



**ICRI GUIDELINES ON SECOND AND THIRD TRIMESTER ULTRASOUND
AND/OR DOPPLER**

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ICRI SUB-SPECIALTY GROUP FOR FOETAL IMAGING

DR. V. R. RAJENDRAN (SUB-SPECIALITY HEAD)

PREPARED BY:

**DR. NAMRATHA PURUSHOTHAMAN
DR. V. R. RAJENDRAN**

IMAGES CONTRIBUTED BY:

DR. SRINIVAS S.

DR. SHAILESH LUNAWAT (SUB-SPECIALTY CO-ORDINATOR)

INDICATIONS FOR DOING SECOND AND THIRD TRIMESTER SCAN

- Evaluation of foetal growth
- Evaluation of a significant discrepancy between uterine size and gestational age
- Assess foetal well being
- Determination of presentation
- Evaluation of liquor
- Evaluation of placenta
- Evaluation of cervix
- Antepartum haemorrhage
- Reduced foetal movements
- Preterm rupture of membranes
- Preterm labour pain
- Lower abdominal pain
- History of fall
- Follow-up of foetal anomalies detected earlier
- High risk cases to assess growth

TIMING

Ultrasound can be performed during any gestational age between 27-40 weeks. Ideally growth scans are to be done between 32-36 weeks to assess growth deviation.

WHAT ULTRASOUND EQUIPMENT SHOULD BE USED

- Real-time trans-abdominal scan – Ideally convex transducer of frequency ≥ 3 MHz
- Trans-vaginal approach can be used to assess cervix, placental position and to look for features of morbidly adherent placenta (when indicated).
- Electronic callipers with biometry charts stored in the machine.
- Routine Doppler is not indicated. Doppler scan can be done in suspected foetal growth restriction, screening for severe early onset foetal growth restriction /screening of preeclampsia high risk group and also for foetal anaemia evaluation.

- Equipment should have colour flow and spectral wave Doppler capabilities.
- Mechanical index (MI) and TI should be displayed on the ultrasound screen.
- Ultrasound system should show the whole spectral Doppler waveform which can be traced using automatic or manual waveform traces.
- System software must be able to estimate peak systolic velocity (PSV), end-diastolic velocity (EDV) and calculate the commonly used Doppler indices i.e. pulsatility (PI) and resistance (RI) indices and systolic/diastolic velocity (S/D) ratio.

FOETAL SAFETY

- Ultrasound is the modality of choice when imaging the pregnancy and foetus. It is non-invasive and safe due to absence of radiation.
- Ultrasound exposure should be as low as reasonably achievable (ALARA) because of the potential for tissue heating when the thermal index exceeds.

PRE-PERFORMANCE OF ULTRASOUND

- Establish the gestational age of the foetus in order to track growth.
- Last menstrual period (LMP) or previously calculated estimated date of delivery (EDD) and previous obstetric history should be noted. If an EDD has been established, prior to this scan, it should be used as a reference point.
- Previous ultrasound reports and imaging be reviewed where possible.
- Indication for the examination should be carefully considered and the examination targeted to answer the clinical problem.
- Fill form F and sign the form prior to scan.

GUIDELINES FOR DOING SECOND AND THIRD TRIMESTER ULTRASOUND

These guidelines aim to describe appropriate assessment of foetal biometry and diagnosis of foetal growth disorders. These disorders consist mainly of foetal growth restriction (FGR), also referred to as intrauterine growth restriction (IUGR) and often associated with small-for-gestational age (SGA), and large-for-gestational age (LGA).

The study should document the following:

- Foetal number.
- Chorionicity and amnionicity in case of multiple gestations.
- Foetal presentation & lie.
- Foetal cardiac activity.
- Foetal biometry.
- Estimation of foetal weight.
- Evaluation of the foetal environment including the placenta, amniotic fluid, umbilical cord and maternal uterus, cervix and adnexa.

FOETAL PRESENTATION & LIE

- Defined by the orientation of the foetal spine to the maternal spine.
- Presentation defines the presenting foetal part close to cervix.

