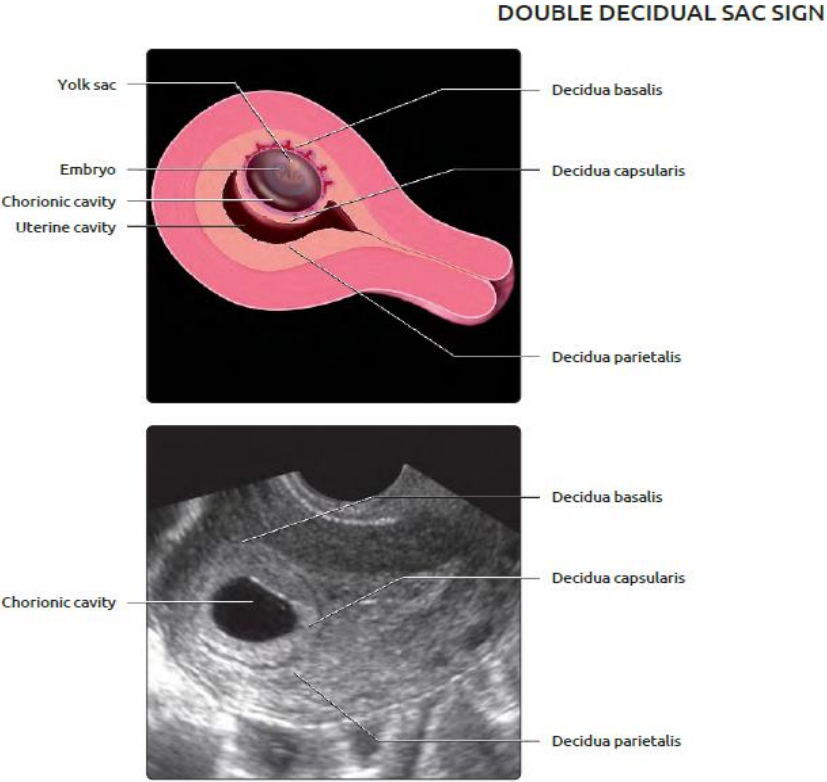


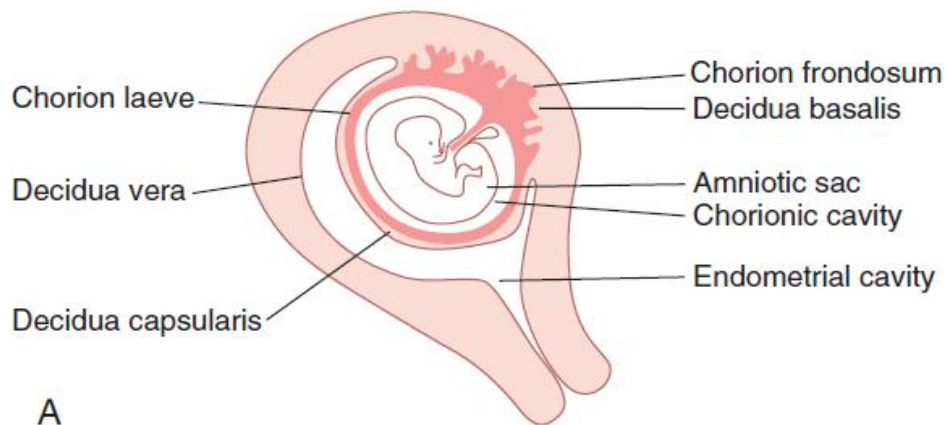
FIG. 30.5 Intradecidual Sac Sign at 32 Days. (A) TAS fails to show the gestational sac. (B) TVS shows the echogenic ring of the sac implanted just below the endometrial stripe. In another woman (C) transverse and (D) sagittal TVS show an early gestational sac (arrow). The sac (arrow) slightly displaces the endometrial stripe posteriorly and has a slightly echogenic rim, seen best on (E) high-resolution image.

Double decidual sac sign

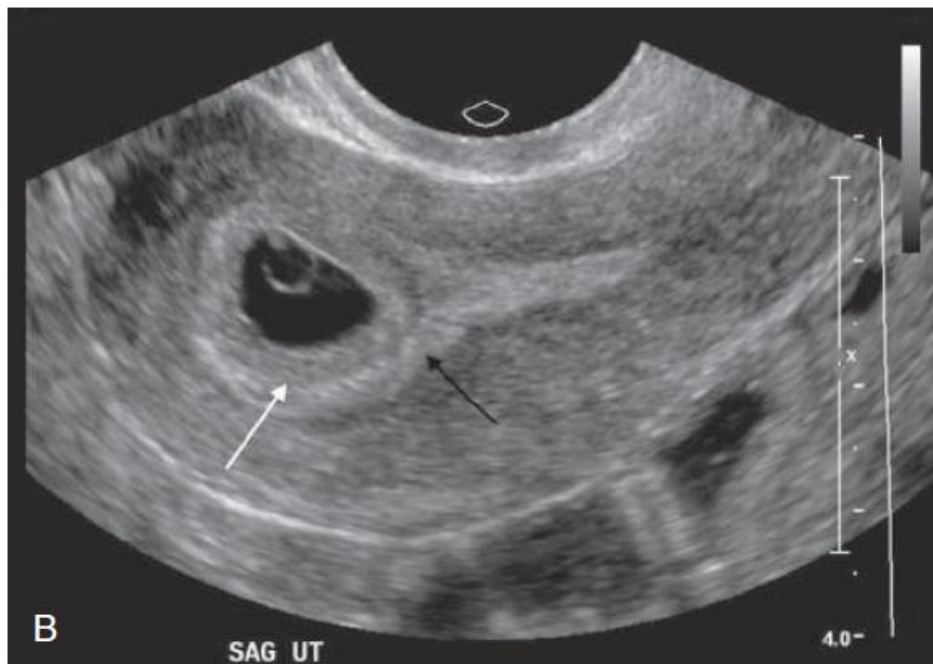
- This graphic illustrates the double decidual sac sign (DDSS). This is seen when the enlarging gestational sac protrudes from the site of implantation and starts to expand into the uterine cavity, exerting mass effect on the opposite uterine wall. The decidua covering the expanding sac is decidua capsularis; that which is being pushed ahead of the expanding sac is the decidua parietalis. The decidua basalis is where the sac is adherent to the uterine wall and marks the site where the placenta will develop.
- The concentric rings created by the decidua capsularis and parietalis create the DDSS



Ultrasound illustration related to Double decidual sac sign.



A



B

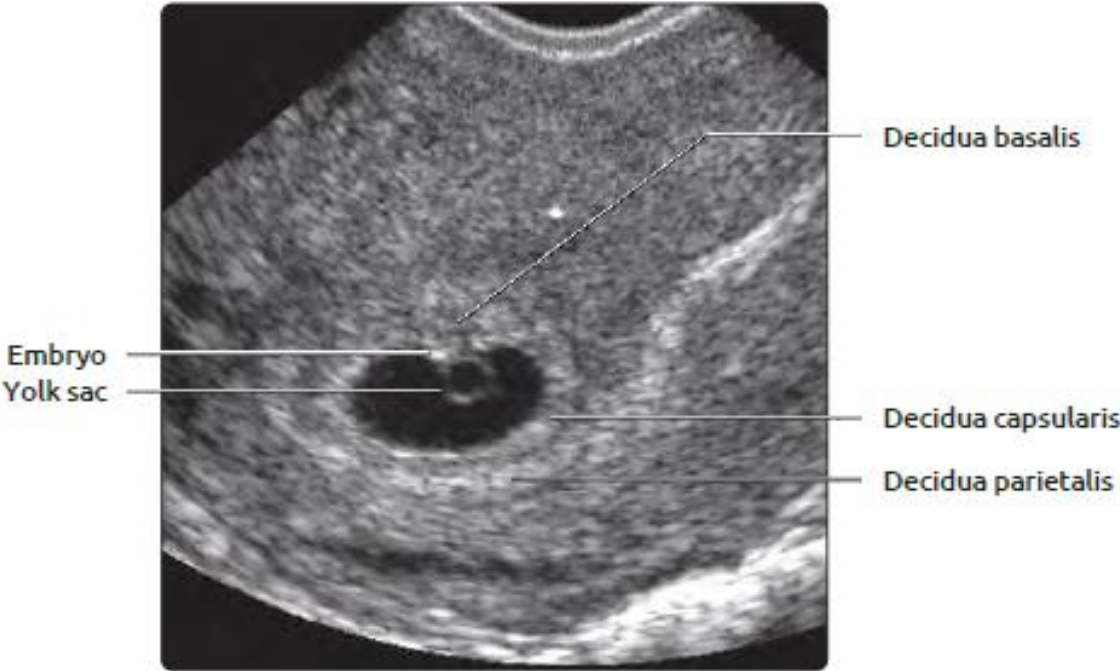
FIG. 30.6 Double-Decidual Sign. (A) Diagram of anatomic basis showing three layers of decidua and endometrial cavity. (B) Sagittal TVS at 5 weeks 6 days shows the decidua capsularis around the gestational sac (*white arrow*) and the maternal decidua vera (*black arrow*) as separate echogenic bands.

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Gestational sac and yolk sac: 5-5.5 weeks



Yolk sac in multiple pregnancy



Dichorionic diamniotic monoamniotic



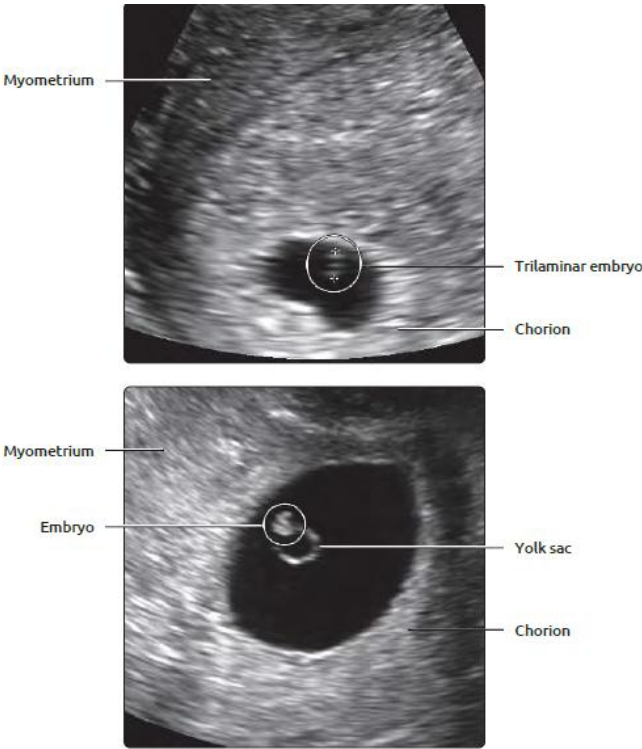
Monochorionic diamniotic



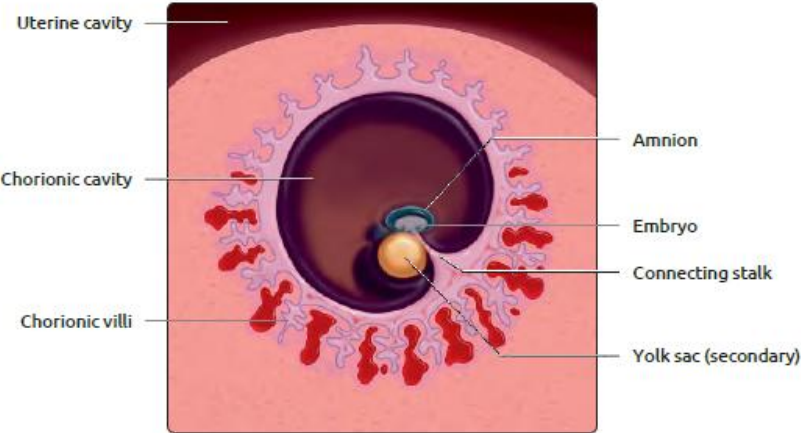
Monochorionic

Ultrasound illustration related to Slide 18.

Embryo: 6-6.5 weeks

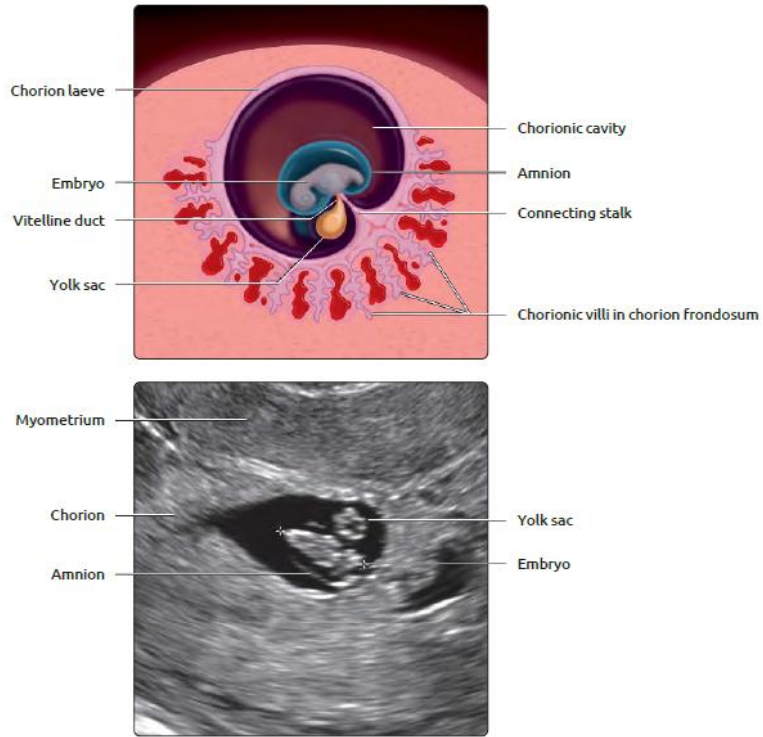


Ultrasound illustration related to Embryo :6-6.5wks
Ultrasound illustration related to Embryo :6-6.5wks.



