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GUIDELINES

ISUOG Practice Guidelines (updated): performance of the routine mid-trimester fetal ultrasound scan

Clinical Standards Committee

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INTRODUCTION

Ultrasonography is used widely for the prenatal evaluation of fetal growth and anatomy, as well as for the management of multiple gestations. The mid-trimester ultrasound scan is performed mainly for anatomical evaluation of the fetus. In experts' hands, most clinically important structural anomalies can be detected[1]. However, there are significant differences in detection rates between centers and between operators. The mid-trimester fetal ultrasound scan also serves as a baseline against which later scans can be compared for the evaluation of fetal growth.

Although many countries have developed local guidelines for the practice of fetal ultrasonography, there are still many areas of the world where they have not been implemented. Most countries offer one mid-trimester scan as part of routine prenatal care. This document, which constitutes an updated version of previously published guidelines[2], suggests the standards that this scan should aim to achieve. Details of the grades of recommendation and levels of evidence used in ISUOG Guidelines are given in Appendix 1.

GENERAL CONSIDERATIONS

Before starting the examination, a healthcare practitioner should counsel the woman/couple regarding the potential benefits and limitations of a routine mid-trimester fetal ultrasound scan.

A routine mid-trimester fetal ultrasound examination includes an evaluation of the following:

- cardiac activity;
- fetal number (and chorionicity and amnionicity in cases of multiple pregnancy);
- gestational age/fetal size;
- basic fetal anatomy;
- placental appearance and location;
- amniotic fluid volume.

In some settings, measurement of cervical length (CL) is offered to women at the time of the mid-trimester scan within the context of prediction and prevention of preterm birth. A current suggestion is that CL measurements should be done by transvaginal scanning, which requires additional consent from the woman, appropriate training of the operator[3] and auditing of the results. When CL measurement can be carried out meeting these conditions, it can be considered as an integral part of the routine mid-trimester scan. The 'ISUOG Practice Guidelines: role of ultrasound in the prediction of spontaneous preterm birth' (in prep.) will provide more guidance and details.

When uterine and adnexal masses (fibroids, ovarian cysts) are visualized, they should be reported, but formal assessment of uterine and adnexal anatomy is not part of the routine mid-trimester scan.

Although many fetal malformations and anomalies can be identified at this mid-trimester scan, some may be missed or may become apparent only later in pregnancy, even with the best sonographic equipment in the best of hands.

Who should have a mid-trimester fetal ultrasound scan?

Recommendation

- All pregnant women should be offered a mid-trimester scan as part of routine pregnancy care (**GRADE OF RECOMMENDATION: B**).

All pregnant women should be offered a mid-trimester scan as part of routine pregnancy care. In many settings, it is customary to perform a routine first-trimester scan to assess viability and pregnancy location, for accurate dating of the pregnancy, for assessment of chorionicity in multiple pregnancy and to evaluate the uterus and adnexa for anomalies that may affect pregnancy management[4]. If the first-trimester scan is normal, then a standard mid-trimester scan should still be offered, to check for anomalies that may not have been evident in early pregnancy. A 2005 cost-effectiveness analysis concluded that strategies which include a mid-trimester ultrasound scan result in more abnormalities being detected and have lower costs per anomaly detected[5]. It is likely that this policy has become even more effective since then, as the detection rate of congenital heart defects may have increased[6]. If anomalies are seen or suspected at the first-trimester scan, the patient should be referred promptly for expert evaluation and counseling, without awaiting the mid-trimester scan. Thereafter, subsequent detailed scans can be performed as needed.

When should the mid-trimester fetal ultrasound scan be performed?

Recommendation

- A routine mid-trimester ultrasound scan can be performed between about 18 and 24 weeks of gestation, depending on technical considerations and local legislation (**GOOD PRACTICE POINT**).

A routine mid-trimester ultrasound scan is usually performed between about 18 and 24 weeks of gestation. This may be adjusted according to technical considerations, including high body mass index. Countries in which pregnancy termination is restricted by gestational age should balance detection rates against the time needed for counseling and additional investigation.

Who should perform the mid-trimester fetal ultrasound scan?