FOETAL CARDIAC ACTIVITY

- Documentation of the foetal cardiac activity can be performed by **saving a movie (cine-loop) clip** of the moving heart **or by using M-mode**, whereby a still image reflecting cardiac activity can be printed and stored for documentation.

FOETAL BIOMETRY

Foetal biometry should include the following measurements:

For head measurements, image is well magnified. The head is horizontal. It is oval in shape and symmetrical.

The landmarks seen are:

1. Centrally positioned, continuous midline echo (falx cerebri).
2. The midline echo is broken anteriorly at one third of its length by the cavum septum pellucidum.
3. The thalami are located symmetrically on each side of the midline.

- Biparietal diameter (BPD) measured from the outer edge to the inner edge of the osseous margins of the cranium in an axial section that includes the cavum septum pellucidum and thalami.
- Head circumference at same level as BPD, traced at the outer margin of the osseous vault.
- Occipito-frontal distance at same level as the BPD, from the anterior edge of the osseous surface to the posterior edge of the osseous surface on the outer aspect.
- Abdominal circumference (AC) measured in a transverse view of the abdomen at the level of the junction of the umbilical vein and portal vein anteriorly and the spine in a true transverse section posteriorly, kidneys not visible. Bladder not visible. The cross section of the foetal abdomen should fill at least 30% of the monitor screen. Ensure not to distort the circular shape of the foetal abdomen by applying too much pressure with the transducer.
- Femur length that includes the shaft only; vertical orientation of the bone is inappropriate. Measurements are to be taken end to end, and, if both femora are seen in the same plane, the bone in the near field is to be measured.

Every effort must be made to obtain ideal planes for measurement. If these are not possible, several of the sub-optimal planes described in literature may be used. However, the compromise on an ideal view should be mentioned in the report.

FOETAL WEIGHT ESTIMATION:

- Foetal weight estimates should be derived from charts in the machine, or in case these are not available, from standard charts. Measurements should include cranial measurements, AC and femoral length. Hadlock chart with HC, AC and FL is ideal. Deviation of measurements from norm has traditionally been reported as equivalents in weeks and days. There is a recent trend of reporting deviations as centiles and this is encouraged.
- EFW may be used to monitor foetal size and growth. However, use of EFW also has disadvantages. Errors in single-parameter measurements are multiplied; accuracy of EFW is compromised by large intra- and interobserver variability, with errors in the range of 10–15% being common; errors are relatively larger in the fetuses of greatest interest, i.e. those that are SGA or LGA.

- Given the errors inherent in estimation of foetal weight, the time interval between scans should typically be at least 3 weeks, to minimize false-positive rates for the detection of foetal growth disorders.
- An AGA foetus is one whose size is within the normal range for its gestational age. AGA foetuses typically have individual biometric parameters and/or EFW between the 10th and 90th percentiles. SGA foetuses 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.
- A FGR or IUGR foetus is one that has not achieved its growth potential. It has been classified into early-onset (detected before 32 weeks' gestation) and late-onset (detected after 32 weeks' gestation) types. Not all SGA foetuses are growth-restricted; most are likely to be 'constitutionally' small.
- LGA foetuses typically have EFW or AC above the 90th percentile, although 95th centile, 97th centile, $+2SD$ and Z-score deviation have also been used as cut-offs in the literature. Macrosomia at term usually refers to a weight above a fixed cut-off (4000 or 4500gms).

FOETAL GROWTH:

- It is important to differentiate between the concept of foetal size at a given timepoint and foetal growth, the latter being a dynamic process, the assessment of which requires at least two ultrasound scans separated in time.
- Foetal growth velocity, typically represented as deviation from growth-velocity charts (change in centiles or Z-score with advancing gestation), is particularly relevant for assessing foetal growth, rather than foetal size.

GROWTH CHARTS:

- Growth charts for head circumference, biparietal diameter, abdominal circumference, femur length, humerus length, and EFW are available.
- The three lines on the graphs represent different growth rates. The red line in the centre, referred to as the 50th percentile, shows an average pattern of growth. The

thinner lines above and below, the 90th and the 10th percentiles, show the top and bottom ranges of normal growth.