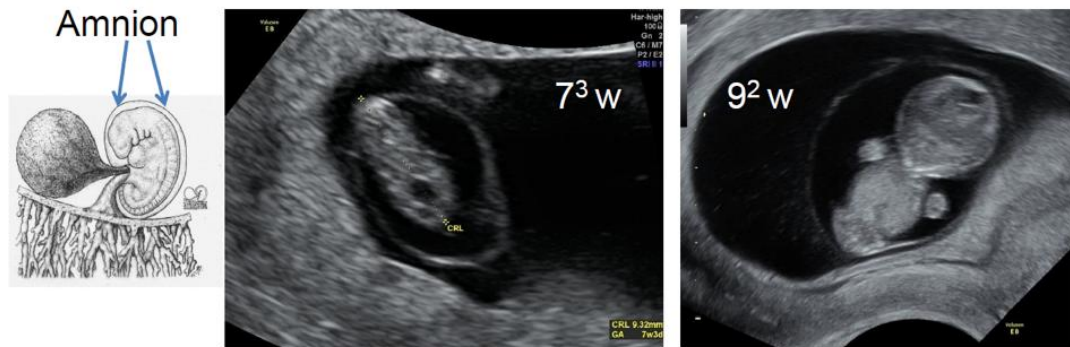
Amnion: 7-8 weeks

EMBRYONIC DEVELOPMENT: 7-8 WEEK



Ultrasound illustration related to Embryo, Amnion-7-8weeks.

Amnion

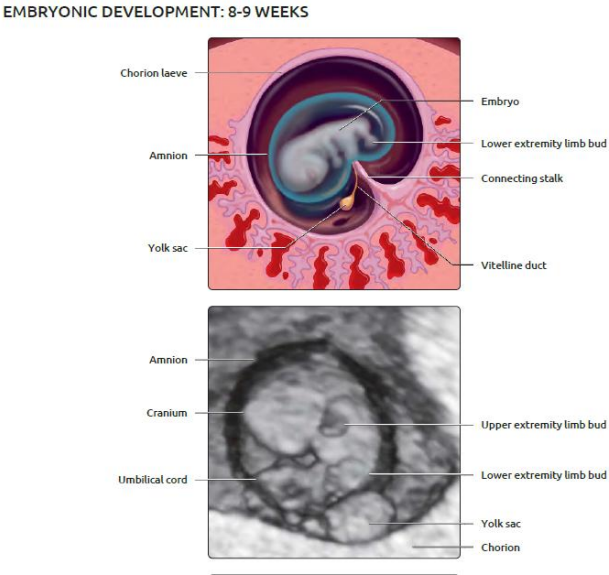


Basic Training



Ultrasound illustration of amnion

Embryo: 8-9 weeks



Ultrasound illustration related to Embryo : 8-9 weeks.

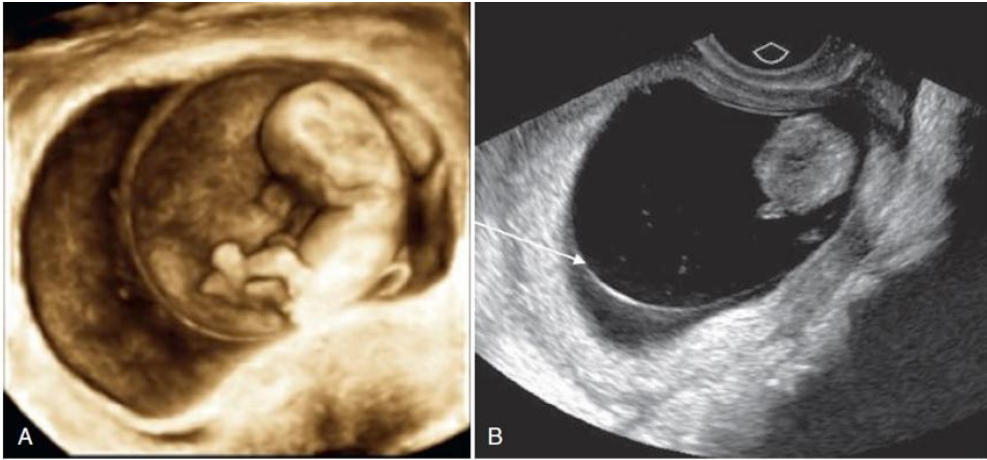
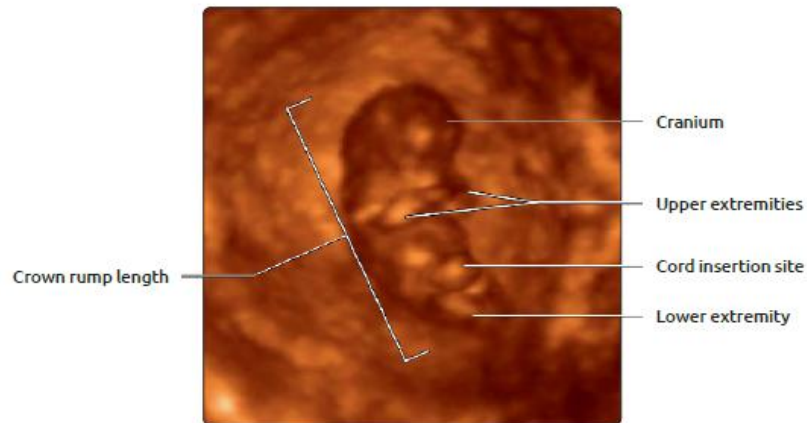
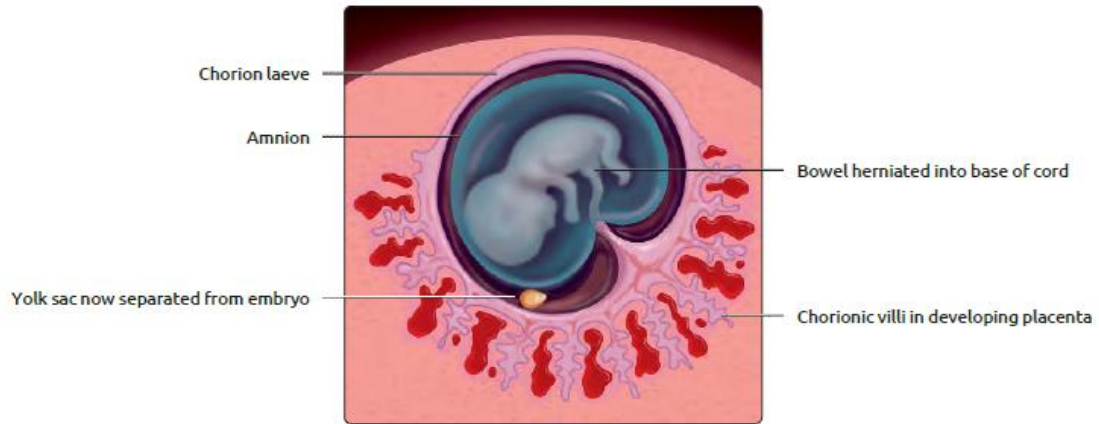


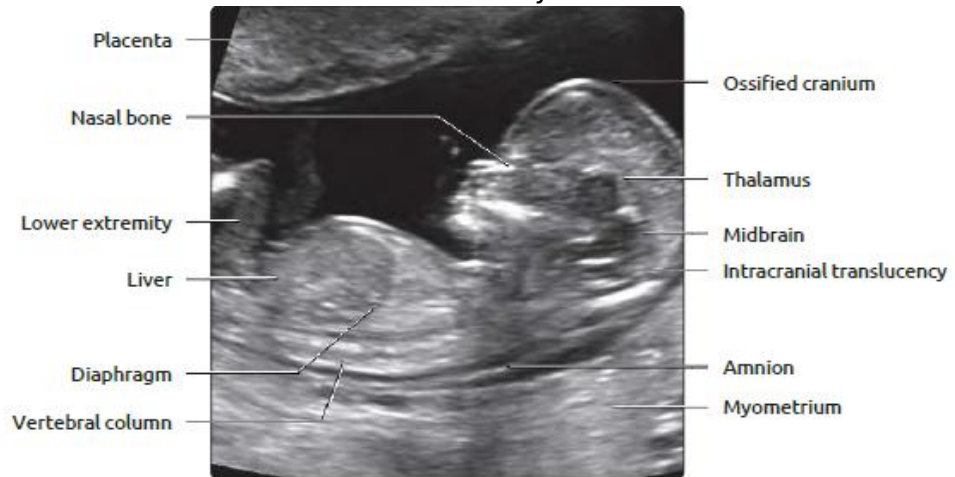
FIG. 30.14 Normal 12-Week Gestation. (A) Surface rendering image from three-dimensional TVS shows the embryo within the amnion. (B) Two-dimensional TVS shows the amnion (*arrow*) approaching, but not fused with, the chorionic sac.

Embryo: 10-13 weeks

EMBRYONIC DEVELOPMENT: 10-13 WEEKS



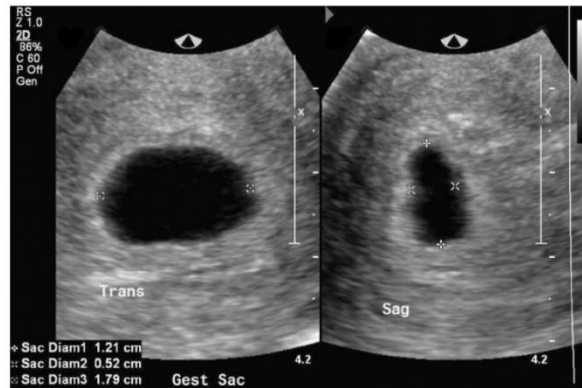
Ultrasound illustration related to Embryo: 10-13 weeks.



Ultrasound illustration related to Embryo: 10-13 weeks.

First Trimester Measurements: Mid sac Diameter (MSD)

- Early assessment of gestational age before embryo is clearly seen.
- Use transvaginal ultrasound whenever possible in early pregnancy
- Measure gestational sac from inner edge to inner edge
- Obtain measurements in 3 Perpendicular planes: Length Height (AP diameter) Width (transverse) , add the three largest dimensions and divide the total by 3
- Measure the largest dimensions Avoid including echogenic trophoblastic rim Normal sac growth ≈ 1 mm/day



IG. 30.17 Gestational Age Established by Mean Sac Diameter (MSD). Gestational age can be estimated measuring the sac in three mensions. Average of three measurements is used to correlate with gestational age prior to visualization of the embryonic pole. MSD of 12 mm consistent with gestational age of 6 weeks 0 days. However, these data are not used to formally establish pregnancy dating. Sonographic dating of the pregnancy is done with the crown-rump length when cardiac activity is present.

Ultrasound illustration related to how to measures mid sac diameter



Yolk sac measurements

- Magnify image so yolk sac occupies large portion of screen
- Measure the inner diameter to inner diameter
- Measure the widest diameter.
- Use calipers carefully at inner echogenic margins
- Normal size: 2–6 mm; Regresses after 10weeks
- Abnormal if >6mm, Irregular shape , thick or calcified wall



Crown rump length

- Most accurate method for first trimester dating
- Best between 11–13 weeks
- Obtaining true midsagittal view of embryo/fetus should be in neutral position (Not flexed Not hyperextended)
- Magnify fetus to occupy most of screen
- Measure from: Crown of head to rump (caudal end) from skin to skin and exclude limbs



Figure 1 Crown–rump length (CRL) measurement technique in a fetus with CRL 60 mm (12 + 3 weeks). Note neutral position of neck.

Nuchal Translucency

- Obtain true midsagittal fetal profile
- Fetus should be in neutral position
- Magnify image so fetal head and thorax fill screen
- Measure maximum lucent area at posterior neck
- Place calipers: Inner edge to inner edge
- Normal: <3mm

Table 2: US Findings Diagnostic of Pregnancy Failure

Finding	Imaging Appearance
Absent cardiac activity by the time the CRL is a certain size	CRL \geq 7 mm with no heartbeat
Absent embryo by the time the gestational sac is a certain size	MSD \geq 25 mm with no embryo
Absent embryo by a certain point in time; requires two US examinations	Absence of embryo with heartbeat 2 or more weeks after US showed gestational sac without yolk sac

Absence of embryo with heartbeat 11 or more days after US showed gestational sac with yolk sac

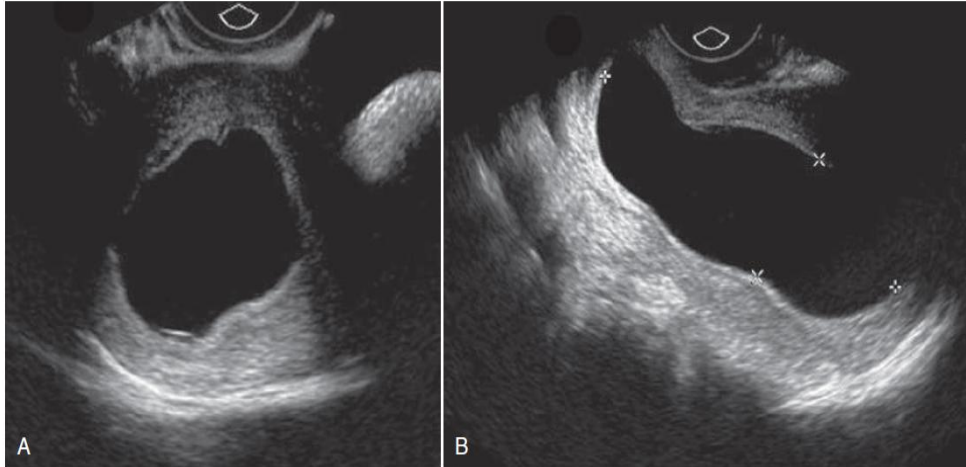


FIG. 30.20 TVS Findings Diagnostic of Early Pregnancy Failure With Large, Empty Sac. (A) Transverse and (B) sagittal images of an empty gestational sac with MSD (*calipers*) greater than 25 mm. No yolk sac or embryonic pole is visualized.