Recommendation

- Individuals who perform obstetric scans routinely should have been trained for the practice of diagnostic ultrasonography in pregnant women (**GOOD PRACTICE POINT**).

Individuals who perform obstetric scans routinely should have been trained for the practice of diagnostic ultrasonography in pregnant women. Local regulations should be followed for training, maintenance of skills and certification, as these vary between jurisdictions[7]. Simulation training may also be considered[8].

In order to achieve optimal results from routine screening examinations, scans should be performed by individuals who fulfill the following criteria:

- trained in the use of diagnostic ultrasonography and related safety issues;
- regularly perform fetal ultrasound scans;
- participate in continuing medical education activities;
- have established appropriate referral patterns for management of suspicious or abnormal findings;
- routinely undertake quality assurance and control measures.

What ultrasonographic equipment should be used?

For routine screening, equipment should have at least the following:

- real-time, grayscale ultrasound capabilities;
- transabdominal transducers with suitable resolution and penetration (usually 2–9-MHz range);
- adjustable acoustic power output controls with output display on the screen;
- freeze-frame capability;
- electronic calipers;
- capacity to print/store images;
- regular maintenance and servicing, important for optimal equipment performance;
- suitable cleaning equipment and cleaning protocols;
- color and pulsed Doppler are desirable;
- transvaginal probes are desirable.

What document should be produced/stored/printed or sent to the referring healthcare provider?

Recommendation

- The results of the scan should be documented and communicated appropriately, and copies of the reports and images should be stored for future reference (**GOOD PRACTICE POINT**).

The report of the examination should be produced and forwarded promptly to the referring care provider. Its content should follow local practice and regulations. A sample form is appended to these Guidelines (Appendix 2), and may be modified as appropriate. Standard practice on how to communicate with the pregnant woman before and during the scan and how to provide the results should be established. Generally, any significant concerning findings should be communicated promptly and separately to the care provider to facilitate appropriate patient care. It is reasonable to include recommendations for further management if the person performing the scan is entitled to do so and prompt

referral should be organized when indicated. Reports may be electronic or on paper. The number of images produced will vary according to local protocols. It is strongly suggested that both reports and images are stored so they are easily and rapidly accessible for review or transmission, and they are archived following local guidelines and regulations.

Is prenatal ultrasonography safe?

Recommendation

- Prenatal ultrasonography appears to be safe in clinical practice; however, it should follow the ALARA principle and not be performed solely for parental entertainment purposes (**GOOD PRACTICE POINT**).

Prenatal ultrasonography appears to be safe in clinical practice. To date, there has been no independently confirmed study to suggest otherwise. Nonetheless, fetal exposure times should be minimized, using the lowest possible power output needed to obtain diagnostic information, following the ALARA principle (As Low As Reasonably Achievable)[9]. More details are available in the ISUOG Safety Statement[10]. Equipment, probes and gels should be treated appropriately to provide a safe environment for patients and staff. Although prenatal ultrasonography can provide beautiful souvenir images of the fetus, it should not be performed solely for entertainment purposes[10].

What if the examination cannot be performed in accordance with these Guidelines?

Recommendation

- If the examination cannot be performed completely in accordance with adopted guidelines, the scan should be repeated to ensure a complete examination, or the patient should be referred to another examiner (**GRADE OF RECOMMENDATION: C**).

These recommendations represent minimum suggested Practice Guidelines for the mid-trimester fetal ultrasound scan. If time, equipment and skills allow, more comprehensive evaluation is encouraged. Consideration should be given to local circumstances, standard practice and regulations. Reasons for deviations from these recommendations should be documented. If the examination cannot be performed completely in accordance with adopted guidelines, the scan should be repeated to ensure a complete examination, or the patient should be referred to another examiner, as abnormalities are eventually detected in 0.5–5% of such cases[11,12]. This should be done as soon as possible, to minimize unnecessary patient anxiety and unnecessary delay in the potential diagnosis of congenital anomalies or growth disturbances.

What is the role of a more targeted ultrasonographic examination?

