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Imaging in Obstetrics and Gynecology

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5

CHAPTER

Ultrasound in Third Trimester

Vandana Bansal, Rupal Parekh

BACKGROUND

The main objective of third trimester obstetrical ultrasound examination is to provide accurate diagnostic information regarding fetal growth (both growth restriction and macrosomia) and Doppler flows, fetal wellbeing, amniotic fluid volume, fetal presentation, placental localization and cord insertion and may also be used as a second look for various late onset fetal anomalies.

The rationale is to identify and triage risk pregnancies and improve outcomes via timely management. This is not solely possible by clinical examination alone. It helps in reducing maternal and neonatal morbidity and mortality by timely diagnosis, timely decisions and interventions and better postnatal preparedness towards managing early neonatal problems.

CURRENT SCENARIO OF OBSTETRIC IMAGING IN INDIA AND THE WORLD

It is universally recommended that all high-risk pregnancies should be offered serial ultrasound for growth assessment from 26–28 weeks of gestation. Additionally, third trimester scan is used selectively in late pregnancy where there are specific clinical indications. Routine late pregnancy ultrasound screening in unselected low-risk population is currently not recommended by most guidelines due to insufficient evidence of its benefit and the lack of cost effectiveness in resource constrain settings. However more and more recent studies have shown that routine third trimester ultrasonography, including Doppler, can help in risk-stratification of otherwise clinically low-risk pregnancies and improve perinatal survival.

The Ministry of Health and Family welfare government of India has published guidelines on the use of ultrasonography during pregnancy which recommend only one obstetric ultrasound during pregnancy between 18 and 19 weeks of pregnancy as part of routine Ante Natal Care (ANC) package which provides opportunity to diagnose congenital anomalies and detect soft markers of aneuploidy. This single scan will also give information on gestational age and number of live fetuses with placental location and pelvic pathology if any. Additional ultrasound examinations can be done if clinically indicated. There is no mention of a third trimester ultrasound in our Indian guidelines.[1]

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WHO recommendations on antenatal care for a positive pregnancy experience (2016) states one ultrasound scan before 24 weeks should be done for pregnant women to estimate gestational age, improve detection of fetal anomalies and multiple pregnancies, reduce number of inductions for post term pregnancy and improve a woman's pregnancy experience. No routine doppler ultrasound examination in the third trimester nor any late pregnancy scan is recommended.[2]

Hence the need for any additional third-trimester scans is based on local guidelines, clinical requirement and presence of maternal or fetal risk factors that are known to be associated with abnormal growth.

INDICATIONS/COMPONENTS OF ULTRASOUND EXAMINATION IN THIRD TRIMESTER

A standard list of indications for which a second or third trimester ultrasound may be asked for has been enumerated by the AIUM ACR ACOG SMFM SRU guidelines on Practice parameters for performance of standard diagnostic ultrasound examination, 2018.[3] These may be indicated at any time even in the third trimester as per the clinical situation. The starred indications may not be accurately determined in the third trimester and are more accurate in the second trimester but in developing countries like ours, this may be the first time that the patient may report for ultrasound.

Standard Second and Third Trimester USG Examination[3]

1. *Estimate gestational age**
2. *Number of feti and chorionicity**
3. Identify fetal presentation and placental location
4. Evaluation of fetal anatomy and follow-up screening for the anomalies*
5. Assessment of cervical length
6. Assess fetal wellbeing with fetal growth and color doppler.
7. Evaluation of a significant discrepancy between uterine size and clinical gestational age, poor maternal weight gain
8. Suspected amniotic fluid abnormalities
9. Evaluation of premature rupture of membranes and/or preterm labor
10. Evaluation of vaginal bleeding
11. Evaluation of abdominal or pelvic pain
12. Suspected placental abruption in antepartum bleeding
13. Evaluation of placental pathology such as placenta previa and morbidly adherent placenta spectrum
14. Suspected fetal death for viability
15. Adjunct to amniocentesis, CVS, fetal reduction or other invasive procedure
16. Adjunct to maneuver such as external cephalic version

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17. Evaluation of a pelvic mass*
18. Suspected uterine anomalies*

IMAGING PARAMETERS FOR A STANDARD EXAMINATION IN THIRD TRIMESTER[3]

- *Fetal cardiac activity, fetal number, and presentation* should be documented. Abnormal heart rate and rhythm should be documented. Ultrasound is also used for the confirmation of malpresentations where Leopold maneuvers may not be sensitive enough. Obstetric management would change with the diagnosis of a malpresentation at term. Multiple gestations require the documentation of additional information: chorionicity, amnionicity, fetal discordancy in growth or CRL and amniotic fluid assessment in each sac by a single vertical pocket.
- A semiquantitative estimate of *amniotic fluid volume (AFV)* should be documented. Either of the parameters can be used such as amniotic fluid index (AFI), single deepest pocket (SDP/MVP), and 2-diameter pocket. For AFI, measure DVP in the 4 quadrants of the uterus that is at least 1 cm wide and is free of fetal parts and cord, while holding the ultrasound transducer perpendicular to the table and parallel to the long axis of the patient's body and add the measurements.
- For oligohydramnios, a cut off value of SVP <2 cm is a preferred criteria over AFI <5 cm since it results in fewer interventions without a significant difference in perinatal outcome. Whereas for polyhydramnios, a cut off of SVP >8 cm or AFI >24 cm can be used. It is preferrable to assess polyhydramnios using AFI.
- For twins single pocket estimation MVP (normal range 2–8 cm) is used.
- The *placental location*, appearance and distance from internal os should be documented. The umbilical cord should be evaluated for number of vessels in the cord and *placental cord insertion site. These should be documented. Also look for placental pathology such as* morbidly adherent placenta and vasa previa using colour Doppler.
- *Fetal weight estimation* can be done from measurements, i.e., BPD, HC, AC and femoral diaphysis length. Scans to assess interval growth velocity should be ideally performed at least 3 weeks apart. A shorter scan interval may result in confusion as even the best weight prediction methods can yield errors as high as +15%. The biometry parameters are plotted against standardized growth charts (e.g., Hadlock, WHO, Intergrowth 21) to assess growth trends.
- *Assessment of fetal wellbeing* in the third trimester includes biophysical profile and additional Doppler parameters, such as umbilical artery Doppler, middle cerebral artery (MCA), ductus venosus and uterine artery Doppler velocimetry.

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- *Pregnancy dating* should not be performed in third trimester due to inherent inaccuracy. However if there are no prior antenatal sonography and the patient report late to the clinician, then the head circumference plus femur length can be used as a third trimester dating parameter with a variation of +15 days.
- *Detection of evolving or missed anomalies:* The third trimester scan should look beyond fetal well-being alone, and look for structural survey as well. The must see planes should be evaluated to rule out any evolving anomaly which presents first time in second half of gestation namely CNS abnormalities, genitourinary/GI tract anomalies or cardiac evolving anomalies.

Fetal Growth Surveillance

Fetal growth restriction (FGR) is an important cause of perinatal morbidity and mortality. Timely diagnosis in the antenatal period along with intensive fetal surveillance such as color Doppler can improve the perinatal outcome.