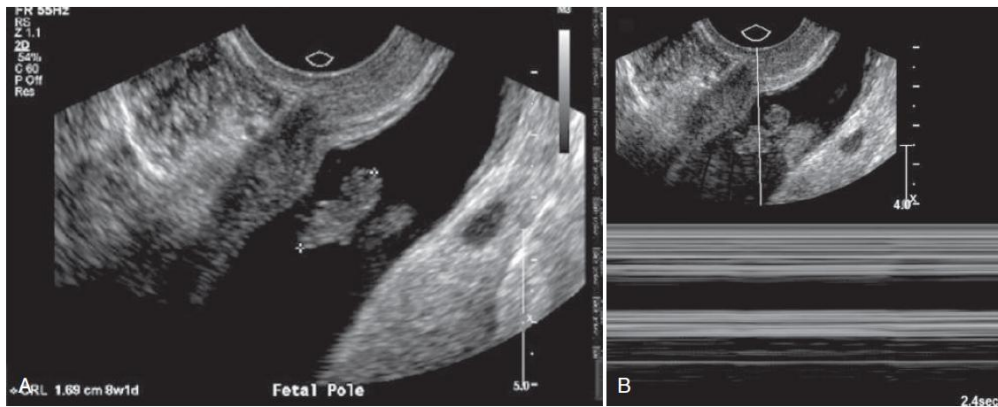


FIG. 30.18 Ultrasound Findings Diagnostic of Early Pregnancy Failure. (A) TVS shows an embryo (*calipers*) measuring larger than 7 mm without cardiac activity. (B) M-Mode confirms no fetal cardiac activity. See also Video 30.2.

Table 3: US Findings Suspicious for but Not Diagnostic of Pregnancy Failure

Finding	Imaging Appearance
Absent cardiac activity by the time the CRL is a certain size	CRL <7 mm with no heartbeat
Absent embryo by the time the gestational sac is a certain size	MSD 16–24 mm with no embryo
Absent embryo by a certain point in time	Absence of embryo with heartbeat 7–13 days after US showed gestational sac without yolk sac
	Absence of embryo with heartbeat 7–10 days after US showed gestational sac with yolk sac
	Absence of embryo 6 or more weeks after last menstrual period
Morphology of gestational sac, amnion, and yolk sac	Empty amnion, enlarged yolk sac (>7 mm), small gestational sac relative to embryo (<5-mm difference between MSD and CRL)

Source: Rodgers SK et al. *RadioGraphics* 2015;35:2135–2148

TABLE 30.2 Worrisome Findings for Early Pregnancy Failure

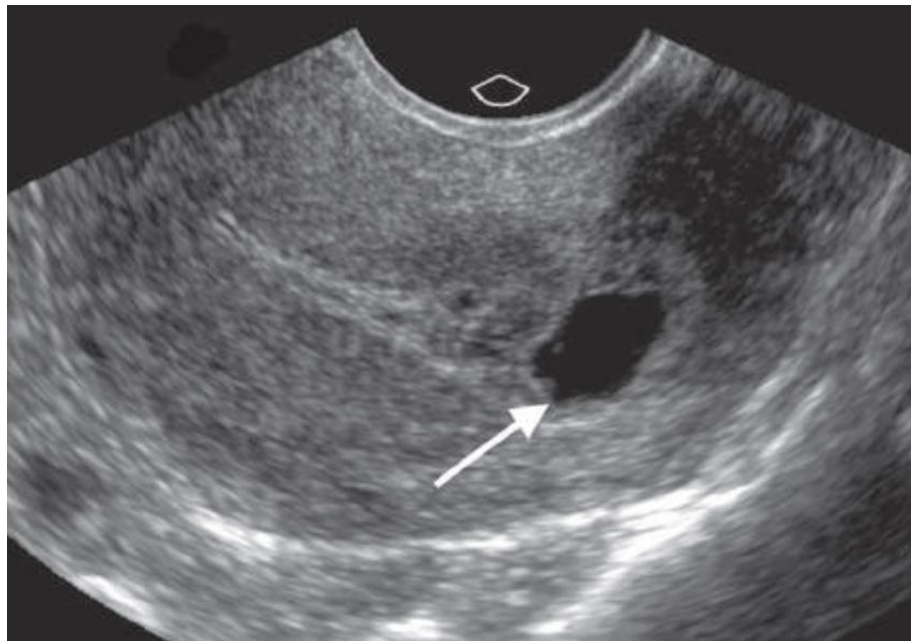
Finding	Comment
Embryo with CRL < 7 mm and no heartbeat	Embryo 2-6 mm without cardiac activity is a worrisome finding. Follow-up is needed to assess for cardiac activity in 1 week to ensure 100% specificity in diagnosis of miscarriage.
Gestational sac with MSD 16-24 mm and no embryo	Embryo is typically seen by the time the MSD is 16 mm. Follow-up in 10-14 days is needed to ensure 100% specificity in diagnosis of miscarriage.
Gestational sac appearance	Irregular shape of sac, low position of sac, and weak decidual reaction are associated with miscarriage, but the size of the embryo and presence or absence of cardiac activity guides the diagnosis of miscarriage.
Small MSD in relationship to CRL	Low fluid is associated with poor outcome. If MSD-CRL < 5, follow-up is recommended.
Abnormal amnion size	Expanded amnion or empty amnion as evaluated by an experienced sonologist is diagnostic of miscarriage. If any uncertainty is present, then follow-up should be obtained.
Yolk sac > 6 mm	Findings are associated with miscarriage, but the size of the embryo and presence or absence of cardiac activity guides the diagnosis.
Calcified yolk sac	
Embryonic bradycardia	Heart rate (HR) < 100 may be seen with 1- to 2-mm embryo and be a normal finding. In general, when HR is <100, follow-up is recommended.
Large subchorionic hemorrhage	Large hemorrhage is associated with miscarriage, but the size of the embryo and presence or absence of cardiac activity guides the diagnosis of miscarriage.

Table 4: US Indicators of Poor Prognosis in Early Pregnancy

Feature	Imaging Appearance
Gestational sac	Irregular contour, low-lying position
Yolk sac	Calcified, larger than 7 mm
Amnion	Empty, enlarged, or expanded
Embryo	Amorphous shape
Cardiac activity	Bradycardia of 85 beats/min or less
Chorionic villi	Hydropic/cystic change
Subchorionic hemorrhage	Large, particularly if it encircles at least two-thirds of the gestational sac circumference

Source: Rodgers SK et al. *RadioGraphics* 2015;35:2135–2148.

Figure: Irregular gestational sac



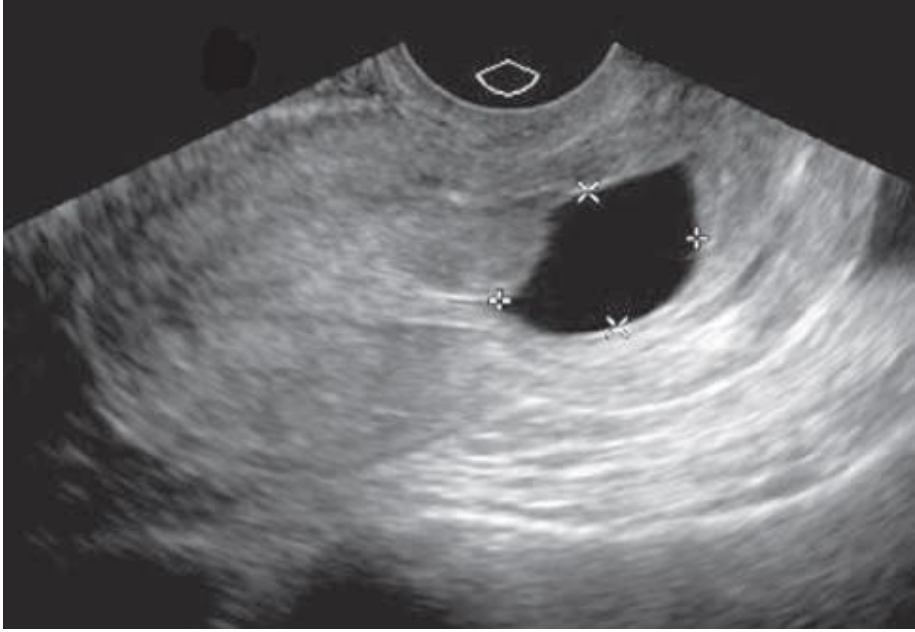


Figure: Chorionic Bump and irregular gestational sac

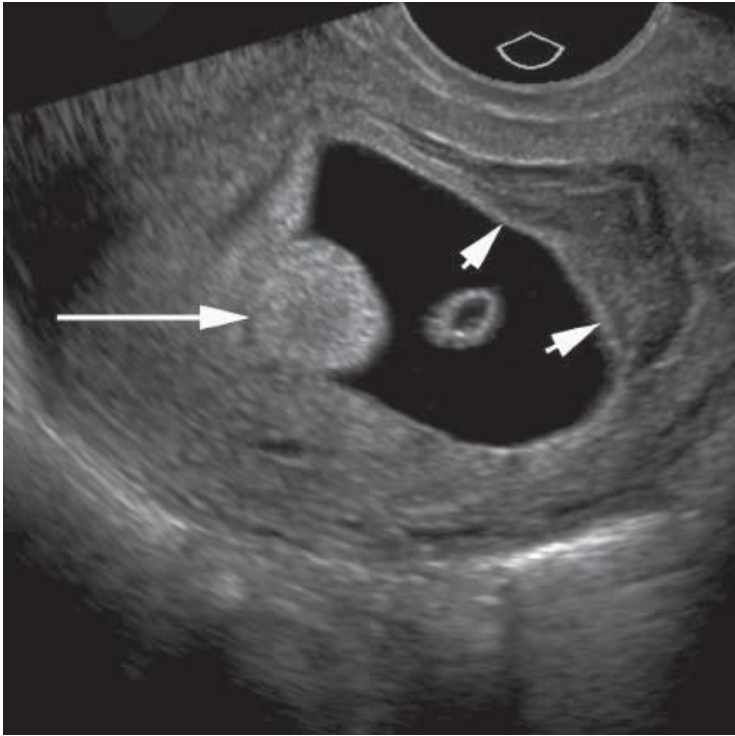




FIG. 30.22 Small Sac Size in Relationship to Embryo (MSD – CRL = <5 mm). The gestational sac containing a yolk sac and embryonic pole is smaller than expected. This pregnancy eventually failed.

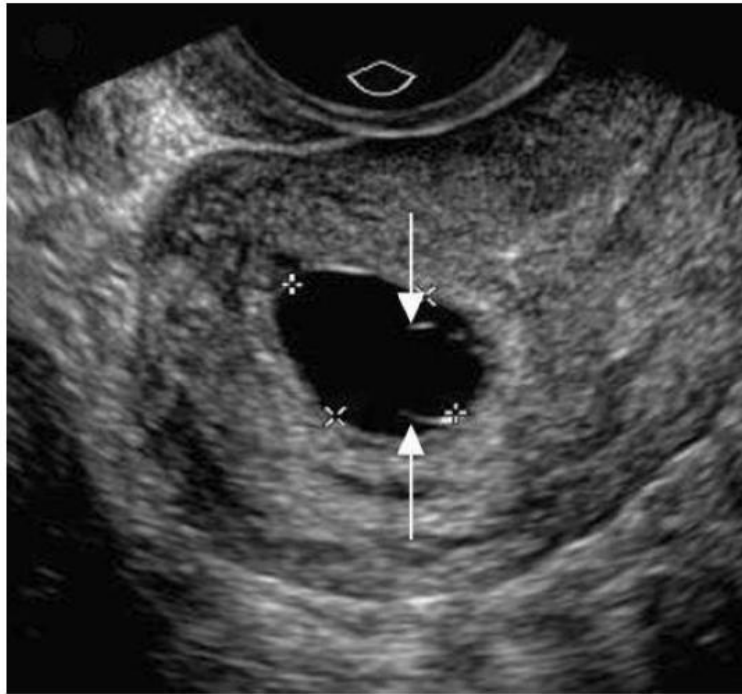


FIG. 30.23 Empty Amnion. TVS at 6 weeks by dates shows gestational sac (*calipers*) with an abnormally large empty amnion (*arrows*). Early pregnancy failure was later confirmed.

Expanded amnion

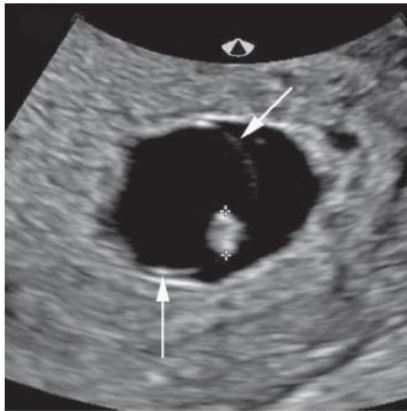


FIG. 30.25 Embryonic Bradycardia. A small embryo in a 10-week pregnancy with a heart rate of 69 beats/min. This embryo later was found to not have cardiac activity. A round amniotic sac is seen on the left and the large yolk sac is seen to the right of the embryo.