These Guidelines refer to routine ultrasound evaluation of pregnant women who have no maternal, fetal or obstetric risk factors. Even if risk factors are present, it is still appropriate to consider a mid-trimester scan following these Guidelines, for baseline pregnancy evaluation. Additional, more comprehensive, detailed ultrasonographic examinations in response to specific clinical situations should be performed to address specific needs. These are best performed by specialists experienced in such comprehensive evaluations, and are beyond the scope of these general Guidelines.

Individuals or clinics performing routine ultrasonographic scans during pregnancy should have referral mechanisms in place to manage suspected or detected anomalies. A complete screening examination according to the Guidelines presented here should still be performed before referring a woman, unless technical factors prevent completion of the initial evaluation.

GUIDELINES FOR EXAMINATION

Fetal biometry and wellbeing

Recommendations

- The biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) can be measured routinely for the assessment of fetal size (**GOOD PRACTICE POINT**).
- If the fetus has not been dated previously, HC or HC plus FL can be used for dating after 14 weeks (**GRADE OF RECOMMENDATION: B**).

The following sonographic parameters can be measured routinely for assessment of fetal size[13,14]:

- biparietal diameter (BPD);
- head circumference (HC);
- abdominal circumference (AC);
- femur length (FL).

Measurements should be performed in a standardized manner on the basis of strict quality criteria[15–17] and in accordance with ISUOG Practice Guidelines[13]. An image should be obtained to document each measurement. Examples of still images appropriate for fetal biometry are demonstrated in Figure 1. An audit of results can help to ensure accuracy of techniques with regard to specific reference tables[16,18].

A first-trimester ultrasound examination should have been offered routinely[4], allowing exact gestational-age assessment. If gestational age has not already been established at a dating or first-trimester scan, it should be determined at the mid-trimester scan. Although head measurements (BPD and HC) and FL have all been used in the past, recent evidence from the INTERGROWTH-21st study indicates that HC alone or HC plus FL may be

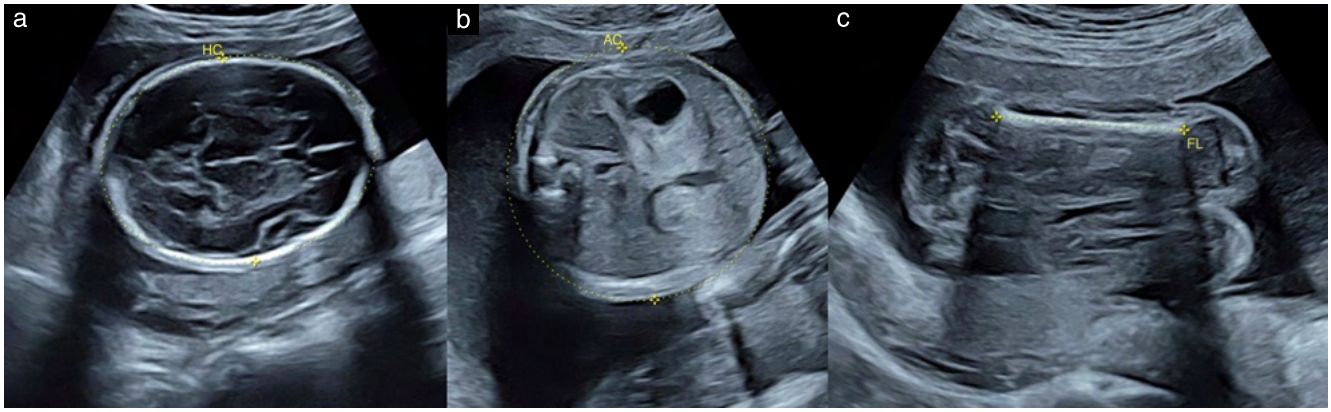

Figure 1 Standard fetal biometry. Sonographic measurements of: (a) head circumference (HC), (b) abdominal circumference (AC) and (c) femur length (FL).

the most accurate predictor of gestational age after 14 weeks[19]. Subsequent scans should not be used to calculate a new estimated date of confinement if gestational age has already been established by a high-quality scan earlier in the pregnancy.

Biparietal diameter (BPD)

Recommendation

- Outer-to-outer placement of calipers is preferable when measuring BPD (**GOOD PRACTICE POINT**).