- The biometry measurements measured over time is plotted on graph to look for the trend of growth.

EVALUATION OF FOETAL ENVIRONMENT:

- The evaluation of the foetal environment includes assessment of the amniotic fluid, the umbilical cord, the placenta, the cervix and the myometrium and adnexa.
- The two techniques that are most commonly proposed for the estimation of amniotic fluid include assessment of the single maximal vertical pocket of fluid or the amniotic fluid index. The single maximal vertical pocket (MVP) technique involves findings the single largest pocket of amniotic fluid on ultrasound, free of cord and foetal parts, and the measuring the greatest vertical dimension with the ultrasound transducer perpendicular to the floor. The amniotic fluid index (AFI) technique is based on the division of the uterus into 4 equal quadrants and measuring the deepest vertical pocket of fluid in each quadrant (same technique as for MVP) and then adding the four measurements together.
- The umbilical cord should be assessed for the number of vessels, its point of origin and its point of insertion. Masses in the umbilical cord, if any, should be noted. Cord length is unreliable to assess but a short cord if noted should be documented. Cord around neck may be documented.
- Placental evaluation should include location, echogenicity, thickness and the retroplacental area. Accessory lobes should be looked for and noted if present. Location includes a measurement of the distance of the inferior margin of the placenta from the internal os. Focal areas of altered echogenicity should be characterized if possible and noted. Abnormally thin or thick placentas should be documented and maximum thickness should be measured in these situations. Features of placental invasion / morbidly adherent placenta should be looked for.
- Cervix should be mentioned only if asked for. Evaluation of cervix should ideally be done by transvaginal ultrasound. Note should be made about cervical length, internal os, presence of funnelling.

- The myometrium should be assessed for fibroids and any thinning of previous scars. Any maternal adnexal mass should be noted and characterized if possible.

GUIDELINES TO PERFORM DOPPLER OF FOETO-PLACENTAL CIRCULATION

INDICATIONS

- Suspected foetal growth restriction.
- Screening of severe early onset FGR or preeclampsia in high risk women.
- Assessing foetal anaemia
- Monochorionic twins

FOETAL SAFETY

- All foetal imaging, including Doppler US, should be performed only for valid medical indications with use of techniques to decrease foetal exposure to as low as reasonably achievable (ALARA), in accordance with the ALARA principle.

COLOR FLOW IMAGING: PRACTICAL GUIDELINES

- (1) Select the appropriate applications/set-up key. This optimizes parameters for specific examinations.
- (2) Set power to within foetal study limits. Adjust colour gain. Ensure focus is at the region of interest and adjust gain to optimize colour signal.
- (3) Use probe positioning/beam steering to obtain satisfactory beam/vessel angle.
- (4) Adjust pulse repetition frequency/scale to suit the flow conditions.
- (5) Set the colour flow region to appropriate size. A smaller colour flow 'box' may lead to a better frame rate and better colour resolution/sensitivity.

SPECTRAL DOPPLER IMAGING: PRACTICAL GUIDELINES

- (1) Set power to within foetal study limits.
- (2) Position the pulsed wave Doppler cursor on the vessel to be investigated.
- (3) Adjust gain so that the sonogram is clearly visible and free of noise.
- (4) Use probe positioning/beam steering to obtain a satisfactory beam/vessel angle. Angles close to 90° will give ambiguous/unclear values. The beam/vessel angle should be 60° or less if velocity measurements are to be made.
- (5) Adjust the pulse repetition frequency/scale and baseline to suit flow conditions. The sonogram should be clear and not aliased.
- (6) Set the sample volume to correct size. Correct the angle to obtain accurate velocities. Use the B-mode and colour flow image of the vessel to make the angle correction.