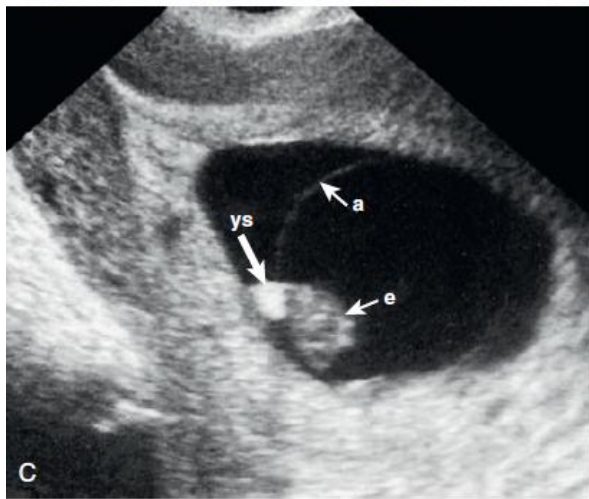
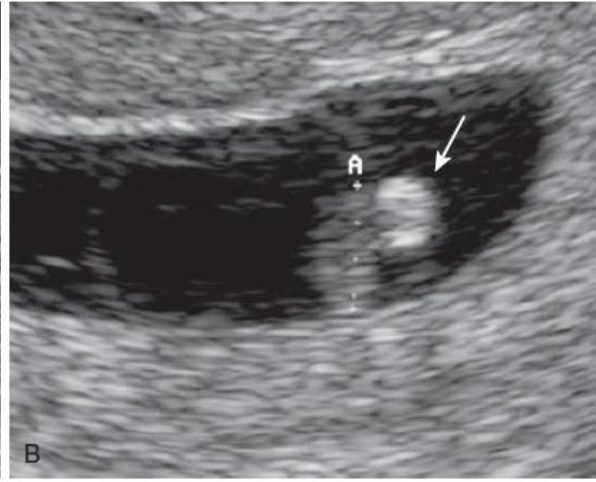
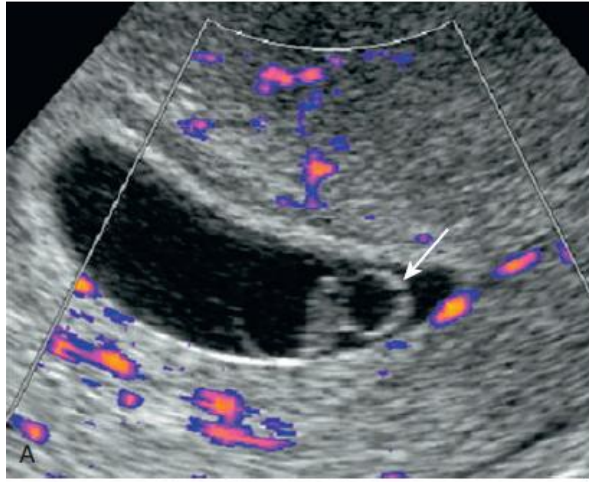


FIG. 30.26 Embryonic Demise With Yolk Sac Calcification. (A) TVS color Doppler at 7 weeks menstrual age (CRL, 6.5 mm) shows an embryo without cardiac activity (no color) and a normal-appearing yolk sac (*arrow*). (B) Repeat scan 5 days later shows no change in the size of the embryo (*calipers*) and a dense yolk sac (*arrow*) with faint distal shadowing. (C) In a different pregnancy, TVS sagittal scan shows calcified yolk sac (*ys*). No cardiac activity was identified in embryo with CRL of 18 mm. *a*, Amnion; *e*, embryo. See also Video 30.4.

Subchorionic Hemorrhages

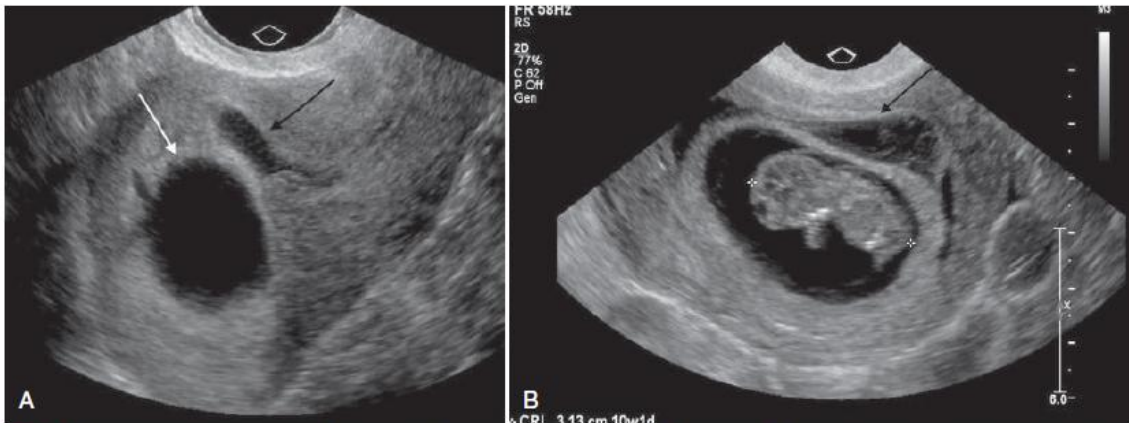


FIG. 30.27 Subchorionic Hematoma. (A) Sagittal TVS at 7 weeks' gestation shows a small hypoechoic collection (*black arrow*) adjacent to the gestational sac (*white arrow*). The live embryo was not in the field of view. The bleed resolved and pregnancy continued uneventfully. (B) In another patient, sagittal transverse TVS at 10 weeks' gestation shows a large subacute hemorrhage (*black arrow*) with a lacy appearance to the clot. A live embryo (*calipers*) is present. See also Video 30.5.

Haematoma



Table -5: Correlation of quantitative serum β -hCG Level and Ultrasound findings in early pregnancy

Gestational Age	Quantitative β -hCG Level (Approx.)	Expected Transvaginal Ultrasound (TVS) Finding
Very early pregnancy (before sac visible)	5–50 mIU/mL	Positive pregnancy test only; no visible intrauterine findings
4–4.5 weeks	50–500 mIU/mL	Thickened endometrium / decidual reaction
4.5–5 weeks	1,000–2,000 mIU/mL	Small gestational sac becomes visible
5–5.5 weeks	2,000–7,000 mIU/mL	Yolk sac visible within gestational sac
5.5–6 weeks	5,000–10,000 mIU/mL	Embryo (fetal pole) becomes visible
~6 weeks	>10,000 mIU/mL	Cardiac activity may be detectable
6.5–7 weeks	10,000–50,000 mIU/mL	Definite embryo with cardiac activity
7–8 weeks	20,000–100,000 mIU/mL	Amnion, limb buds, spine, and embryonic motion develop

Table 5: Follow-up Ultrasound and β -hCG Recommendations in At-Risk Early Pregnancy

Initial Finding / Risk Situation	Recommended Follow-up
Positive pregnancy test but no gestational sac seen	Repeat β -hCG in 48 hours and repeat TVS in 7–10 days
β -hCG >1500–2000 mIU/mL with empty uterus	Repeat β -hCG + repeat TVS within 48 hours–7 days
Small gestational sac without yolk sac	Repeat TVS after 7–14 days
Gestational sac with yolk sac but no embryo	Repeat TVS after 7–11 days
Embryo <7 mm without heartbeat	Repeat TVS after 7–10 days
MSD 16–24 mm without embryo	Repeat TVS after 7–10 days
Irregular gestational sac	Repeat TVS in 7–10 days
Enlarged yolk sac (>7 mm)	Repeat TVS in 7–10 days
Empty amnion	Repeat TVS in 7–10 days
Subchorionic hemorrhage	Clinical + ultrasound follow-up

Table 6: Interpretation of Follow-up Findings

Follow-up Finding	Possible Meaning
No gestational sac on initial scan	Very early IUP, ectopic pregnancy, or completed abortion
Empty uterus despite elevated β-hCG	Suspicious of ectopic pregnancy or failed pregnancy
Persistent empty gestational sac	Possible nonviable pregnancy
No embryo after yolk sac identified	Suspicious of pregnancy failure
No heartbeat on follow-up scan	Possible or confirmed pregnancy failure
Irregular gestational sac	Poor prognosis / abnormal pregnancy
Large subchorionic hemorrhage involving more than 2/3rd of the perimeter of gestational sac	Increased miscarriage risk
Adnexal mass with pelvic pain/free fluid	Possible ectopic pregnancy
Very high β-hCG with abnormal uterine echoes	Possible molar pregnancy

Table 7: Interpretation of Serial β -hCG Trend

β-hCG Trend	Likely Interpretation
Significant rise over 48 hours	Likely viable early pregnancy
Slow rise or plateau	Suspicious of ectopic or nonviable pregnancy
Falling β-hCG level	Failed pregnancy or spontaneous abortion
Very high β-hCG level	Consider molar pregnancy or multiple gestation

Ectopic pregnancy

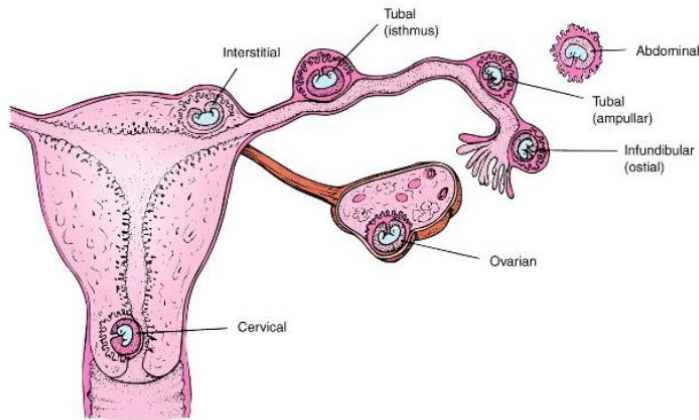


Figure 46-9 Sites of ectopic pregnancy.

Copyright © 2004 Lippincott Williams & Wilkins.

Basic Training



Ectopic pregnancy

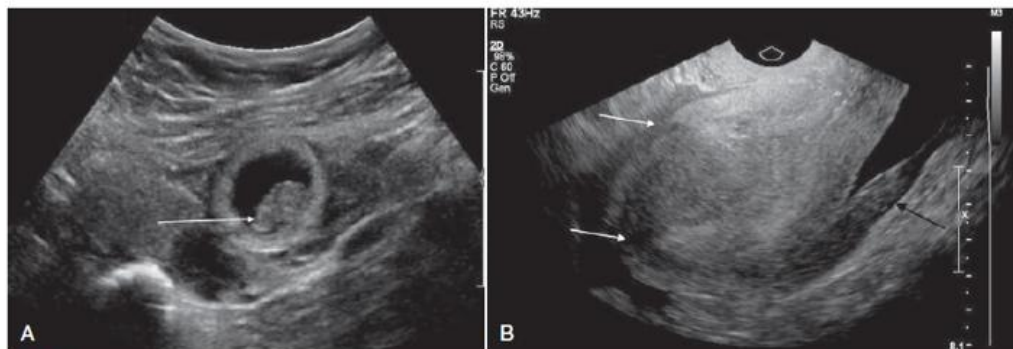
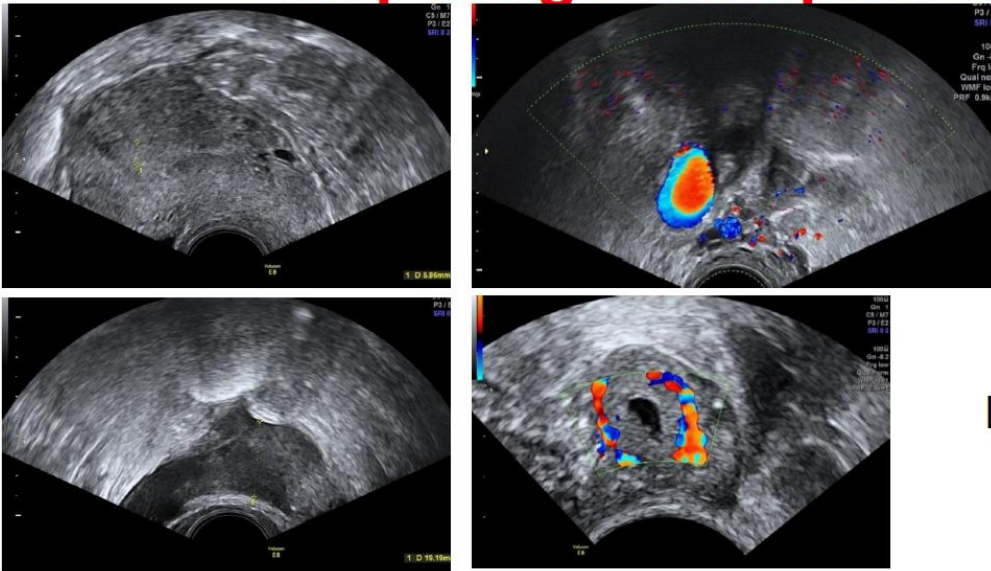


FIG. 30.28 Live Ectopic Pregnancy. A 33-year-old woman with left lower quadrant pain at 9 weeks' gestation. **(A)** Transverse TAS of the right adnexa shows a gestational sac with an embryo. Cardiac activity was seen at real-time imaging. **(B)** TVS shows the uterus (*white arrows*) and some clot in the cul-de-sac (*black arrow*). However, the ectopic pregnancy was only seen on the TAS.