Ultrasound based fetal growth assessment is the modality of choice when there is a suspicion of clinical discrepancy in symphysio-fundal height and gestational age or a high risk pregnancy due to obstetric factor or medical diseases which predispose to FGR.[4]

Accurate estimation of gestational age is a prerequisite before labeling a fetus as small/large for gestational age. Dating pregnancies is best done by early ultrasound examination at 8–14 weeks (CRL <84 mm) or based on HC (if CRL >84 mm). Dating of pregnancy once defined should not be modified as per the subsequent scans.[5]

As per the ISUOG guidelines, EFW may be used to monitor fetal size and growth. For accurately determining interval growth or identifying a growth lag, a preferable time interval between two ultrasound scans of atleast 3 weeks is suggested. However this interval can be shortened when indicated clinically.5

- *AGA* (appropriate-for-gestational age) fetus is one whose size is within the normal range for its gestational age. AGA fetuses typically have individual biometric parameters and/or EFW between the 10th and 90th percentiles **(Fig. 1)**.
- *SGA* (small-for-gestational age) is a fetus whose size is below the cut off threshold for its gestational age. SGA fetuses typically have EFW or AC below the 10th percentile, although 5th centile, 3rd centile, –2SD and Z-score deviation have also been used as cut-offs in the literature **(Fig. 2)**.
- *FGR* (fetal growth restriction) fetus is one that has not achieved its growth potential. Depending upon the period of onset, fetal growth restriction has been classified into early-onset (detected before 32 weeks' gestation) and late-onset (detected after 32 weeks' gestation) types **(Figs. 3A and B)**.

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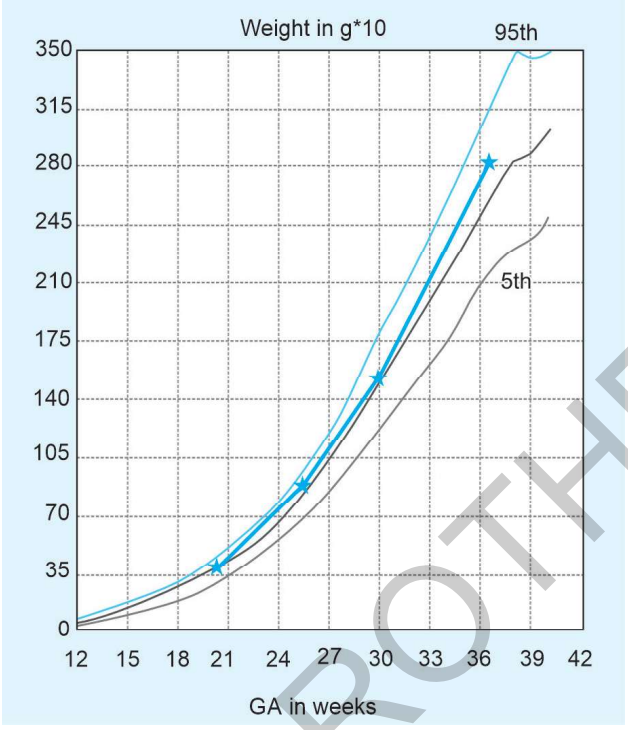


Fig. 1: Appropriate-for-gestational age fetus growth charts.

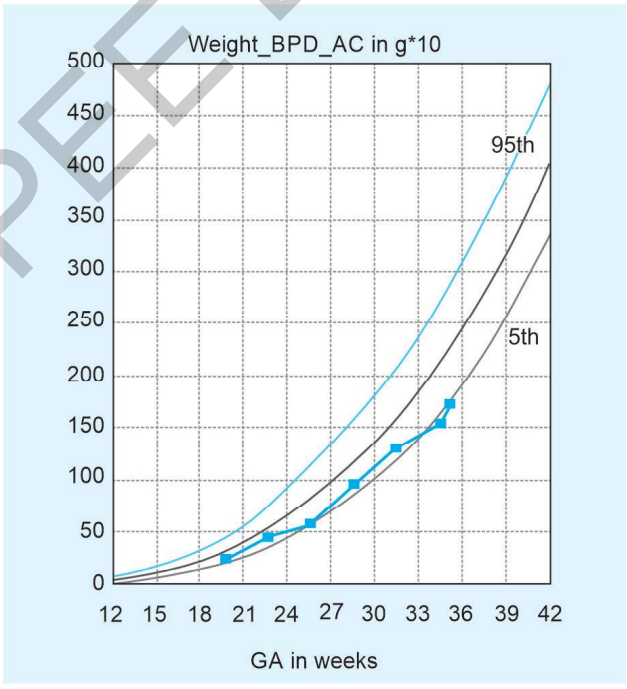
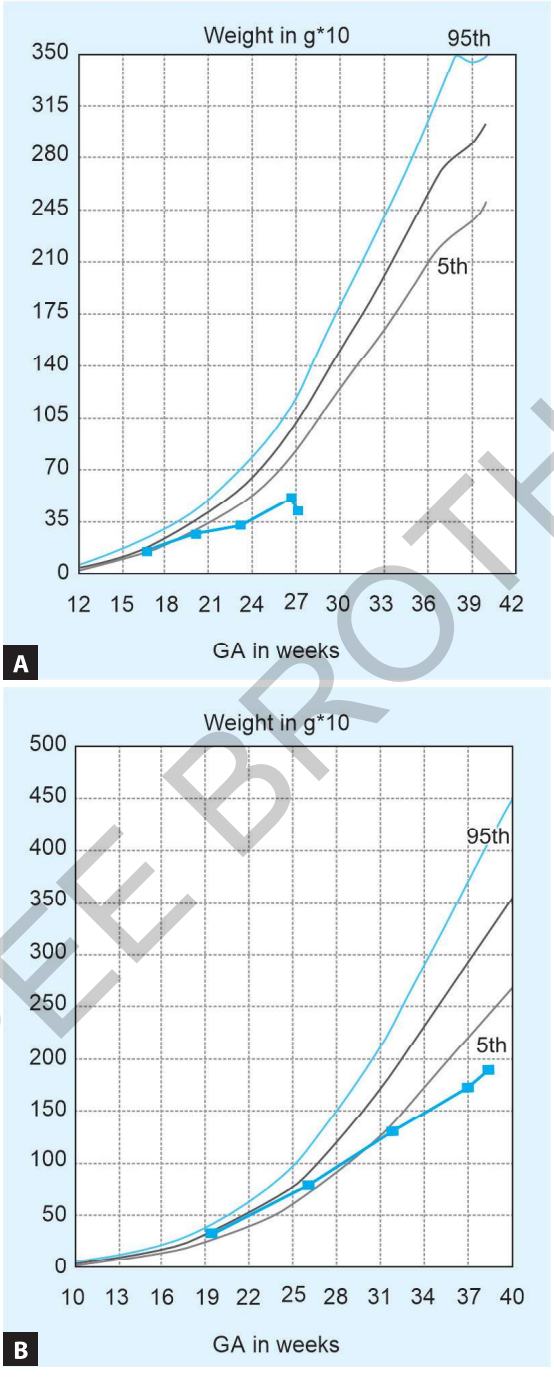


Fig. 2: Small-for-gestational age fetus growth charts.

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Figs. 3A and B: (A) Fetal growth restriction early onset growth charts; (B) Fetal growth restriction late onset growth charts.