Anatomy. The following anatomical landmarks ensure optimal acquisition of the imaging plane for measurement of BPD.

- Transverse view of the fetal head at the level of the thalami;
- ideal angle of insonation is 90° to the midline echoes, but slight variations are permitted;
- symmetrical appearance of both hemispheres;
- midline echo (falx cerebri) interrupted anteriorly only by the cavum septi pellucidi;
- cerebellum not visible.

Caliper placement. Both calipers should be placed according to a specific methodology, because more than one technique has been described (e.g. outer-to-inner edge ('leading edge' technique) *vs* outer-to-outer edge), at the widest part of the skull, perpendicular to the midline. The same technique as that used to establish the reference chart should be used. The cephalic index is a ratio of the maximum head width (BPD) to its maximum length (occipitofrontal diameter (OFD)) and this value can be used to characterize the fetal head shape. Abnormal head shape (e.g. brachycephaly or dolichocephaly) can be associated with syndromes or be the result of oligohydramnios or breech presentation. This finding can also lead to inaccurate estimates of fetal age when the BPD is used; in these cases, HC measurements are even more reliable[20,21]. Recent evidence suggests that outer-to-outer placement of calipers eases standardization, reproducibility and quality control[22].

Head circumference (HC)

Recommendations

- HC can either be measured using the ellipse approach, or derived from BPD and OFD (**GOOD PRACTICE POINT**).
- Outer-to-outer placement of calipers is preferable when measuring HC (**GRADE OF RECOMMENDATION: C**).

Anatomy. The same anatomical landmarks as those for BPD should be used.

Caliper placement. As for the BPD, it is important to ensure that the HC placement markers correspond to those used for the reference chart. If the ultrasound equipment has ellipse measurement capacity, the HC can be measured directly by placing the ellipse around the outside of the skull bone echoes (Figure 1a). Alternatively, the HC can be calculated from the BPD and OFD as follows: the BPD is measured using a leading-edge technique, as described in the 'Biparietal diameter' section, above, whereas the OFD is obtained by placing the calipers in the middle of the bone echo at both the frontal and occipital skull bones. HC is then calculated as $HC = 1.62 \times (BPD + OFD)$. Recent evidence suggests that outer-to-outer placement of calipers eases standardization, reproducibility and quality control[22].

Abdominal circumference (AC)

Recommendations

- For the measurement of AC, the transverse section of the fetal abdomen should be as circular as possible, and the fetal spine preferably in the 3- or 9-o'clock position (**GOOD PRACTICE POINT**).
- AC can either be measured using the ellipse approach, or derived from anteroposterior and transverse abdominal diameters (**GOOD PRACTICE POINT**).

Anatomy. The following anatomical landmarks ensure optimal acquisition of the imaging plane for measurement of AC.

- Transverse section of the fetal abdomen (as circular as possible);
- umbilical vein at the level of the portal sinus;
- stomach visible;
- kidneys not visible.

Caliper placement. The AC is either measured directly at the outer surface of the skin line, with ellipse calipers (Figure 1b), or calculated from linear measurements made perpendicular to each other, usually the anteroposterior abdominal diameter (APAD) and the transverse abdominal diameter (TAD). To measure the APAD, the calipers are placed on the outer borders of the body outline, from the posterior aspect (skin covering the spine) to the anterior abdominal wall. To measure the TAD, the calipers are placed on the outer borders of the body outline, across the abdomen at the widest point. The AC is then calculated as $AC = 1.57 \times (APAD + TAD)$.

Femur length (FL)

Anatomy. The FL is imaged with both ends of the ossified diaphysis visible. The longest axis of the ossified diaphysis is measured. The same technique as that used to establish the reference chart should be used with regard to the angle between the femur and the insonating ultrasound beam. An angle of insonation between 45° and 90° is typical. Technical improvements in modern ultrasound machines have reduced the beam width, which has affected fetal measurements in the lateral direction[23]. This has clinical implications and recent measurement charts should be used, as using older ones may lead to an overestimation of the FL[24].