Ectopic right fallopian tube

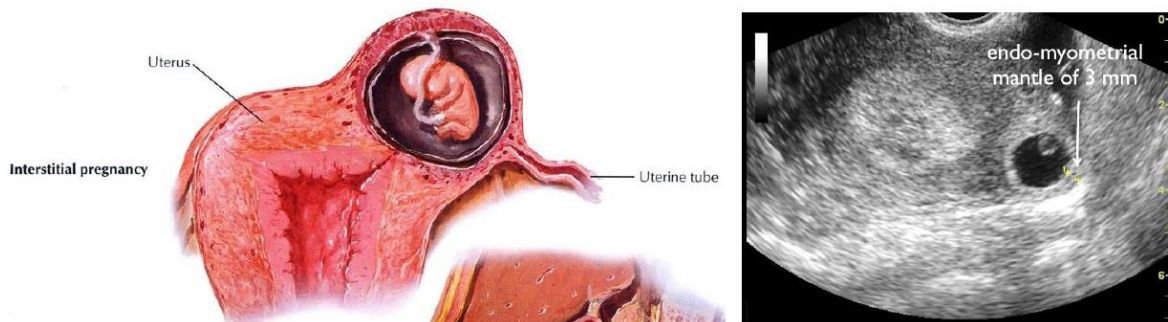


LMP 8 weeks

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Interstitial pregnancy



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Cervical ectopic pregnancy Gestational sac in lower segment in cervical canal



Basic Training



Gestational sac in lower segment - in cs scar



Basic Training



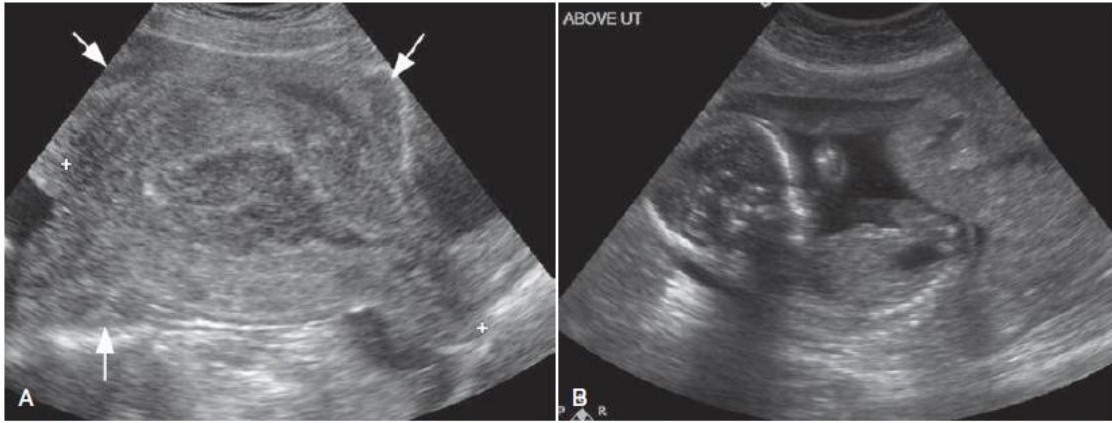


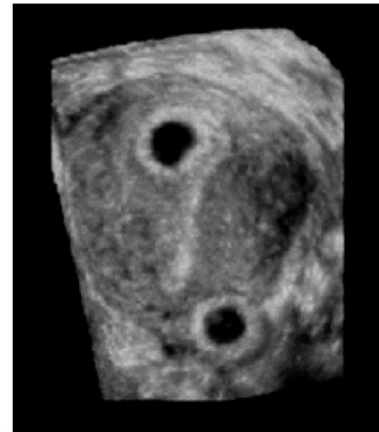
FIG. 30.35 Abdominal Ectopic Pregnancy. A 19-year-old woman with acute abdominal pain and syncope. **(A)** Sagittal TAS demonstrates a mildly enlarged uterus with an endometrial cavity distended with blood. Blood is also seen surrounding the uterus (*arrows*). **(B)** TAS superior to the uterine fundus demonstrates a 15-week abdominal ectopic pregnancy. Surgical treatment confirmed abdominal ectopic secondary to uterine rupture caused by an interstitial ectopic pregnancy.

Heterotopic pregnancy

Prevalence heterotopic pregnancy
 Spontaneous pregnancy 1:30,000
 ART pregnancy 1:100-500



Intrauterine



Ectopic

Maruotti & Russo Fert Ster 2010;94:e49

First Trimester Ultrasound Reporting Template

Name: _____ Age _____ Date _____ MRN _____

Pregnancy Location:

- Intrauterine pregnancy identified
- Pregnancy of unknown location
- Suspicious ectopic pregnancy
- Adnexal mass present
- Free pelvic fluid present

Gestational Sac: Present Absent Single Multiple Regular shape Irregular shape |
MSD: _____ mm

Yolk Sac: Present Absent Single Multiple Enlarged (>7 mm) Calcified

Embryo/Fetal Pole: Present Absent | CRL: _____ mm

Cardiac Activity: Present Absent | Fetal Heart Rate: _____ bpm

Subchorionic Hemorrhage: Absent Small Moderate Large

Estimated Gestational Age: _____ EDD _____

Conclusion: _____

Recommendation: _____

Reported by _____ **Signature** _____ **Date** _____

Facility _____

Referral Template for High-Risk Patients

Patient Name: _____ Age: _____ Date: _____

Gestational Age: _____

Clinical Concern/Diagnostic impression

- Suspected ectopic pregnancy
- Heavy vaginal bleeding
- Suspected abortion
- Pregnancy of uncertain viability
- Molar pregnancy
- Bradycardia or absent fetal cardiac activity with concerning findings
- Other: _____

Key	Ultrasound	Findings:

Reason	for	Referral:

Referring Facility/Team: _____

Name, Signature and date: _____

Section 3: Second trimester/anatomical scan ultrasound

Definition: it is comprehensive scanning of the fetus for anomaly detection commonly at the gestational age of 18wks to 22wks

Objectives: The systemic evaluation of fetal development and maternal health to ensure the pregnancy is progressing without complication.

Indications for detailed fetal anatomic survey

- Previous fetus or child with a congenital, genetic or chromosomal abnormality
- Known or suspected fetal anomaly
- Fetus at increased risk for a congenital anomaly, such as maternal diabetes, teratogen exposure
- Other conditions affecting the fetus, including congenital infections and maternal drug dependence.

Benefits of Routine second -trimester ultrasound screening

- -More accurate gestational age
- -Detection of major malformation before birth
- -Earlier Detection of multiple pregnancy
- -Lower incidence of induction for post-term pregnancy
- -Early detection of placenta previa and vasa previa
- -Fewer low birth -weight singleton births
- -Reassurance of a normal pregnancy

Biometrics to measure

- The Minimum Measurements to Report Are:
 - Biparietal Diameter (BPD)
 - Head Circumference (HC)
 - Abdominal Circumference (AC), And
 - Femur Length (FL)

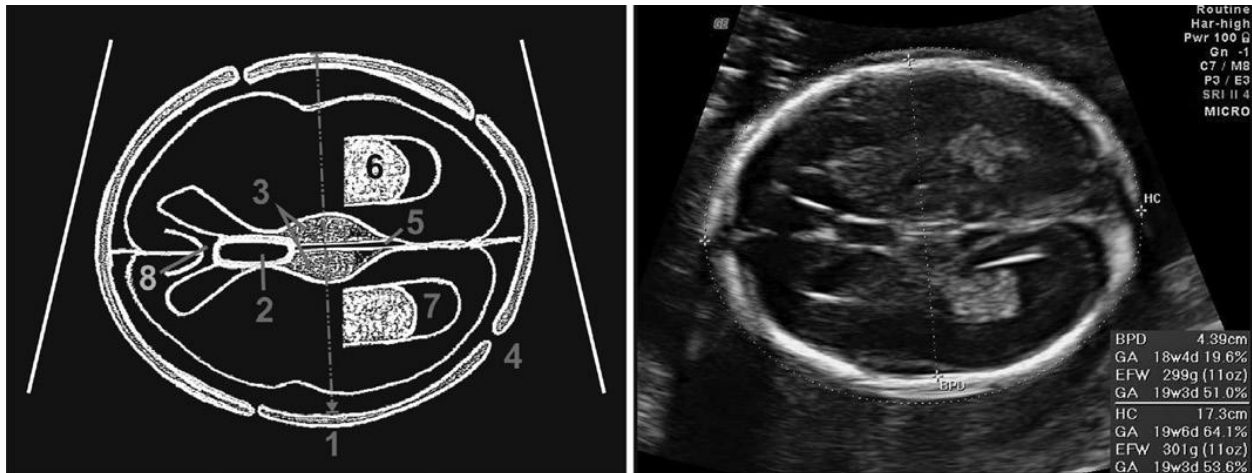
Additional Biometrics when needed

- Humerus Length (HL)
- Nasal Bone Length (NB)
- Nuchal Fold (NF)
- Cerebellar Diameter (TCD)
- Cisterna Magna And
- Cervical Length

- Amniotic fluid assessment maximum: vertical pocket or amniotic fluid Index (AFI) can be used if there is concern about excess or insufficient amniotic fluid.
- Fetal movements should be observed and commented upon
- It is essential to see flexion or extension of a limb at least once during the scanning process to reduce the chance of missing a case of arthrogryposis
- Similarly, the opening of the hands to exclude clenched fingers is important to rule out several syndromes.

Fetal head measurement at BPD level

- Cross section of the fetal head obtained at the level of the Thalami
- The cerebellum, orbits and ears should not be visualized in this scanning plane
- The falx should be positioned horizontal and equidistant from both parietal bones
- The operator should look for a symmetrical appearance to both hemispheres
- Behind this in the middle of the falx a thin slit representing the third ventricle is often visible



Caliper Placement

- Biparietal Diameter (BPD):
 - Is measured from outer skull bone to inner skull bone, perpendicular to the falx at the maximum diameter
- Head Circumference (HC):
 - is measured as an ellipse around the outside of the skull bones

What to see at Cerebellar Plane

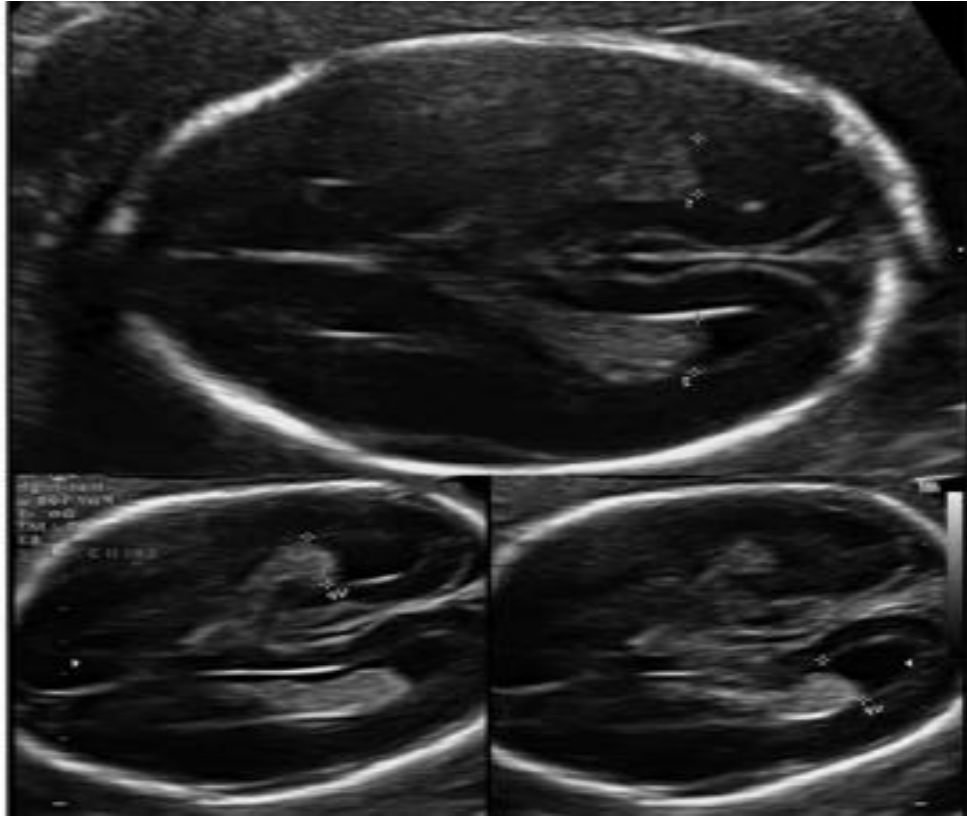
- Cerebellum
 - Cerebellar size in millimeters correlates with gestational age up to 20 weeks and is larger than gestational age after this time.
 - A cerebellum measuring 2 mm less than gestational age is a concerning finding.
- Measuring cisterna magna

- measured from the posterior margin of the cerebellar vermis to the inside of occipital bone in the midline (following an imaginary continuation of the falx).
- Normal: 2-10mm
- Measure Nuchal Fold Thickness
 - Measurement taken from outer skin line to outer bone in the midline Less than 6 mm is considered normal up to 22 weeks.
 - When measuring the nuchal fold angling the probe to place the falx at $\sim 15^\circ$ to horizontal may provide a sharper image of skin line and bone.



Measurement of lateral ventricles at the trans-ventricular level

- Above the level of the BPD
- Used to measure the size of Ventricles
- The lateral ventricular measurement can be taken from inner wall to inner wall at the level of the glomus of the choroid plexus
- The lateral ventricle should be measured at right angles to the falx
- Over the gestational range 15 to 40 weeks 10 mm or larger is considered abnormal
- It may be advantageous to measure the near field ventricle as well as the far field lateral ventricle



Evaluation of the fetal face

- Planes: Axial and Coronal Plane
- The orbits, nose and mouth need to be separately visualized
- Areas which warrant particular attention are the size and spacing of the eyes as well as the upper lip (which is best imaged in two planes)
- Shortening (hypoplasia) of the nasal bone has been associated with Down syndrome
- The orbits should be equal size with the gap between each orbit approximately the same as the width of each orbit.
- The lenses can be seen as central circles that should not have internal echogenicity. Lens opacity may indicate congenital cataracts.