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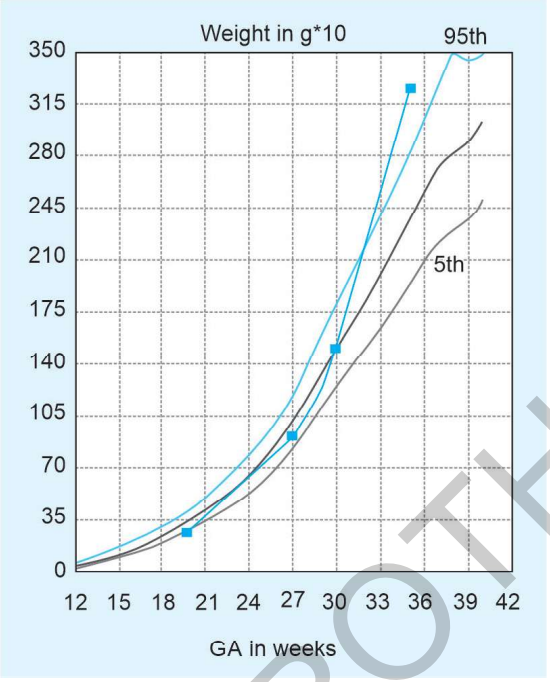


Fig. 4: Large-for-gestational age growth charts.

Another traditional method of classification involves the symmetry of fetal body proportions being indicative of the underlying etiology for FGR. The ISUOG recommendations state that the terms 'symmetrical' and 'asymmetrical' FGR should be abandoned since they do not provide additional information with regard to etiology or prognosis.[5]

- *LGA* (large-for-gestational age) fetus where the fetal size is above cut off threshold for gestational age. LGA typically is defined as EFW or AC above the 90th percentile. Macrosomia at term usually refers to a weight above a fixed cut-off (4,000 or 4,500 g) **(Fig. 4)**. The rationale of identifying macrosomia is to prevent or be prepared for shoulder dystocia which a commonly associated complication. Screening for LGA in the general population may be more accurate when the examination is performed at 36 rather than 32 weeks.

Fetal growth curves have been developed in an attempt to improve the detection rate of SGA, e.g., the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Fetal Growth Studies, INTERGROWTH-21st and World Health Organization Multicentre Growth Reference Study (WHO Fetal). The latter two studies on fetal growth started with the assumption that infants and children of well-off parents represent optimal growth in size and that there would be no differences internationally in fetal growth when conditions were optimal.[6-9] Customized growth charts

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TABLE 1: Consensus-based definitions for early and late fetal growth restriction (FGR) in absence of congenital anomalies.[5,10]

Early FGR: GA <32 weeks, in absence of congenital anomalies	*Late FGR: GA ≥32 weeks, in absence of congenital anomalies*
AC/EFW <3rd centile or UA-AEDF OR • AC/EFW <10th centile combined with • UtA-PI >95th centile and/or • UA-PI >95th centile	AC/EFW <3rd centile OR At least two out of three of the following: • AC/EFW <10th centile • AC/EFW crossing centiles >2 quartiles on growth centiles or more than 50 centiles • CPR <5th centile or UA-PI >95th centile

have also been proposed according to maternal characteristics (height, weight, parity, ethnicity) and fetal gender.[6-9]

FGR is defined as growth below a cut-off value of EFW/AC < 10th centile. However, the main drawback of using this definition is that the10th centile cut-off value varies depending on the chart used and there is considerable overlap between the two categories.

An international Delphi consensus recently proposed that either of two criteria can be used

EFW/AC below 3rd centile as a sole diagnostic criteria Or EFW/AC below 10th centile PLUS associated criteria (as below). A declining trend in centile or Z score on growth charts warrants additional monitoring **(Table 1)**. ISUOG guidelines recommend the diagnostic criteria for sFGR may be based on Delphi consensus criteria.[5,10]

A diagnosis of FGR should trigger referral to an appropriate unit for individualized management. This will include assessment of fetal well-being in order to identify those fetuses requiring delivery. Antenatal testing modalities include: cardiotocography (non-stress test); basic ultrasound tools such as amniotic fluid index assessment; or advanced modality such as biophysical profile (BPP) score; Color Doppler indices of the umbilical artery, middle cerebral artery or a combination of the two (cerebro-placental ratio); and assessment of ductus venosus flow. Stage based approach to management of FGR has been proposed by Gratacos **(Table 2)**.[11]

Doppler for Diagnosis, Etiology and Surveillance in FGR

Once ultrasound biometry identifies a fetus as SGA (EFW <10th centile), Doppler velocimetry is extremely useful for making the critical differentiation between constitutionally small healthy (<10th centile) fetuses and the pathological growth restricted fetuses and stratify small fetuses which require more surveillance. Doppler flow provides insight into the etiology of fetal growth restriction and is used in monitoring of FGR.

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TABLE 2: Stage-based classification and management of FGR.

Stage	*Pathophysiological correlate*	*Criteria (any of)*	*Monitoring*	*GA/mode of delivery*
I	Severe smallness or mild placental insufficiency	• EFW <3rd centile • CPR <p5 • UA PI >p95 • MCA PI <p5 • UtA PI >p95	Weekly	37 weeks LI
II	Severe placental insufficiency	UA AEDV	Biweekly	34 weeks CS
III	Low-suspicion fetal acidosis	• UA REDV • DV-PI >p95	1 – 2 days	30 weeks CS
IV	High-suspicion fetal acidosis	• DV reverse a flow • c CTG <3 ms • FHR decelerations	12 h	26 weeks CS

Umbilical Artery Doppler

American college of Obstetrics and Gynecology recommends use of Umbilical Artery Doppler (UAD) as a standard method for antepartum fetal surveillance in FGR fetus. Its use in SGA fetus is associated with significant reduction in perinatal mortality rates (29% reduction) as well as reduced iatrogenic intervention.[11]