IMAGE OPTIMISATION

- Recordings should be obtained during absence of foetal breathing and body movements, and if necessary, during temporary maternal breath hold.
- It is advisable to start with a relatively wide Doppler gate (sample volume) to ensure the recording of maximum velocities during the entire pulse. If interference from other vessels causes problems the gate can be reduced to refine the recording.
- The optimal intonation is complete alignment with the blood flow. This ensures the best conditions for assessing absolute velocities and waveforms. When absolute velocity is the clinically important parameter (e.g. middle cerebral artery (MCA) and an angle of $> 20^\circ$ is obtained, angle correction may be used, but this in itself may lead to error.
- The vessel wall filter should be set as low as possible ($\leq 50\text{--}60$ Hz) in order to eliminate the low frequency noise from peripheral blood vessels. When using a higher filter, a spurious effect of absent EDV can be created.
- Doppler horizontal sweep speed should be fast enough to separate successive waveforms. Ideal is a display of four to six (but no more than eight to 10) complete cardiac cycles.

- PRF should be adjusted according to the vessel studied: low PRF will enable visualization and accurate measurement of low velocity flow; however, it will produce aliasing when high velocities are encountered. The waveform should fit at least 75% of the Doppler screen.
- Gain should be adjusted in order to see clearly the Doppler velocity waveform, without the presence of artefacts in the background of the display.

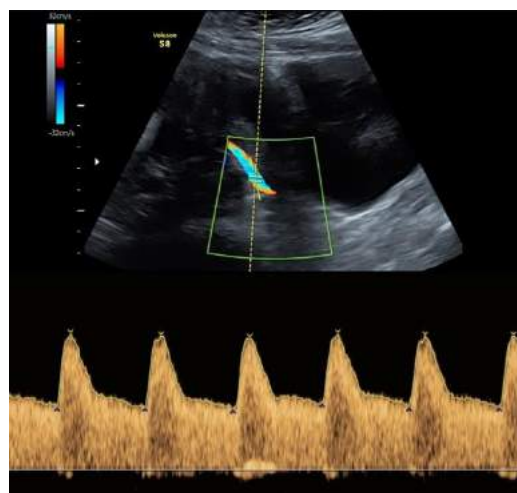
VESSELS STUDIED IN EVALUATION OF ANTENATAL DOPPLER

The commonly studied vessels are uterine arteries, umbilical artery, middle cerebral artery, aortic isthmus and ductus venosus.

SECOND-TRIMESTER UTERINE ARTERY EVALUATION

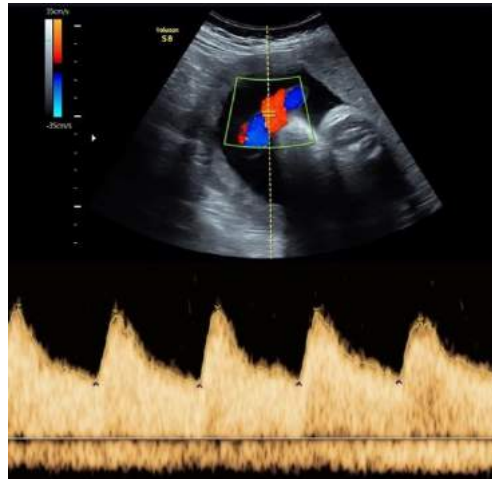
Transabdominal technique: Transabdominally, the probe is placed longitudinally in the lower lateral quadrant of the abdomen, angled medially. Colour flow mapping is useful to identify the uterine artery as it is seen crossing the external iliac artery. The sample volume is placed 1 cm downstream from this crossover point. The same process is repeated for the contralateral uterine artery.

Transvaginal technique: Women should be asked to empty their bladder and should be placed in the dorsal lithotomy position. The probe should be placed into the lateral fornix and the uterine artery identified, using colour Doppler, at the level of the internal cervical os. The same should then be repeated for the contralateral uterine artery.