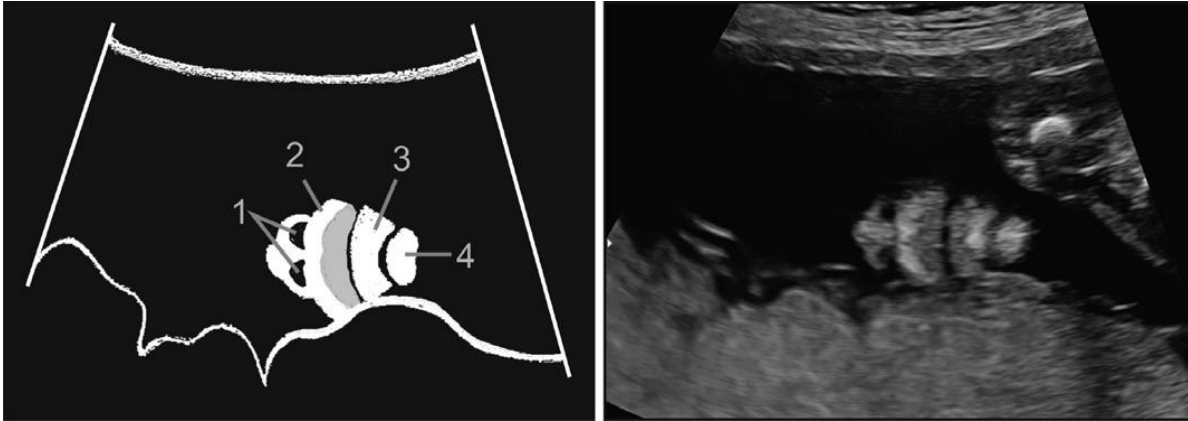


Orbit –Axial plane



Coronal: Nose, lips

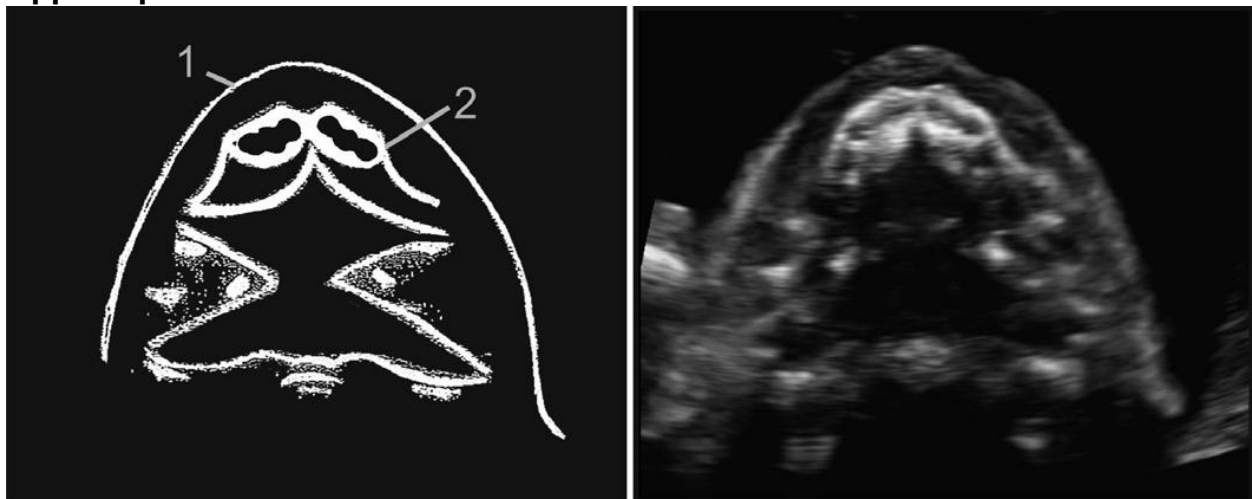
- This image demonstrates two nostrils and a separate intact upper lip.
- Being able to visualize the tip of all four structures (the nose, upper lip, lower lip, and chin) in the same coronal image makes micrognathia an unlikely finding.



Upper lip and palate

- This is a transverse image used to obtain a cross section through the upper lip and hard palate.
- It demonstrates an intact skin line of the upper lip (no cleft). Behind this is an echogenic intact hard palate; this confirms the correct plane, and is useful to distinguish palate involvement if a cleft lip is present
- The hard palate has internal areas of reduced echogenicity representing tooth sockets.

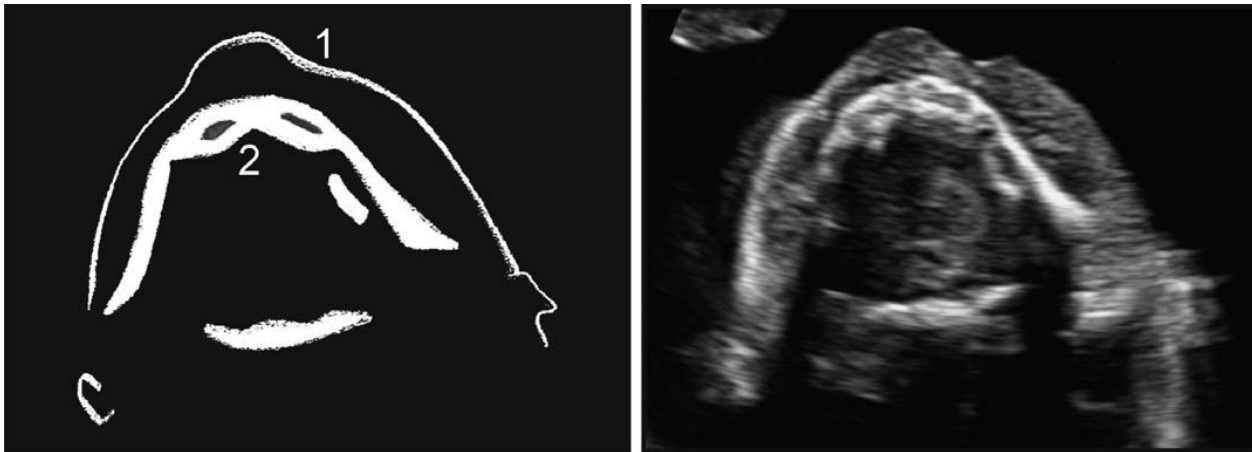
Upper Lip and Palate: Axial View



Lower Lip and Mandible

- This is a transverse image obtaining a cross section through the lower lip and jaw

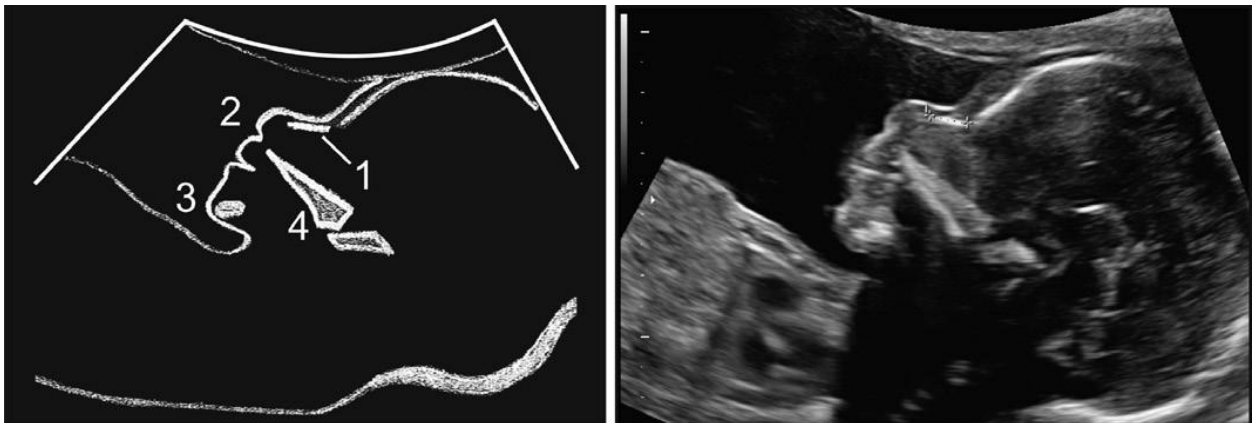
- The image demonstrates an intact lower jaw line. The width of the mandible should be similar to the width of the maxilla and may be reduced in micrognathia



Nasal Bone

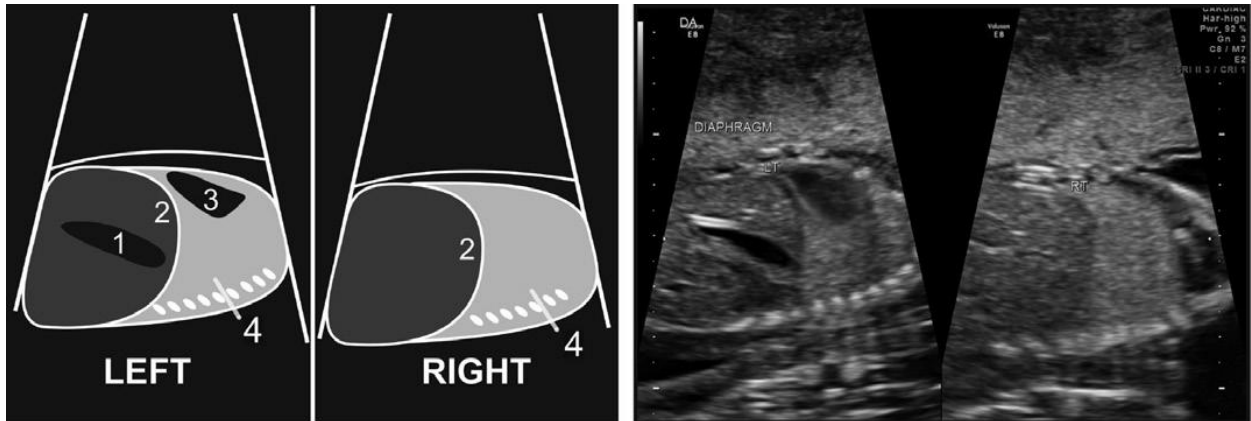
- This is a mid-sagittal image best taken with the angle of the face at about 45°.
- The skin line over the nose should be close to horizontal
- A slight gap between the nasal bone and the frontal bone should be visualized to help identify the extent of the nasal bone.
- A hypoplastic nasal bone has been associated with an increased risk of Down Syndrome
- Normal 4.4 mm at 18 weeks and 5 mm at 20 weeks
- There should be no frontal bossing – no forward sloping of the forehead. The tip of the nose, upper lip, lower lip, and chin should line up along the same imaginary line. If the chin is significantly behind this imaginary line, then micrognathia is suspected

Nasal Bone: Mid Sagittal Plane

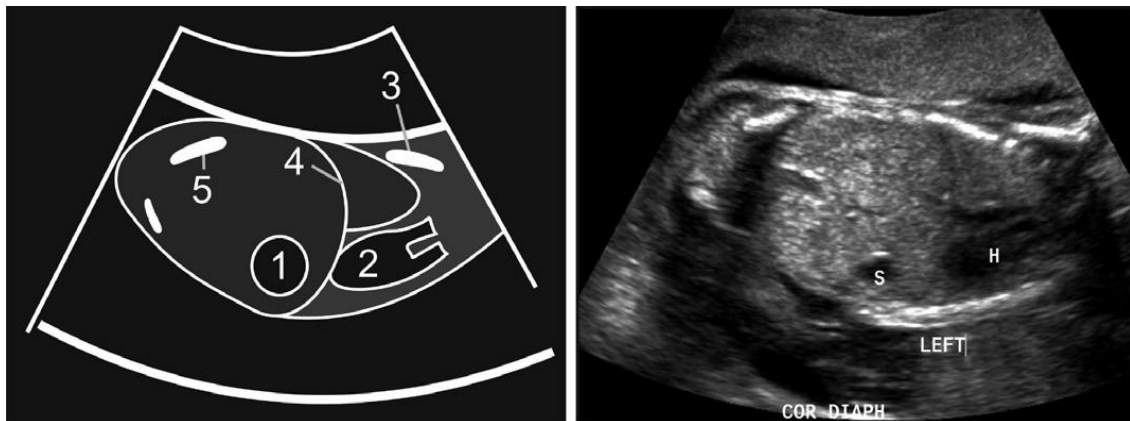


Evaluation of Fetal Chest and Abdomen

- Situs (orientation)
 - Stomach and Heart should be of the left side of the fetus
 - The stomach is a left sided cystic structure that should not cross the midline to the right side
 - The aorta sits just in front of the spine, slightly to the left of the spine.
 - The inferior vena cava (IVC) is anterior to the aorta and right sided.
- Both hemidiaphragms can be visualized sagittal
- The lung fields should be carefully inspected for cystic or echogenic areas
- Sagittal plane



Coronal plane



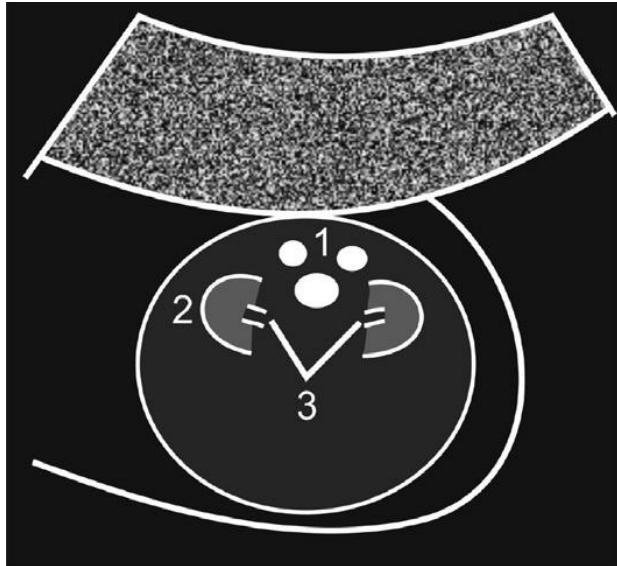
Fetal Abdomen

- The umbilical cord insertion should be imaged to look for abdominal wall defects
- Kidneys and Urinary Bladder must be seen and evaluated
- The fetal kidneys should be imaged in 2 planes, both coronal and axial
- Correct measurement of Abdominal Circumference
 - Level: internal portion of the umbilical vein branching to the right portal vein.
 - measured around the outside of the skin line
 - The section should be circular not oval

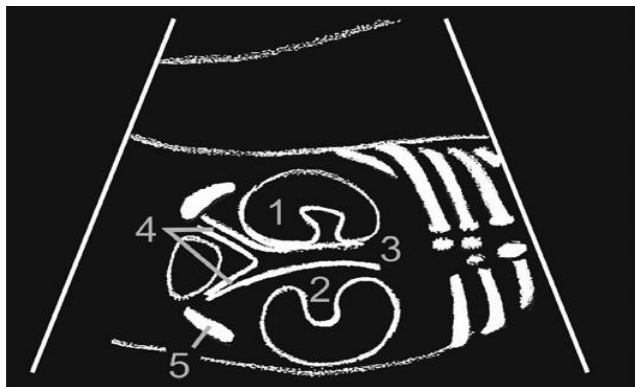
Kidneys

- Size (measured on coronal view): Each kidney should be similar sized (20–22 mm length in the second trimester) with no renal cysts visible.
- Renal Pelvis in AP diameter on axial view should measure <4mm

Kidneys: Axial



Kidneys: Coronal



Survey Guidelines for second trimester ultrasound

Reporting Components

This guide summarizes the essential components of a comprehensive second trimester obstetric ultrasound examination and provides a simple structured reporting template.