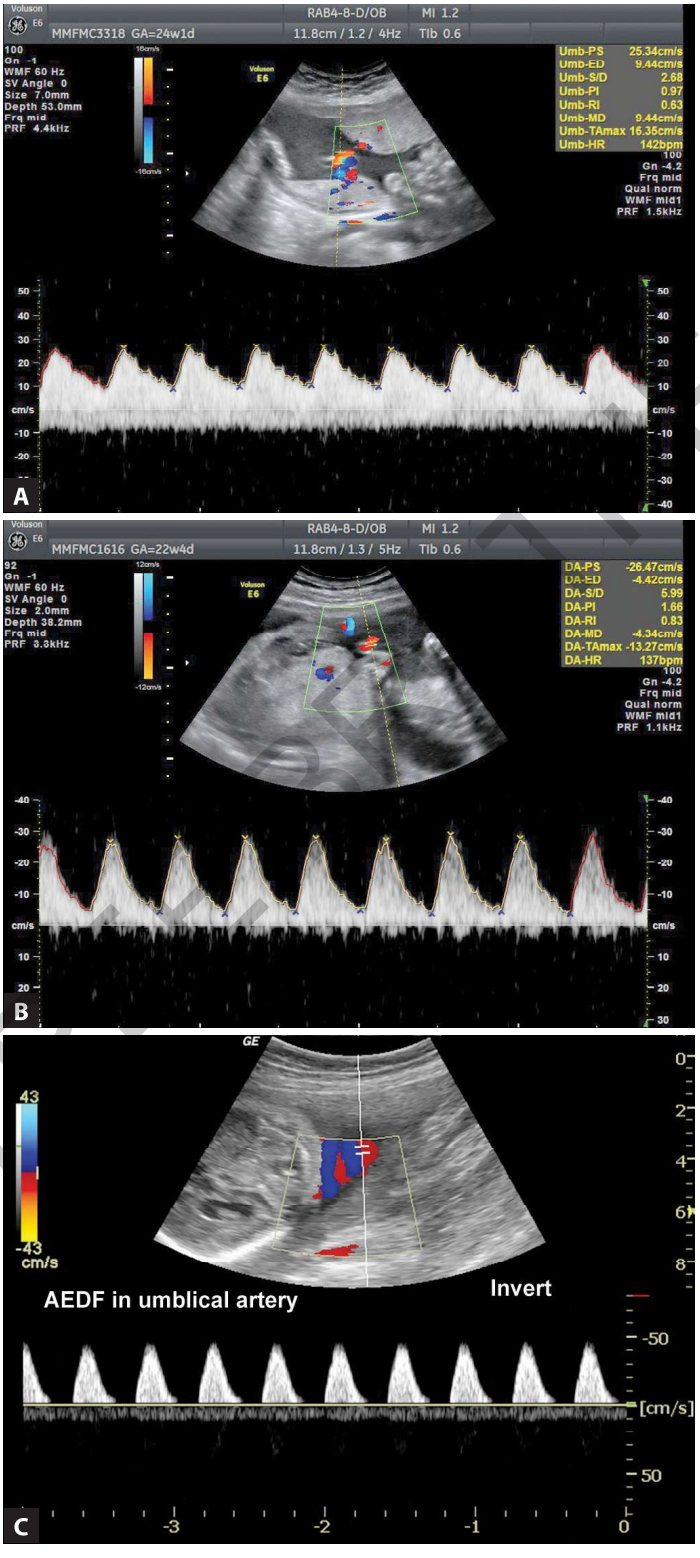
Whereas uterine artery reflects trophoblastic invasion and placental development, Umbilical Artery Doppler reflects placental function and indicates degree of placental insufficiency. It correlates with the tertiary villous architecture and blood flow resistance. Umbilical artery Doppler resistance is elevated if at least 30% of fetal villous vasculature becomes abnormal. Umbilical Artery absent diastolic flow indicates 60–70% damage to villous vascular architecture and an increased risk of perinatal mortality **(Figs. 5A to D)**.

Measurements of umbilical artery doppler indices should be made in a free cord loop. Impedance is highest at the fetal end and lowest at placental end. S/D, RI, PI reference value varies at different gestational age and they can be plotted on centile charts. The PI offers the advantage of smallest measured error, narrower reference limit and advantage of ongoing numeric analysis even when diastolic flow is absent or reversed.[12]

Middle Cerebral Artery Doppler Flow

Middle Cerebral Artery Doppler (MCA) flows depict fetal response to hypoxemia. The fetus adapts itself to chronic hypoxemia with preferentially diverting blood to vital organs (brain, heart and adrenals) leading to increased diastolic flow in the MCA and decrease in doppler indices (Brain sparing effect/Cerebral vasodilatation/Centralization). MCA is particularly valuable

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RAB4-8-D/OB MI 1.2
MMFMC3318 GA=24w1d 11.8cm / 1.2 / 4Hz Tib 0.6
Umb-PS 25.34cm/s
Umb-ED 9.44cm/s
Umb-S/D 2.68
Umb-PI 0.97
Umb-RI 0.63
Umb-MD 9.44cm/s
Umb-TAmax 16.36cm/s
Umb-HR 142bpm
A
RAB4-8-D/OB MI 1.2
MMFMC1616 GA=22w4d 11.8cm / 1.3 / 5Hz Tib 0.6
DA-PS -26.47cm/s
DA-ED -4.42cm/s
DA-S/D 5.99
DA-PI 1.66
DA-RI 0.83
DA-MD -4.34cm/s
DA-TAmax -13.27cm/s
DA-HR 137bpm
B
GE
43
-43 cm/s
AEDF in umblical artery
Invert
[cm/s]
C

Figs. 5A to C

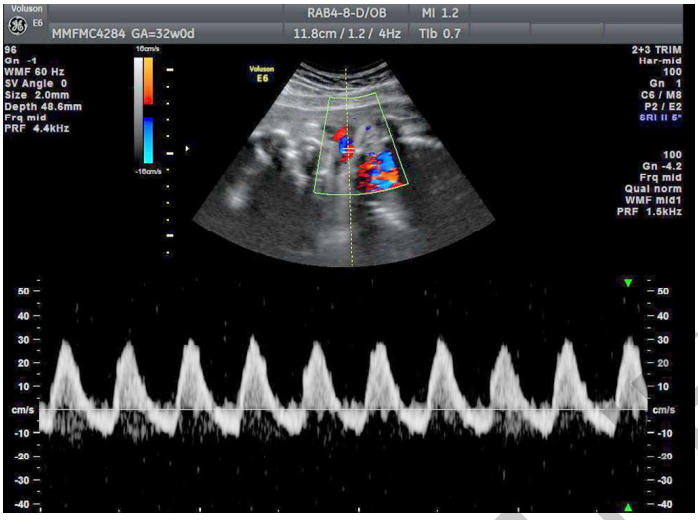


Fig. 5D

Figs. 5A to D: (A) Normal umbilical artery Doppler; (B) High resistance umbilical artery Doppler; (C) Absent diastolic flow umbilical artery Doppler; (D) Reversed diastolic flow umbilical artery Doppler.

for the identification and prediction of adverse outcome among late-onset FGR, independently of the UA Doppler, which is often normal in these fetuses **(Figs. 6A and B)**.[11]

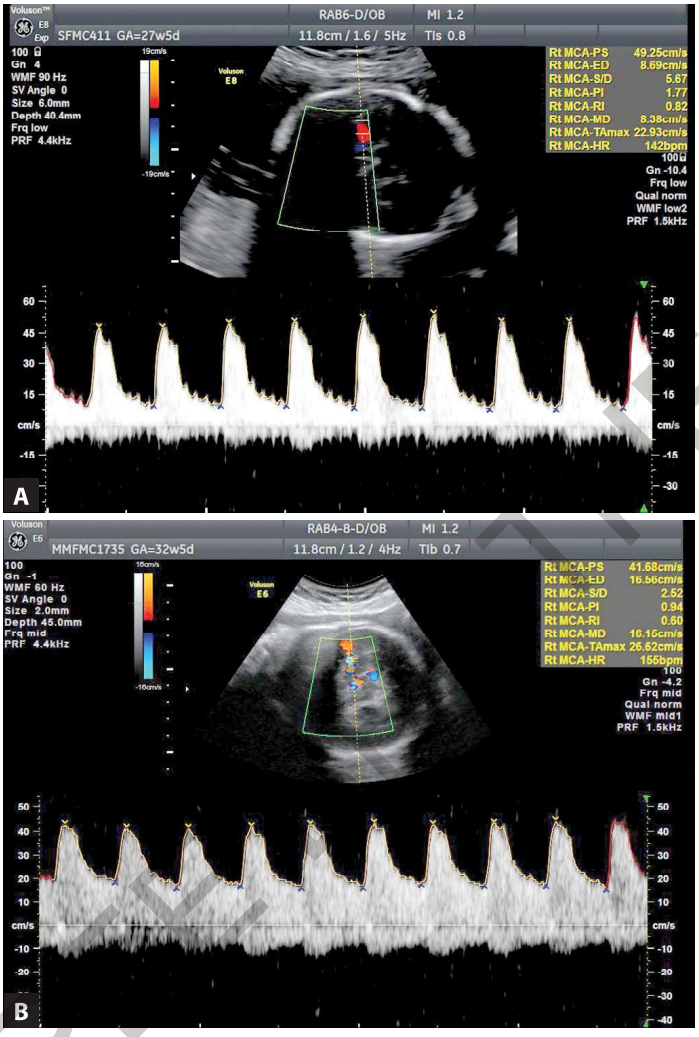
While evaluating MCA for pulse wave doppler measurement, sample gate should be placed at proximal third of the MCA, near the origin in the internal carotid artery. Systolic velocity is inversely variable with distance from origin point.