Caliper placement. Each caliper is placed at the ends of the ossified diaphysis without including the distal femoral epiphysis if it is visible (Figure 1c). This measurement should exclude triangular spur artifacts that can extend the diaphysis length falsely.

Estimated fetal weight (EFW)

Recommendations

- The Hadlock-3 formula (HC, AC, FL) appears to be the most stable mathematically, and its use is recommended in most clinical scenarios (**GRADE OF RECOMMENDATION: C**).
- The deviation of the estimated fetal size from the expected mean for the gestational age should be expressed as centile (or *Z*-score), and the chosen reference standard should be indicated in the report (**GOOD PRACTICE POINT**).
- Fetal biometry charts which are prescriptive, obtained prospectively, truly population-based and derived from studies with the lowest possible methodological bias should be favored (**GOOD PRACTICE POINT**).
- The use of the Delphi 2016 criteria should be used for the definition of fetal growth restriction (FGR) (**GOOD PRACTICE POINT**).

Mid-trimester sonographic measurements can be used to identify anomalies of fetal size[25]. Estimated fetal weight (EFW) or AC can be used as a baseline parameter for the detection of subsequent growth problems[26].

Despite many efforts to develop new models for calculating EFW, the three-parameters (HC, AC, FL) formula reported by Hadlock *et al.*[25] provided the best fetal weight estimates in a large study cohort[27], and should be considered the method of choice for assessment of all fetuses, including those suspected to be either small or large[13]. Various approaches may be used to optimize the detection of abnormal growth[14]. However, the degree of deviation from normal at this early stage of pregnancy that would justify action (e.g. follow-up scan to assess fetal growth or fetal chromosomal analysis) has not been established. Recent research suggests that EFW as early as the mid trimester could be used in a competing-risks model to predict subsequent small-for-gestational age[28].

Additional measurements to demonstrate evidence of growth, taken at least 3 weeks from those obtained at a preceding scan, are usually reported as deviations from mean values with their expected ranges for a given age[29]. This information should preferentially be expressed as percentile of a reference range or *Z*-score, or on a graph. The use of *Z*-scores allows monitoring of severe anomalies and facilitates data quality control. The chosen reference standards should be indicated in the report[30,31]. Fetal biometry charts which are prescriptive, obtained prospectively, truly population-based and derived from studies with the lowest possible methodological bias should be favored, although practitioners should be aware of nationally or locally recommended charts[13].

Whenever abnormal growth is suspected, the use of diagnostic criteria for fetal growth restriction (FGR) based on the Delphi 2016 consensus criteria should be encouraged[13,14,32,33]. Abnormal umbilical artery Doppler indices and/or maternal symptoms of hypertension or pre-eclampsia should prompt emergency referral.

Amniotic fluid volume assessment

Recommendation

- Amniotic fluid index (AFI) may be preferable in assessing polyhydramnios, while deepest vertical pocket (DVP) may be preferable in assessing oligohydramnios (**GRADE OF RECOMMENDATION: C**).

The amount of amniotic fluid should be evaluated either subjectively, defined as 'normal' or 'abnormal' (reduced or increased), or semiquantitatively, by measurement of the deepest vertical pocket (DVP) of amniotic fluid or the amniotic fluid index (AFI). For DVP, the largest vertical pocket free of umbilical cord or fetal parts is measured. DVP $\leq$ 2.0 cm is considered as decreased amniotic fluid volume, DVP > 2 cm and $\leq$ 8.0 cm as normal amniotic fluid volume, and DVP > 8 cm as increased amniotic fluid volume[34]. Reference values for gestational age can also be used[35].

The AFI can be estimated from 18 weeks of gestation by measuring four vertical pockets free of umbilical cord and/or fetal parts, one from each quadrant of the uterus[36]. Both AFI and DVP correlate poorly with the actual dye-calculated volume of amniotic fluid, and neither of them appears significantly better than the other[37]. However, it appears that AFI identifies more women as having oligohydramnios than does DVP, thereby increasing the rate of labor induction, but without improving the clinical outcome[37,38]. Observational evidence comparing ultrasound with dye-determination of amniotic fluid volume has shown that DVP may be superior for identifying oligohydramnios and the AFI superior for identifying polyhydramnios[39]. Recommendations for performing semiquantitative assessment of the amniotic fluid volume are:

- (i) hold the ultrasound transducer perpendicular to the maternal position;
- (ii) identify clear boundaries of the upper and lower edges of the pocket;
- (iii) measure the largest unobstructed amniotic fluid pocket;
- (iv) use color Doppler for areas where the umbilical cord is not visualized clearly.