1. Fetal Heart Activity

- Confirm fetal heartbeat is present.
- Document fetal heart rate and rhythm.
- Normal fetal heart rate: 110–160 bpm.
- Use M-mode when assessing heart activity.

2. Number of Fetuses

- Determine whether pregnancy is single or multiple.
- For twins/multiples, assess chronicity and amnionicity when possible.

3. Gestational Age and Fetal Growth

- Measure BPD (Biparietal Diameter).
- Measure HC (Head Circumference).
- Measure AC (Abdominal Circumference).
- Measure FL (Femur Length).
- Use measurements to estimate average gestational age.

4. Amniotic Fluid

- Assess amniotic fluid volume.
- Document deepest vertical pocket or AFI.
- Report as normal, reduced, or increased.

5. Placenta

- Document placental location.
- Describe abnormal placental appearance or grade if present.

6. Basic Anatomical Survey

- Head, face and neck: cerebellum, choroid plexus, cisterna magna, nuchal fold.
- Lateral ventricles, septum pellucidum and falx.
- Upper/lower lip, palate and eyes.
- Chest and diaphragm.
- Abdomen: stomach, kidneys, bladder, cord insertion and cord vessels.

- Spine: assess for spina bifida.
- Extremities: morphology, movement and number.
- Genitalia when clinically indicated.

Second Trimester Obstetric Ultrasound Report Template

Patient Name: _____ Age: _____ Date: _____

Fetal Assessment

Fetal number: _____

Presentation: _____

Cardiac activity:

- Present / Absent
- Fetal heart rate: _____ bpm
- Rhythm: Regular / Irregular

Biometry

Parameter	Measurement
BPD	_____
HC	_____
AC	_____
FL	_____

Average Gestational Age: _____

Placenta and Amniotic Fluid

- Placental location: _____
- Placental appearance/grade: _____
- Amniotic fluid: Normal / Reduced / Increased
- AFI / Deepest pool: _____

Conclusion: _____

Examined by: _____

Signature: _____

Anatomical Survey

Head & Face: Normal / Abnormal _____

Chest & Diaphragm: Normal / Abnormal _____

Abdomen: Normal / Abnormal _____

Spine: Normal / Abnormal _____

Extremities: Normal / Abnormal _____

Genitalia: Male / Female / Not assess

Impression: _____

Examined by: _____

Signature: _____

Section 4: Third Trimester Scan

The sonographer, nurse and technician should be able to:

Core Competencies

- Confirm **fetal viability**
- Determine **fetal presentation**
- Assess **fetal growth**
- Evaluate **placental location** and **placental grading**
- Assess **amniotic fluid volume** and **amniotic fluid index**
- **Determine fetal size**
- **Identify multiple gestation**
- Identify **high-risk findings requiring referral**

Clinical Integration

- Correlate ultrasound findings with:
 - Gestational age
 - Maternal symptoms
- Make appropriate:
 - **Reassurance**
 - **Follow-up**
 - **Referral decisions**

1. STANDARD SCANNING PROTOCOL (STEP-BY-STEP)

Step 1: Patient Preparation

- Confirm identity
- Explain procedure in simple language
- Ensure:
 - Comfortable supine position (slight left tilt) and occasionally on lateral side
 - Privacy maintained

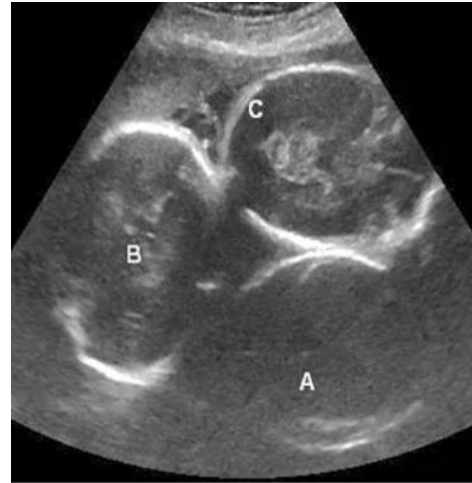
Step 2: Machine Setup-knobology

- Select **obstetric preset**
- Use **curvilinear probe (3.5–5 MHz)**
- Adjust:
 - Depth
 - Gain
 - Focus

Step 3: Systematic Scan Sequence

1. Fetal Viability

- Visualize fetal heart
- Record:
 - Present / Absent
 - Heart rate (if possible)—120 -160 bpm (sustained rate <110 or >160: abnormal)



2. Number of Fetuses

- Single
- Multiple –
 - membranes/placenta
 - fetal heads / heart
 - presentation of 1st twin(breech)
- If multiple → refer

3. Fetal Presentation

- Cephalic (head-down)
- Breech
- Transverse/oblique
- Cord presentation / cord around the neck



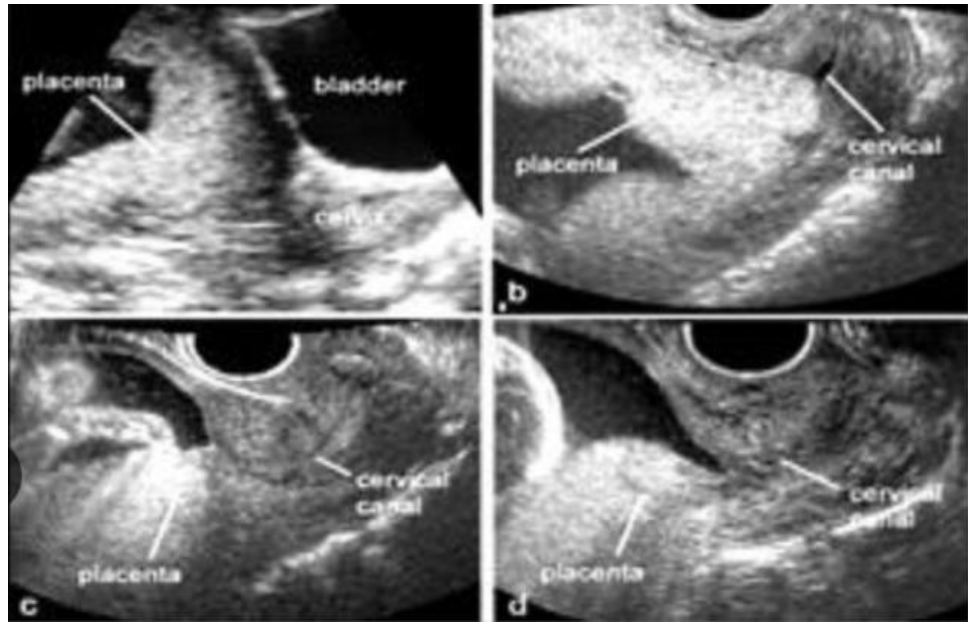
Breech presentation



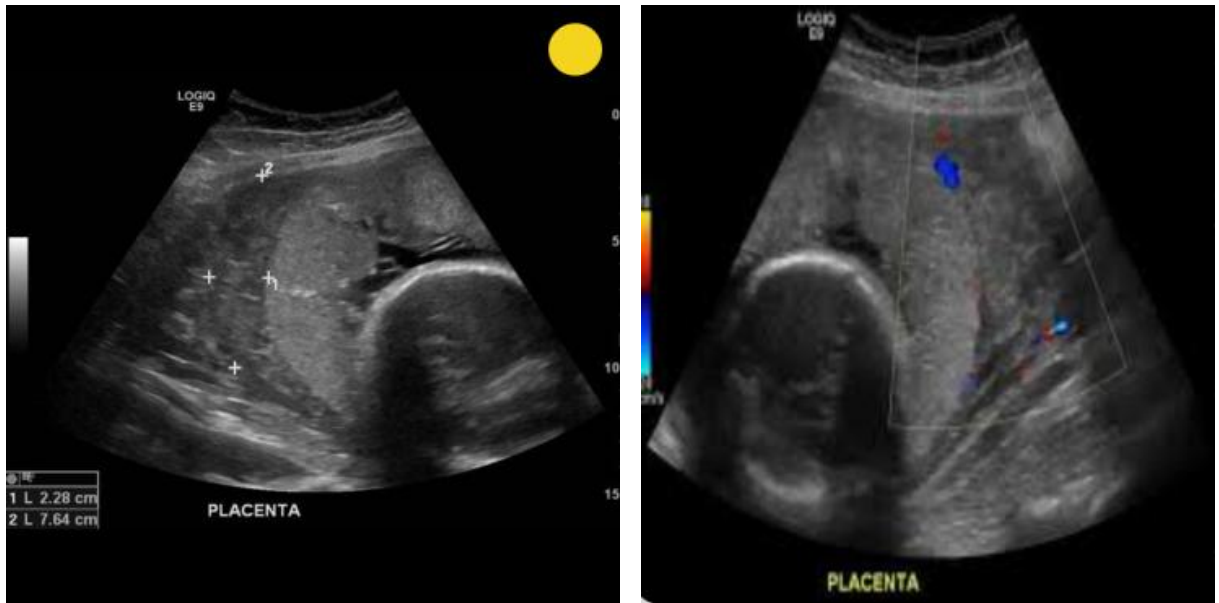
Cord around the neck

4. Placenta Assessment

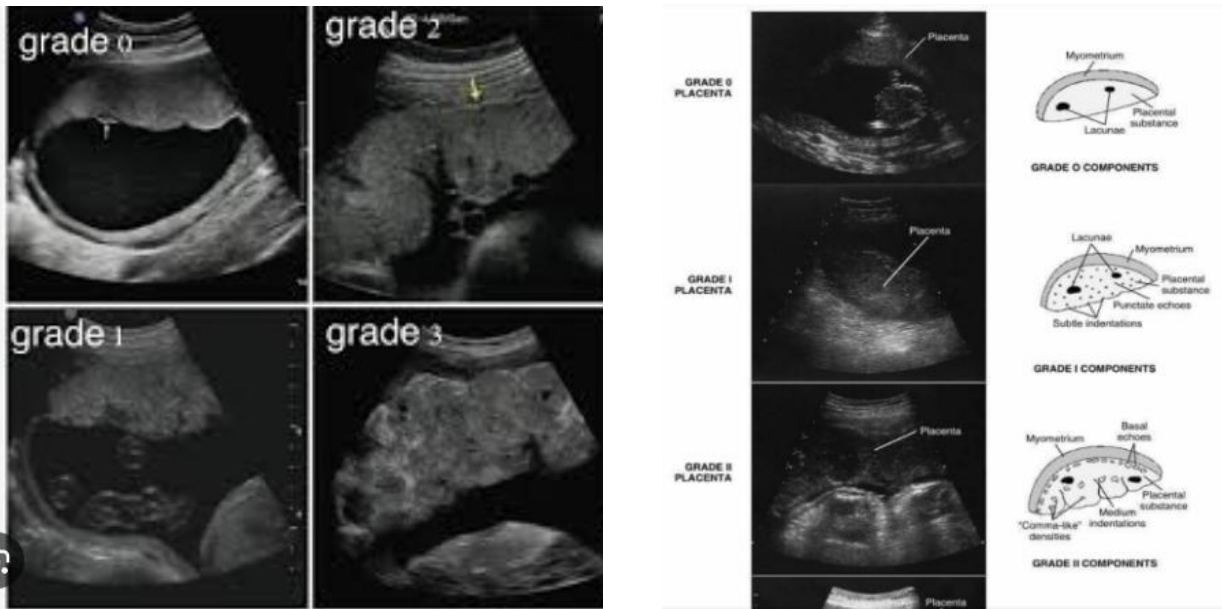
- Location:
 - fundal, anterior, posterior, low lying
 - Low-lying
 - Distance from os
 - (if < 2cm low lying)
 - Check: Distance from cervix
 - Look for:
 - Placenta previa (referral)
 - Retroplacental hemorrhage (Abruptio)
 - Urgent referral
- Placental grading
 - Grade 0 – III
 - Grade III > 39 weeks
 - Possible postdate >42 weeks



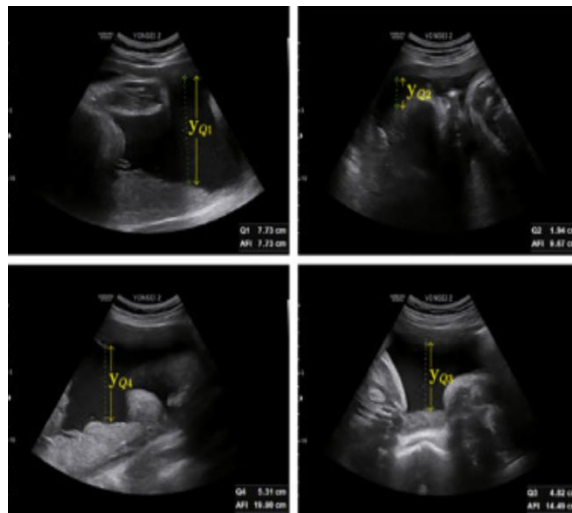
Placenta



Placenta previa (referral)



Retroplacental hemorrhage (Abruptio)



5. Amniotic Fluid Assessment

Method: AFI (preferred) or Single Deepest Pocket (MVP)