The highest point of the waveform is considered as PSV (Peak systolic velocity in cm/s). Fetal middle cerebral artery doppler for peak systolic velocity is a non-invasive means to assess fetal anemia in Rh isoimmunized pregnancies.[12]

Cerebroplacental ratio: Cerebroplacental ratio (CPR) is the ratio between the middle cerebral artery pulsatility index (MCA-PI) and the umbilical artery pulsatility index (UA-PI). The CPR is essentially a diagnostic index that improves the sensitivity of UA and MCA alone in late onset FGR. A reduced MCA PI or MCA/umbilical artery PI ratio (cerebroplacental ratio <1) are early signs of hypoxemia in late FGR.

Ductus venosus doppler: DV is the strongest marker among all Doppler parameters to predict the short-term risk of fetal death in early-onset FGR. DV flow waveforms become altered only in advanced stages of fetal compromise Thus, absent or reversed 'a' wave pattern is normally considered sufficient to recommend delivery at any gestational age, after completion of steroids **(Figs. 7A and B)**.[11]

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Figs. 6A and B: (A) Middle cerebral artery normal Doppler; (B) Middle cerebral artery Doppler showing brain sparing effect.

The waveform is usually triphasic, (M-shape) that reflects pressure volume changes in right atria through cardiac cycle. Normal blood flow in DV is forward flow throughout the cardiac cycle. Doppler measurement is best achieved in the sagittal plane from the anterior lower fetal abdomen.[12]

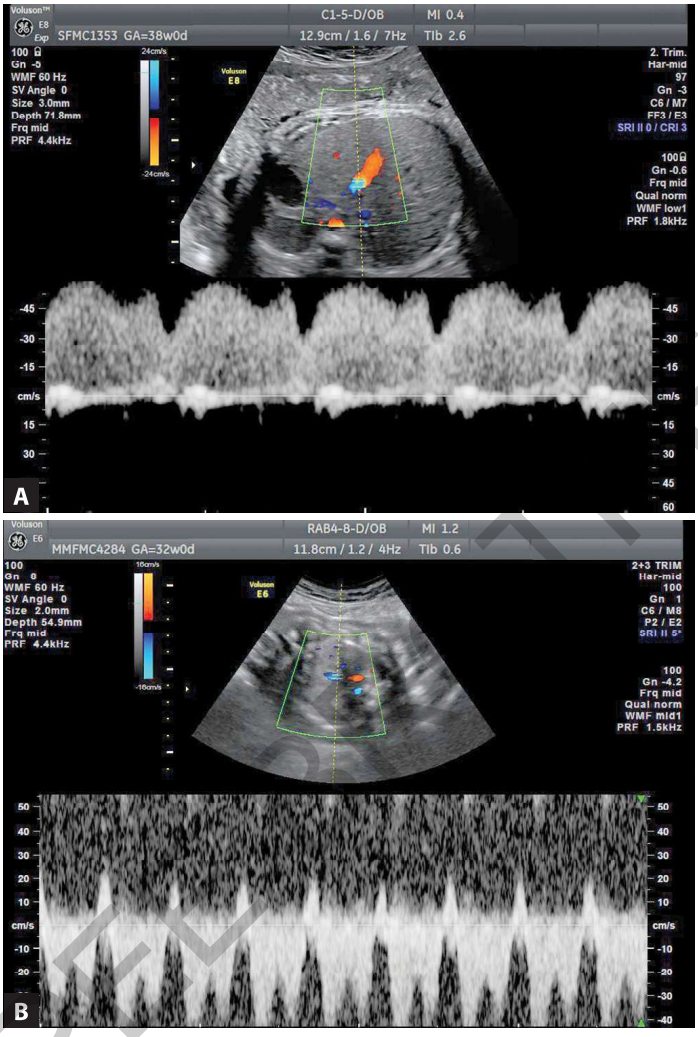
Based upon Doppler changes, Stage based approach to management of FGR has been proposed by Gratacos **(Table 2)**.[11]

Antepartum Fetal Surveillance

Biophysical Profile

Fetal biophysical scoring originally described by Manning et al, is based on assessment of five discrete biophysical variables. Four of the

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Figs. 7A and B: (A) Ductus venosus normal Doppler; (B) Reversed a wave in ductus venosus Doppler.

variables (except NST) namely, fetal breathing movements, gross body movements, fetal tone, and amniotic volume (fetal urine output) are monitored simultaneously by dynamic ultrasound imaging. These variables are dependent on the integrity of the fetal CNS and show abnormal response in a compromised fetus **(Table 3)**.[13]

A composite value of 8 or 10 indicates that the fetal status is reassuring or normal as long as the score of 8 does not include an abnormal amniotic fluid volume. The presence of oligohydramnios demands further testing or delivery, irrespective of the composite score value. A score of 6 is equivocal and requires further testing in 24 hours if less than 37 weeks or consideration for delivery if >37 weeks. A BPP score of 4 or less is suggestive of fetal compromise and an indication for delivery if salvageable weeks of gestation. If gestational

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TABLE 3: Manning's biophysical profile scoring.[13]

Variable	*Score 2*	*Score 0*
Fetal Breathing movements	≥30 seconds of sustained fetal breathing movements in 30 minutes	<30 seconds of fetal breathing movements in 30 minutes
Fetal movements	≥3 gross body movements in 30 minutes. Simultaneous limb and trunk movements are considered as single movement	≤2 gross body movements in 30 minutes
Fetal tone	At least one episode of motion of a limb from a position of flexion to extension and return to flexion	Fetus in a position of semi- or full- limb extension with no return to flexion with movement; absence of fetal movement is counted as absent tone
Fetal reactivity	Two or more FHR accelerations of at least 15 beats/minute and lasting at least 15 seconds and associated with fetal movements in 40 minutes	No acceleration or less than 2 accelerations of FHR in 40 minutes
Quantitative amniotic fluid volume	SVP ≥2 cm	SVP <2 cm
Maximal score	10	
Minimal score		0

age less than 32 weeks then extended monitoring during the time of maternal steroid administration maybe appropriate and individualized.[14]

The false negative rate of BPP is 0.7/1000, a value better than that of the NST i.e. antepartum death of a structurally normal fetus within one week of a normal BPP. The negative predictive value of BPP is similar to NST (98.5%). The positive predictive value of an abnormal test is 50.8%. More than 97% of the pregnancies tested have normal test results.[14]

The gradual hypoxia concept suggest that not all variables carry same power. Fetal heart rate reactivity (NST), amniotic fluid volume and fetal breathing movements are the most powerful markers of perinatal outcome. Amniotic fluid volume reflects chronic changes in intrauterine oxygenation, whereas the other 4 variables are indicators of a more acute state.[14]

Biophysical profile is time consuming and requires ultrasound training. However, it has no contraindications and involves no risk for the mother or the fetus. It is both more sensitive and more specific in predicting abnormal outcome than the NST.