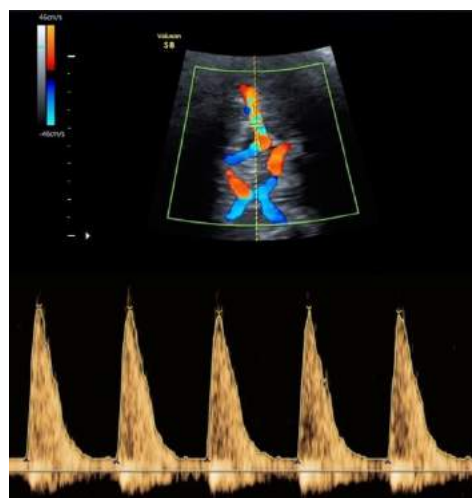
UMBILICAL ARTERY

There is a significant difference in Doppler indices measured at the foetal end, the free loop and the placental end of the umbilical cord. The impedance is highest at the foetal end, and absent/reversed end-diastolic flow is likely to be seen first at this site. For the sake of simplicity and consistency, measurements should be made in a free cord loop.



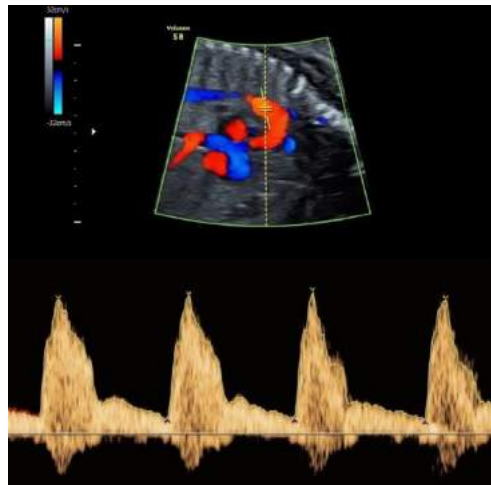
MIDDLE CEREBRAL ARTERY

An axial section of the brain, including the thalami and the sphenoid bone wings, should be obtained and magnified. Colour flow mapping should be used to identify the circle of Willis and the proximal MCA. The pulsed-wave Doppler gate should then be placed at the proximal third of the MCA, close to its origin in the internal carotid artery (the systolic velocity decreases with distance from the point of origin of this vessel).



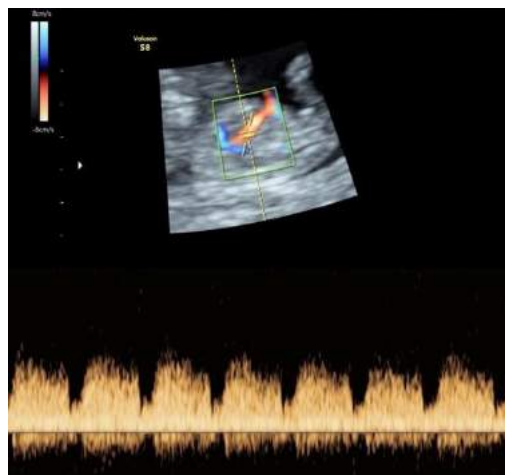
AORTIC ISTHMUS

Aortic isthmus is a segment of aorta located between origin of the left subclavian artery and the connection of the ductus arteriosus to the descending aorta. It can be easily identified in aortic arch view or three vessel tracheal view. The pulsed wave Doppler is placed at the isthmus and velocity waveforms obtained during foetal quiescence with the angle of intonation kept close to 0° and no more than 30° .



DUCTUS VENOSUS

The ductus venosus (DV) is identified in transverse view of foetal abdomen at the same anatomic plane as abdominal circumference. Colour flow mapping demonstrating the high velocity at the narrow entrance of the DV confirms its identification and indicates the standard sampling site for Doppler measurement.



ASSESSING FOR FOETAL ANAEMIA

Indications

- Maternal-foetal alloimmunisation
- Any suspicion of foetal anaemia
- Unexplained hydrops
- MCDA twins with known or suspected TTTS or twin anaemia-polycythaemia sequence (TAPS)

Middle cerebral artery peak systolic velocity (MCA PSV)

Magnified axial plane of foetal head is obtained at the level of thalami and wings of sphenoid. The angle between the ultrasound beam and the direction of blood flow should be kept as close as possible to 0°. Care should be taken to avoid any unnecessary pressure on the foetal head. At least three and fewer than 10 consecutive waveforms should be recorded. The highest point of the waveform is considered as the PSV (cm/s). The PSV can be measured using manual callipers or auto-trace. >1.5 MoM is abnormal.