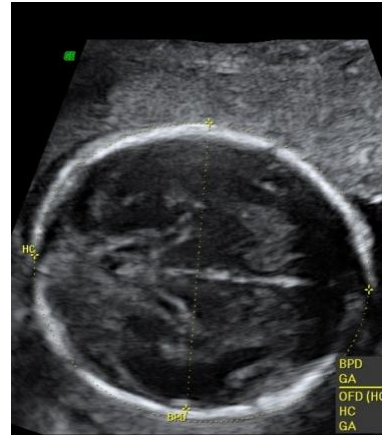
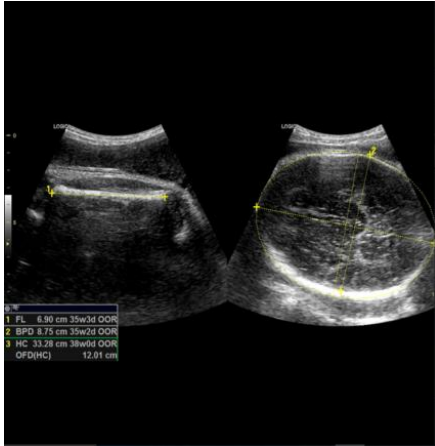
- Normal: ~5–24 cm
- Oligohydramnios: <5 cm
- Polyhydramnios: >24 cm
- Maximum vertical pocket (MVP): Normal: 2-8cm
- Pocket with no fetal parts or cord

6. Fetal Biometry

Measure:

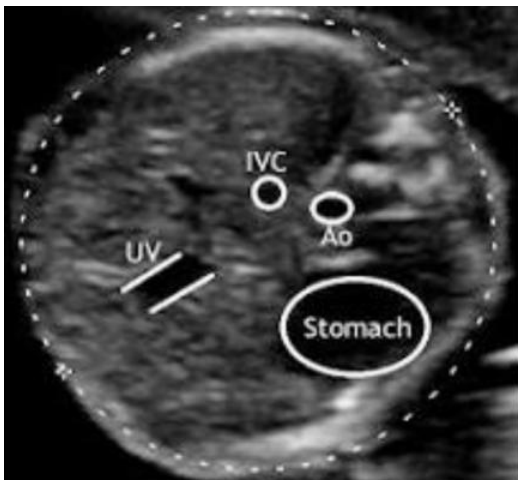
✦ Biparietal Diameter (BPD)

- Axial view of head
- Landmarks:
 - Thalami
 - Cavum septum pellucidum



✦ Abdominal Circumference (AC)

- Round abdomen
- Landmarks:
 - Stomach
 - Umbilical vein



✦ Femur Length (FL)

- Longest bone
- Measure full length

✦ Head Circumference (HC)

7. Estimated Fetal Weight (EFW)

- Use machine calculation (At least four of the above biometry needed depending on the machine) in Kg or grams (if grams divide by 1000 to change to Kg in your report)
- Or chart reference
- Compare with growth curve and GA
 - Below growth curve: May suggest IUGR
- 4kg or more: Macrosomia : referral

8. Basic Wellbeing and Biophysical Profile (BPP)

- **Fetal Breathing Movements:** At least one episode of 30+ seconds within 30 minutes.
- **Fetal Movement:** At least three discrete body/limb movements.
- **Fetal Tone:** At least one episode of extending and flexing an extremity.
- **Amniotic Fluid Volume:** At least one pocket of fluid measuring at least 2 cm.
- **Nonstress Test (Heart Rate):** Two or more accelerations of heart (if cardiotocography (CTG) equipment is available. *(Most times unavailable in the scan room being a non-sonographic test)*)
- **Scored as 0 (abnormal) and 2 (normal) over 10 if Nonstress test was done using CTG or over 8 in the absence of CTG.** Score of 6 and above acceptable, score of 4 or less is abnormal
- **A continuous observation for at least 30 minutes is must** before defining any variable as “absent”, or abnormal and scored 0

2. INTERPRETATION GUIDELINES

● Normal Findings

- Growth appropriate for GA
- Normal AFI
- Normal placenta location
- Cephalic presentation (late pregnancy)

● Abnormal Findings (MANDATORY REFERRAL)

- No fetal heartbeat
- Suspected fetal distress (from heart rate measurement)

- Breech or transverse (late term)
- Low-lying placenta / previa/ retroplacental haemorrhage or collection
- Oligohydramnios / polyhydramnios
- Suspected IUGR (small measurements- disparity between GA and growth curve)
- Large baby (macrosomia suspicion > 4kg)
- Multiple pregnancy
- Cord around the neck
- Any gross congenital anomaly
- **Any uncertainty**

3. EXPANDED REPORTING TEMPLATE (STANDARD)

STANDARDIZED 3rd TRIMESTER ULTRASOUND REPORT

Patient Information

- Patient ID: full name and hosp. No (if hosp No. unavailable use client's phone number)
- Age:
- Gravidity/Parity:
- LMP:
- GA (by dates):

Scan Findings

1. Fetal Status

- Viability: Present / Absent
- Number: Single / Multiple- presentation of 1st twin

2. Presentation

- Cephalic / Breech / Transverse / Cord / Limbs

3. Placenta

- Location:
- Grade (Grade 0, I, II, III): Grade III >39weeks
- Distance from os (if < 2cm low lying)

4. Amniotic Fluid

- AFI:
- Interpretation: Normal / Low / High

5. Biometry

- BPD:
- AC:
- HC:
- FL: (if only one parameter to be assessed, use FL)
- EFW:

6. Growth Assessment

- Appropriate for GA / Small / Large

7. Additional Findings

- Post date, Gross Congenital anomalies

IMPRESSION (VERY IMPORTANT)

- Normal pregnancy
OR
- Suspected IUGR / abnormal fluid / abnormal presentation

PLAN

- Reassure
- Follow-up
- Refer (urgent / routine)

4. GUIDELINES FOR TRAINEES

Trainee must:

- Correctly identify presentation in $\geq 90\%$ cases
- Accurately measure BPD, AC, FL
- Recognize abnormal AFI
- Make correct referral decision

△Common Errors to Avoid

- Wrong plane for BPD/AC
- Measuring oblique femur
- Overcalling placenta previa
- Ignoring maternal history
- Poor documentation

5. QUALITY ASSURANCE PROTOCOL

Daily Practice

- Save images:
 - BPD
 - AC
 - FL
 - Placenta
- Document all scans

Supervisor Review

- Weekly review of:
 - 5–10 scans per trainee
- Feedback:
 - Measurement accuracy
 - Interpretation

Equipment Checks

- Probe functioning
- Power back up

6. FIELD CHECKLIST (PRINTABLE)

3rd TRIMESTER ULTRASOUND CHECKLIST

Patient & Setup

- Confirm patient ID
- Explain procedure
- Proper positioning

Scan Steps

- Fetal heartbeat present
- Number of fetuses
- Presentation identified
- Placenta location assessed
- AFI measured

Biometry

- BPD measured correctly
- AC measured correctly
- FL measured correctly

Interpretation

- Growth assessed
- Normal vs abnormal identified

Decision

- Reassure
- Follow-up
- Refer

Documentation

- Report completed
- Images saved
- Logbook updated

7. COUNSELLING PROTOCOL (IMPORTANT)

Simple Language Examples:

- “Your baby is doing well.”
- “The baby is small; we need to send you to a bigger hospital.”
- “The placenta is low; you need further care.”

8. FINAL NOTE (CRITICAL)

This level of ultrasound is:

- **Basic screening**, NOT definitive diagnosis
- Designed to:
 - Detect risk
 - Trigger referral

THIRD TRIMESTER OBSTETRIC ULTRASOUND – JOB AID

Hypothetical Quick Reference for Midwives, CHOs, Nurses & Sonographers



1 SCAN SEQUENCE – STEP BY STEP

- 1 PREPARE**
 - Confirm patient ID
 - Explain procedure
 - Position: Supine, slight left tilt
- 2 CHECK VIABILITY**
 - Fetal heartbeat present?
- 3 NUMBER OF FETUSES**
 - Single or Multiple?
- 4 PRESENTATION**
 - Cephalic / Breech / Transverse
- 5 PLACENTA LOCATION**
 - Fundal / Anterior / Posterior / Low-lying / Previa
- 6 AMNIOTIC FLUID**
 - Measure AFI
 - Normal / Low / High
- 7 BIOMETRY**
 - BPD, AC, FL
 - Calculate EFW
- 8 INTERPRETATION**
 - Normal or Abnormal?
 - Decide: Reassure / Follow-up / Refer
- 9 DOCUMENT & COUNSEL**
 - Complete report
 - Counsel mother
 - Plan follow-up

2 FETAL PRESENTATION – WITH IMAGES

CEPHALIC (Head Down)
Round head seen in pelvis with spine above.

BREECH (Buttocks/ Feet Down)
Buttocks or feet seen in pelvis.

TRANSVERSE (Sideways)
Fetal back across uterus horizontally.

3 PLACENTA LOCATION – WITH IMAGES

FUNDAL (Top of uterus)

ANTERIOR (Front wall)

POSTERIOR (Back wall)

LOW-LYING (Near cervix)

PLACENTA PREVIA (Covers cervical os)

IF LOW-LYING OR PREVIA → REFER

4 AMNIOTIC FLUID ASSESSMENT (AFI)

HOW TO MEASURE AFI – 4 QUADRANTS

1. Divide uterus into 4 quadrants with an imaginary line.
2. Measure the deepest vertical pocket (cm) in each quadrant.
3. Add all 4 measurements = AFI (cm)

AFI INTERPRETATION	
AFI (cm)	INTERPRETATION
< 5	Oligohydramnios (Low) – REFER
5 – 24	Normal
> 24	Polyhydramnios (High) – REFER

If AFI not possible, use single deepest vertical pocket (SDVP). Normal SDVP ≥ 2 cm

5 BIOMETRY – HOW TO MEASURE (WITH REAL IMAGES)

A. BIPARIETAL DIAMETER (BPD)
Plane: Axial view of the head

HOW TO MEASURE

- Place calipers on outer edge of parietal bones
- Ensure thalami & CSP are visible

B. ABDOMINAL CIRCUMFERENCE (AC)
Plane: Transverse view of abdomen

HOW TO MEASURE

- Elliptical shape of abdomen
- Include skin line
- Stomach & umbilical vein should be visible

C. FEMUR LENGTH (FL)
Plane: Longitudinal view of femur

HOW TO MEASURE

- Measure the longest portion of femur
- Include both echogenic ends

D. ESTIMATED FETAL WEIGHT (EFW)
Calculated automatically by machine using BPD, AC, FL ± HC
OR
Use Johnson & Toshach / Hadlock chart (if machine not available)

GROWTH ASSESSMENT	
EFW for GA	Interpretation
10th – 90th	Appropriate
< 10th	Small for GA (IUGR) – REFER
> 90th	Large for GA (Macrosomia) – Consider referral

6 QUICK DECISION GUIDE (HYPOTHETICAL CASE EXAMPLES)

ANY ABNORMAL FINDING?

NO → **CASE A: NORMAL SCAN**
• All findings within normal range
→ **REASSURE & ROUTINE CARE**

YES → **CASES B–F: ABNORMAL / HIGH RISK**

- No fetal heartbeat
- Breech / Transverse (late)
- Placenta previa / Low-lying
- AFI < 5 or > 24 cm
- IUGR or Large for GA
- Multiple pregnancy
- Any major anomaly
- Uncertain findings

→ **REFER (Urgent / Routine)**

Always correlate with clinical findings and history

7 ULTRASOUND REPORT – QUICK TEMPLATE (HYPOTHETICAL)

Patient Name: _____ Date: _____
 GA (by dates): _____ weeks G ____ P ____ A ____

Indication: _____

FINDINGS	
Fetal Heartbeat:	Present / Absent
Number of Fetuses:	Single / Multiple
Presentation:	Cephalic / Breech / Transverse
Placenta Location:	Fundal / Anterior / Posterior / Low-lying / Previa
AFI (cm):	(Normal / Low / High)
Biometry	
BPD (mm):	_____
AC (mm):	_____
FL (mm):	_____
EFW (g):	_____
Growth Assessment:	Appropriate / Small / Large
Other Findings:	_____
IMPRESSION:	
PLAN:	Reassure / Follow-up / Refer
Comments:	_____
Sonographer: _____	Supervisor: _____

8 COUNSELLING – KEY MESSAGES (EXAMPLES)

WHEN FINDINGS ARE NORMAL

Your baby is growing well. Continue your antenatal care.

WHEN FINDINGS ARE ABNORMAL

We found something that needs more care. We will refer you to a bigger health facility.

WHEN FOLLOW-UP IS NEEDED

We will see you again on (date) to check the baby. Please come back.

9 RED FLAGS – REFER IMMEDIATELY

- ! No fetal heartbeat after 20–22 weeks
- ! Heavy bleeding / Placenta previa
- ! Severe oligohydramnios (AFI < 5 cm)
- ! Severe polyhydramnios (AFI > 24 cm)
- ! Severe fetal growth restriction
- ! Multiple pregnancy with complications
- ! Major fetal anomaly suspected
- ! Reduced fetal movement ± abnormal scan
- ! Any uncertainty / cannot complete scan

10 COMMON PITFALLS – AVOID

- ✗ Wrong plane (BPD)
- ✗ Oblique measurement (AC)
- ✗ Poor image (too dark/bright)
- ✗ Not including bone edges (FL)
- ✗ Calipers not on bone edges (BPD)
- ✗ Not measuring deepest pocket (AFI)

11 DAILY QUALITY CHECKLIST

- ✓ Machine working well
- ✓ Probe clean and intact
- ✓ Image clear (depth, gain, focus)
- ✓ Correct measurements taken
- ✓ Report completed
- ✓ Images/measurements saved
- ✓ Logbook updated
- ✓ Patient counselled
- ✓ Referral done if needed

12 KEY SAFETY PRINCIPLES (WHO/ISUOG)

- ✓ Use ultrasound only when clinically indicated
- ✓ ALARA principle – keep exposure As Low As Reasonably Achievable
- ✓ Focus on essential findings only
- ✓ Do not use ultrasound for non-medical purposes
- ✓ Maintain privacy, dignity and respect
- ✓ Document and store findings accurately
- ✓ Refer when in doubt – patient safety first