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Modified Biophysical Profile

Several abbreviated modifications of the original BPP have been introduced in order to rationalize the use of human and equipment resources without impairing test performance.

The modified BPP, proposed by Vintzileos et al, describes a testing scheme using the most powerful components of the BPP, NST (using Acoustic stimulation test, AST) with an evaluation of the amniotic fluid. Thus, this modification assesses both the most sensitive acute marker (fetal heart rate tracing) and chronic marker (amniotic fluid volume) of fetal well-being.[15] AST is used to shorten the time required to achieve a reactive NST.

The test has excellent negative and positive predictive values. It is easy to interpret, has clearly defined end points, and can be performed in a short period of time about 20 minutes[15]:

- If both NST and amniotic fluid index are normal, weekly fetal surveillance with MBPP is continued.
- If both tests are abnormal (Nonreactive NST, decreased amniotic fluid volume) and the gestational age is beyond 36 weeks the preferred option would be delivery. If gestational age is below 36 weeks, then management is individualized. Doppler studies, full BPP, or delivery may be used to depending on the circumstances.
- If amniotic fluid volume is decreased but the NST is reactive, a search for indicators of placental insufficiency or undiagnosed rupture of membranes need to be undertaken and management will be dependent on the final diagnosis.
- If amniotic fluid is normal and NST is Nonreactive, further testing with full BPP or Doppler is indicated.

Overall, the MBPP has a false positive rate (60 %) comparable to the NST, but higher than a full BPP. The false negative rate (0.8/1,000), decreased testing time and the ease of performance of MBPP make it an excellent approach for the evaluation of high-risk patients in large numbers. The ACOG [American College of Obstetricians & Gynecologists] guidelines in 2014, have concluded that the modified BPP test is as predictive of fetal well-being as other approaches to biophysical fetal surveillance[15].

Amniotic Fluid Volume (AFV)

The American College of Obstetricians and Gynecologists ACOG has defined Oligohydramnios as SVP <2 cm or AFI <5 cm. For oligohydramnios look for additional USG parameters including Fetal growth and color doppler, KUB system for evaluation for Bilateral renal agenesis, renal disorders or obstructive lesions and target history for premature rupture of membranes.

If polyhydramnios is seen, rule out common associations like maternal diabetes, fetal abnormalities (mostly gastrointestinal obstructions causing

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swallowing impairment like cleft lip, neck tumors, esophageal and duodenal atresia, cardiac and CNS anomalies), chromosomal and genetic abnormalities, conditions that result in anemia and hyperdynamic circulation like placental tumors and fetal infections and idiopathic in 50–60% of cases.

Detection of Late Evolving Fetal Anomalies

A 3rd trimester structural survey is important to screen for evolving anomalies as they may manifest for the first time in later gestation. 50% of all anomalies are detected prior to 24 weeks and other half remain undiagnosed or detected after 24 weeks. Often the early detection of anomaly maybe missed due to smaller size of organs (at earlier stage of development) precluding the assessment, unfavorable fetal position or poor ultrasound machine resolution.

Some anomalies which manifest as functional impairment (e.g. urogenital) are detected for the first time in the third trimester.[16] Also the phenotypic expression of some abnormalities become apparent only at a later gestation, such as short limbs in the case of achondroplasia, dilated bowel in the case of bowel atresia or abnormal shape of the head in the case of craniosynostosis. Some of the abnormalities develops only during the third trimester, such as ovarian cysts in response to maternal estrogenic stimulation or ventriculomegaly following fetal brain hemorrhage or maternal infection.

These anomalies might be overlooked if the third trimester sonography is not done in view to detect anomalies. Among the various anomalies detected in the third trimester about 50% are comprised of central nervous system and the urogenital system. Other organ systems that commonly manifest late anomalies are musculoskeletal and gastrointestinal system.[16]

The potential benefits of diagnosing a fetal anomaly in third trimester, previously undiagnosed, include planning the location, timing, and route of delivery. It may be modified in order to improve perinatal care, the opportunity to arrange for in-utero transfer to an appropriate level of neonatal care; allow the parents time and counselling to prepare for the birth of an anomalous child; perform prenatal genetic analysis such as third-trimester amniocentesis and plan neonatal counselling and follow-up.

In special circumstances where grave consequences are expected for the child then, as per legal permissions (national guidelines) , termination of pregnancy along with feticide, may be opted.

The must see planes along with common conditions to rule out are listed as below **(Table 4)**.

Fetal CNS Abnormalities

About 15% of pregnancies with a fetal CNS abnormality first detected in the third trimester have a previous normal second-trimester anomaly scan.

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TABLE 4: USG planes in third trimester and abnormal findings pointing to potential fetal conditions.

Plane (ultrasound)	*Abnormal findings to watch for*	*Late appearing Potential conditions to rule out*
Head biometry BPD and HC plane	Below -3SD usually associated with cortical anomalies and a sloping forehead	Microcephaly
Head BPD plane—cerebral cortex	Sulcation and gyration	• Poorly formed sulci gyri—lissencephaly • Excessive sulci gyri—polymicrogyria • *Note:* Cerebral cortical defect are difficult to diagnose on USG and may require MRI
Head axial planes—ventricles plane and cerebellar plane	• *Symmetry of the hemisphere* • *Ventricular plane:* Lateral Ventricle measurement >10 mm • Thalamic plane • Cerebellar plane	• Ventriculomegaly • Posterior fossa anomaly • Vein of Galen aneurysm • Arachnoid cyst
Heart	• Situs, size and symmetry of the heart • 4 chamber view, outflow tracts • 3 Vessel Trachea view • Watch for Caliber of great vessels, forward flow, stenosis or regurgitation of flow, chamber asymmetry	• Rhabdomyoma • Great vessels—pulmonary atresia or stenosis, coarctation aorta
Chest	• Sagittal and coronal view and assessment of diaphragm • Any masses—size, midline shift , LHR ratio for CDH • For pleural effusion: Volume of fluid collection and lung volume , hydrops if any	• Congenital diaphragmatic hernia • Pleural effusion • Congenital pulmonary airway malformation
Abdomen	• Any dilated bowel loop • Small bowel -8 mm and large bowel 18 mm • For echogenic bowel, reduce gain setting and check if foci are as echogenic as bone • Associated finding of FGR or TORCH stigma, liver calcification • If any atresia then proximal segment distention • More higher lesions will present with polyhydramnios	• Abdominal Cysts and echogenic bowel • Duodenal atresia • Small and large bowel atresia or Volvulus • ascites

Contd...

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Plane (ultrasound)	*Abnormal findings to watch for*	*Late appearing Potential conditions to rule out*
KUB	Abdominal coronal plane to check if: • Kidneys bilaterally present, bladder • Confirm renal artery arising from aorta • Check renal parenchyma—rule out echogenic or cortex thinning, loss of architecture, cysts if any • If hydronephrosis is seen then measure renal pelvis in axial plane • Renal pelvis anteroposterior (AP) diameter cutoff value in the third trimester is >7 mm, and an AP diameter >15 mm is associated with an increased risk for need of postnatal surgery	• Hydronephrosis • MCDK • PCKD

The most common central nervous system anomalies detected late is mild ventriculomegaly.