WHICH INDICES TO USE?

S/D ratio, RI and PI are the three well-known indices to describe arterial flow velocity waveforms. All three are highly correlated. PI shows a linear correlation with vascular resistance as opposed to both S/D ratio and RI, which show a parabolic relationship with increasing vascular resistance. Additionally, PI does not approach infinity when there are absent or reversed diastolic values. PI is the most commonly used index in current practice.

Cerebroplacental ratio (CPR) The CPR is the ratio of MCA PI and UA PI (i.e. MCA PI divided by UA PI). <5th percentile is abnormal.

REPORTING GUIDE AND RECOMMENDATIONS

- Report the PI value and whether it is normal or abnormal for each Doppler performed.
- Report the MoM for MCA PSV, if performed.

REPORTING TEMPLATE

Name of Patient:

Age:

ID number:

Date of exam:

Referring physician:

Indication for scan:

Obstetric score:

Clinical history:

Technical conditions: Good / Limited by.....

LMP:

GA by LMP:

EDD by LMP:

Corrected gestational age if any:

Findings:

Number of foetus(es):

Presentation:

Lie:

Foetal heart rate:

Foetal movements: (normal activity/ decreased activity)

BPD () cm () Percentile

HC () cm () Percentile

AC () cm () Percentile

FL () cm () Percentile

EFW: () grams () Percentile

AFI:

Singe deepest pocket:

Placental site: () mm from internal os.

Cervix: () mm length (only if requested).

Limited anatomic survey within the limits of late gestation, foetal lie & maternal condition.

IMPRESSION:

- **Single live intra uterine gestation**
- **Foetal EFW is on () percentile.**
- **Foetal biometry within normal range:**
- **Growth chart attached.**

DISCLAIMER:

- *Patients identity is based on her own declaration.*
- *This investigation has been done as per request of the referring doctor.*
- *Proper history with details of previous scan / medical history are to be provided.*
- *The findings in the present scan including the presentation, lie, liquor, presence of cord may change over time in subsequent scans.*
- *In spite of utmost care taken, all measurements are subject to statistical and intra- / inter-observer variability.*
- *Errors in EFW in the range of 10-15% is common; errors are relatively larger in SGA and LGA foetuses.*
- *Doppler value should be interpreted along with appropriate reference range.*
- *ICRI has made every effort to ensure that conditions of reporting are as per available references, neither the society nor any of its employees or members accepts any liability for the consequences of any inaccurate or misleading data opinions or statements.*
- *The information provided is as per current literature available cited infra.*
- *I / We have read the above information and understand the implications.*

Place

Date

Signature of person undergoing the pregnancy scan

Signature of husband / accompanying person

REFERENCES

1. American Institute of Ultrasound in Medicine. AIUM practise guidelines for the performance of obstetric ultrasound examination. *J Ultrasound Med* 2010.
2. American College of Radiology [ACR] and American College of Obstetrics and Gynaecology [ACOG]. *ACR practice guidelines for communication of diagnostic imaging findings*.
3. ISUOG Practice Guidelines: Ultrasound assessment of fetal biometry and growth; published online in *Wiley Online Library* 2019.
4. Practice guidelines for performance of routine mid-trimester fetal ultrasound scan. *Ultrasound Obstet Gynecol* 2011.
5. Fetal growth longitudinal study of the INTERGROWTH-21ST project. *Lancet* 2014.
6. New Zealand Obstetric Doppler Guidelines. *NZMFMN, revised October 2015*.
7. Doppler in Obstetrics, ISUOG Educational series. Kypros Nicolaides, Giuseppe Rizzo, Kurt Hecher and Renato Ximenes.
8. ISUOG Practice guidelines: Use of Doppler ultrasonography in Obstetrics 2013.