Two groups of brain abnormalities that can be diagnosed only in the third trimester are developmental anomalies and acquired lesions. Acquired lesions, include as stroke, hemorrhage, infection and tumors, and the former group includes developmental anomalies such as Vein of Galen malformation, and malformations of cortical development which include microcephaly, megalencephaly, lissencephaly/subcortical band heterotopia spectrum, cobblestone complex, heterotopia, polymicrogyria and schizencephaly which become evident during rapid brain enlargement after the end of the proliferation and migration period (2–5 months of gestation).

Abnormalities of sulci-gyri may be due to single gene disorders or other genetic causes, hence the importance of detailed history cannot be over-emphasized.

Fetal Genitourinary Anomalies

Hydronephrosis is the most common genitourinary abnormality diagnosed at the third trimester scan.

Renal abnormalities include urinary tract dilatation disorders like pelvi-ureteric junction obstruction, vesico-ureteric reflux or obstruction, partial obstructive posterior urethral valves present with varying grades of hydronephrosis with/without hydroureter and/or oligohydramnios at different gestational age depending upon the severity of obstruction and level of obstruction. All urinary tract dilatation require 3–4 weekly

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antenatal monitoring for worsening, oligohydramnios, cortical thickness and echogenicity and fetal maturity so as to decide time of delivery balancing the risk of prematurity versus worsening renal function.

Fetal Gastrointestinal Anomalies

Higher the obstruction earlier is the time of presentation in antenatal period by visualization of polyhydramnios and dilated bowel loops proximal to the obstruction while lower bowel obstruction in the colon or rectum may not become obvious even in the late gestation as the fluid is resorbed in the upstream small bowel and colonic loops.

Prenatal diagnosis of bowel obstruction and referral to tertiary center with early neonatal surgical correction reduces morbidity due to aspiration pneumonia or further abdominal distention with respiratory embarrassment if undiagnosed.

Congenital Lung Malformations

Congenital Pulmonary Adenomatoid Malformation (CPAM) and broncho-pulmonary sequestration (BPS) are fetal lung masses where the natural history may be progression/regression or remains stable antenatally and hence require monitoring in the third trimester for worsening or development of hydrops. Congenital Pulmonary Airway Malformation Volume Ratio (CVR) helps determine the risk of development of hydrops and is an important parameter which is to be considered when counseling such patients. A CVR of ≤1.6 at presentation suggests that the risk of hydrops developing is low in the absence of a dominant large cyst.

Congenital diaphragmatic hernia is a malformation with important implications due to high mortality. If diagnosed before 26 weeks gestation with associated liver herniation and a low lung to head circumference ratio (LHR <1) they have a relatively poor prognosis with conventional therapy after birth. The mainstay of management includes meticulous initial evaluation of LHR and extent of liver herniation, chromosomal analysis, antenatal monitoring of the fetus for signs of worsening, cardiac dysfunction and development of hydrops in the third trimester, delivery near term at a tertiary care center with NICU set-up, standard protocols for management of neonate at birth including initial intubation, stabilization and surgical management.

Cardiac Anomalies

Perinatal morbidity and mortality improves drastically when cardiac anomalies are diagnosed prenatally as it gives opportunity of optimum management in a tertiary care unit. Relatively non-lethal with good post-surgical results include isolated ventricular septal defects, isolated transposition of great vessels, Fallot's tetralogy with good size pulmonary

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artery, total anomalous pulmonary venous connections and milder varieties of coarctation of aorta may manifest at later gestation. Also rare conditions like cardiac soft tissue tumors like rhabdomyoma are almost always detected in the late trimester.

Further antenatal monitoring is necessary in the late gestation by an expert fetal medicine/fetal cardiac specialized center for worsening of cardiac function, signs of heart failure or development of hydrops and deciding the timing/mode of delivery at a center with good neonatal intensive care unit for initial assessment and stabilization.

Fetal Musculoskeletal Abnormalities

Diseases of the musculoskeletal system like achondroplasia though rare manifest in the third trimester after 26 weeks. Although these are non-lethal skeletal dysplasia without mental impairment, it is nevertheless of great importance to prepare the parents and to inform them prenatally.

As per a recent study on 52,400 study population on the value of routine ultrasound at 35–37 weeks of gestation in the diagnosis of fetal abnormalities, the incidence of fetal abnormality was 1.9% and 24.8% were detected for the first time at 35–37 weeks.[16] Prenatal diagnosis even if diagnosed late in gestation may have a significant impact on the perinatal management of the fetus with a surgically correctable congenital anomaly. A routine ultrasound during the third trimester is therefore justified.

ROLE OF THIRD TRIMESTER ULTRASOUND IN PLACENTAL LOCALIZATION AND ACCRETA SPECTRUM

Placental location and its relationship with the internal cervical os should be assessed in the third trimester scan. This is specially indicated when a low lying placenta or placenta previa is diagnosed in the mid-trimester scan or when there is a painless episode of bleeding. The distance of the edge of the placenta from the internal os and the position of cord insertion should be assessed. Placenta previa is a risk factor for abnormal cord insertion such as velamentous cord insertion and vasa previa and these anomalies should be ruled out when assessing women with suspected placenta previa in the third trimester. If the placenta is low, subsequent scans are performed as indicated, to assess whether the placenta has moved away from the internal os. Transvaginal ultrasound is preferred for accurate localization of the placental site, particularly when the transabdominal approach is difficult in maternal obesity, uterine scar or fibroids or a posteriorly placed behind the fetal head. If the leading placental edge is more than 20 mm from the internal os, vaginal birth is considered a safe option.

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Women with major placenta previa or a uterine scar may be offered a scan at around 28 weeks to rule out placenta accreta and plan mode of delivery, while women with minor placenta previa may be assessed later in the third trimester.

Placenta Accreta Spectrum

Morbidly adherent placenta (PAS) can occur when placenta is low lying along with a prior Cesarean birth or uterine surgery, including myomectomy or multiple curettages. Hence a third trimester scan should document the position of placenta (anterior or posterior) and its relation to the cervix and scar area and for indicators of placenta accreta.

It is better to error on the side of caution and consider every woman with placenta previa and a prior Cesarean birth or uterine surgery as a potential case of PAS. A prenatally diagnosed PAS is associated with less hemorrhagic complication and should be managed by a well equipped center with multidisciplinary team and surgical expertise of morbidly adherent placenta.

Standardized descriptors of PAS have been described which have a diagnostic accuracy of almost 90% (17). They include:

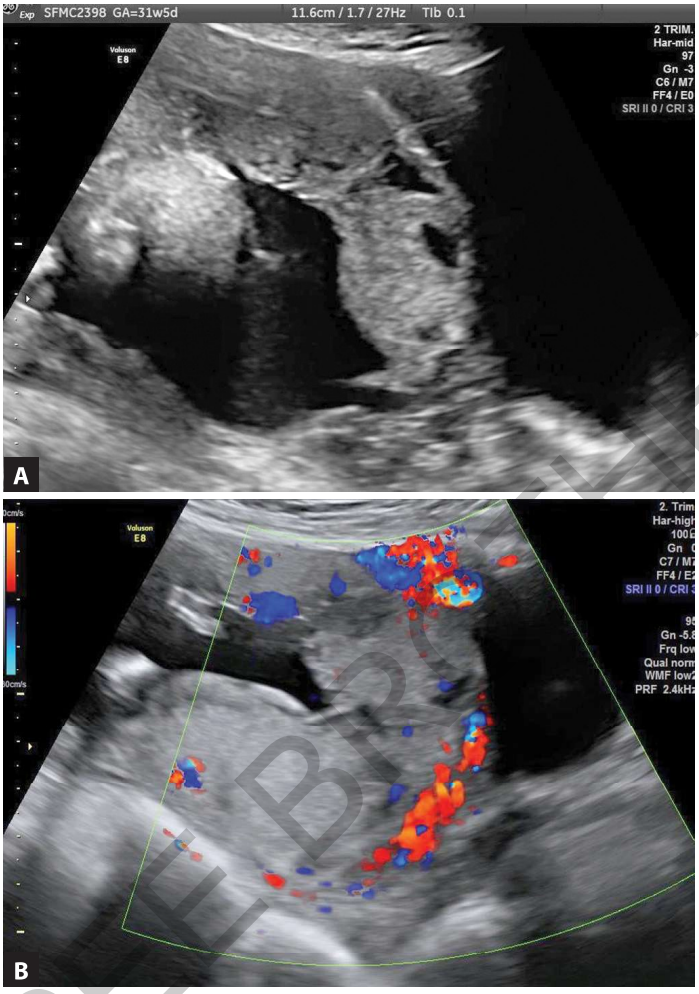
- Loss of the retroplacental clear zone **(Fig. 8A)**
- Myometrial thinning,
- Interruption of bladder wall interface
- Presence of a placental bulge
- Focal exophytic mass
- Uterovesical hypervascularity
- Placental lacunae and
- Bridging vessels **(Fig. 8B)**

Vasa previa is diagnosed by using transvaginal ultrasound and with color Doppler demonstration of the umbilical cord inserting into membranes over the cervix, from where unprotected vessels run into the placenta. Transvaginal ultrasound with color Doppler is a useful tool for screening vasa previa in cases of second-trimester low-lying placenta, bilobed placenta or placenta with succenturiate lobes, and multiple gestation in the third trimester.

GESTATIONAL AGE FOR THIRD TRIMESTER ULTRASOUND

The timing of the third-trimester scan, varies between 28 to 32 and 36 weeks. It should be individualized based on maternal and fetal risk factors and local objectives and resources. The anatomical examination is technically easier at 28–32 weeks. On the other hand, any growth deviations (SGA/LGA) is best detected towards 36 weeks in low-risk pregnancies. In pregnancies at higher risk of complications, it is advisable to do ultrasound examination at 28 to 32 weeks or earlier (18).

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Figs. 8A and B: (A) Placenta accreta loss of retroplacental clear zone; (B) Placenta accreta with bridging vessels.

INTRAPARTUM USG

The use of ultrasound has been proposed to aid in the management of labor. Traditionally, the assessment and management of a woman in labor is based upon clinical findings, However, clinical examination of head station and position is inaccurate and subjective, especially when caput succedaneum impairs palpation of the sutures and fontanels.

Several studies have demonstrated that ultrasound examination is more accurate and reproducible than clinical examination in the diagnosis of fetal head position and station and in the prediction of arrest of labor. At present till there is a consensus on when and which parameters to use, ultrasound in labor should be used as an adjunct and not a substitute for clinical examination. Ultrasound in labor can be performed using a transabdominal

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approach, mainly to determine head and spine position, or a transperineal approach, for assessment of head station and position at low stations.[19]

When to use:

- Tardy progress or arrest in second stage of labor
- Assess the descent/station of the head prior to instrumental assisted vaginal delivery. Combination of Ultrasound assessment and digital examination prior to instrumental vaginal delivery is more accurate compared with digital examination alone in the diagnosis of fetal head position.
- Head malpresentation suspected

Parameters to assess:

- *Fetal head and spine position:* Sonographic assessment of fetal head position is best performed by transabdominal imaging in axial and sagittal planes. Placing the ultrasound probe transversely at the level of maternal suprapubic region, visualize the fetal head.

  Position can be described by depicting a circle in a clock: positions ≥02.30 and ≤03.30 is left occiput transverse (LOT); positions ≥08.30 and ≤ 09.30 as right occiput transverse (ROT); positions >03.30 and <08.30 is recorded as occiput posterior; and positions >09.30 and <02.30 as occiput anterior.
- *Fetal head station and descent* is assessed by transperineal ultrasound in the midsaggital plane with the probe placed between the two labia majora.

  Angle of progression: The AoP is the angle between the long axis of the pubic bone and a line from the lowest edge of the pubis drawn tangential to the deepest bony part of the fetal skull. AoP cut-off value of 120° predicts an easy vacuum delivery.
- *Head attitude and malpresentation:* The longest recognizable axis of the fetal head and the long axis of the pubic symphysis, measured in a midsagittal transperineal view. It is classified as 'head down' (angle <0°), 'horizontal' (angle 0°–30°) and 'head up' (angle >30°).

  Midline angle (MLA): It is measured in the axial plane using a transperineal approach: the echogenic line interposed between the two cerebral hemispheres (midline) is identified, and MLA is the angle between this line and the anteroposterior axis of the maternal pelvis. It utilizes the angle of head rotation as an indicator of birth progress.

CONCLUSION

The third trimester antenatal scan is a highly informative, often underutilized tool. It gives crucial information about fetal wellbeing, growth with color doppler assessment, placental position, liquor estimation, fetal presentation

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as well as anatomical assessment for evolving anomaly if any. These parameters are decision making for an obstetrician prior to delivery. The timing of delivery, mode of delivery, need of tertiary center or NICU availability or need of in utero transfer can be precisely determined only after the third trimester ultrasound assessment. A handy checklist or knowledge of "what to look for" can be a pivot to influence perinatal and neonatal outcomes. The recently published ISUOG third trimester guidelines define a third trimester ultrasound as a standard of care in antenatal management. This article is focused on harnessing the potential of ultrasound in third trimester and labor in order to improve outcomes.

KEY POINTS

- Five basic parameters to see in third trimester (after documenting FHR):
  1. Presenting part, rule out multiple loops of nuchal cord
  2. Placental position, rule out low lying placenta
  3. Liquor assessment
  4. *Growth assessment:* Estimate fetal weight with biometry parameter BPD HC AC FL
  5. *Cervical length:* If risk of late preterm
- Do an anatomical *survey as a basic screening in every scan*. This will lead to identification of evolving or missed anomalies.
- Keep alert for morbidly adherent placenta in previously scarred uterus with anterior placenta.
- If biometry shows growth lag (below 10th centile), need of color doppler assessment and assigning a stage to FGR (as per Barcelona classification) for monitoring and planning time and mode of delivery.
- For twins use biometry with color doppler always to rule out selective FGR and discordance in twin. A discordance more than 15-20% affects perinatal outcome.
- Useful tool for near term evaluation of fetal wellbeing is a modified BPP (NST plus AFI) as it combines acute status of fetus (via NST) and chronic status i.e., placental function (via AFI).

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