Amniotic membranes

From 16 weeks onwards, the amnion and chorion are usually fused. Amniotic sheets are benign findings, to be distinguished from amniotic bands which may cause fetal deformities[40–42].

Fetal movement

Normal fetuses typically have a neutral position and show regular movements. Temporary absence of or a reduction in fetal movements during the scan should not be considered as a risk factor[43]. Abnormal positioning or unusually restricted or persistently absent fetal movements may suggest abnormal fetal conditions, such as arthrogryposis, and should prompt a request for referral[44]. The biophysical profile is not considered part of the routine mid-trimester scan[45].

Umbilical cord

Recommendations

- Although formal assessment of the umbilical cord insertion is not part of the routine mid-trimester scan, if marginal or velamentous cord insertion is visualized, it should be reported (**GOOD PRACTICE POINT**).
- When a single umbilical artery is identified in the mid-trimester scan, care should be taken not to cause anxiety to the parents if there is no evidence of coexisting structural defects or FGR (**GOOD PRACTICE POINT**).

The insertion of the umbilical cord is in the center of the placenta in about 80% of cases, paracentral in about 12% of cases and marginal (within 2 cm of the placental edge) in 5–8% of cases. Velamentous insertion occurs in approximately 1% of cases, and is defined as insertion of the umbilical vessels within the amniotic membranes instead of the placenta[46]. A velamentous cord insertion may be associated with vasa previa and FGR. When marginal or velamentous insertion is visualized, it should be reported; however, formal assessment of umbilical cord insertion on the placenta is not part of the routine mid-trimester scan[47].

Number of vessels. Single umbilical artery (SUA) is the result of obliteration or atrophy of one of the arteries, most commonly the left[48]. It is more frequent in twin pregnancy. The diagnosis is made by direct visualization of the umbilical cord, or by tracking the umbilical arteries around the fetal bladder with color Doppler. SUA is associated with congenital anomalies and FGR[49], although it does not constitute an anomaly *per se*. Therefore, care should be taken not to cause anxiety to the parents if no major anomaly is found at the mid-trimester scan. There is, as yet, no consensus regarding the potential impact of SUA on pregnancy outcome[50,51].

Coiling. Coiling describes the spiral course of the umbilical arteries in the cord. Increased or reduced umbilical cord coiling have no proven significance and should not be reported as part of the routine mid-trimester scan[52].

Doppler ultrasonography

Recommendation

- There is currently insufficient evidence to support universal use of uterine or umbilical artery pulsed Doppler evaluation for the screening of low-risk pregnant women (**GRADE OF RECOMMENDATION: C**).

The application of pulsed-wave Doppler techniques is not currently recommended as part of the routine mid-trimester ultrasound examination. There is insufficient evidence to support universal use of uterine or umbilical artery pulsed Doppler evaluation for the screening of low-risk pregnancies[53]. Color-flow Doppler imaging is encouraged and can assist in the examination of the fetal heart and the cord vessels and in determination of the amount of amniotic fluid.

Multiple gestation

Recommendations

- Chorionicity should be determined in the first trimester, if possible (**GRADE OF RECOMMENDATION: C**).
- When no first-trimester ultrasound examination has been performed and it is not possible to identify two

separate placentae and the fetal gender is the same, the pregnancy should be considered as monochorionic (**GOOD PRACTICE POINT**).

The evaluation of multiple pregnancy should follow specific guidelines[54] and includes the following additional elements:

- determination of chorionicity (and, in monochorionic placentation, amnionicity) may be feasible in the mid trimester, for example, if there are clearly two separate placental masses or the fetal gender is discordant (although there are exceptions to these rules); however, chorionicity is better evaluated before 14–15 weeks, when the lambda sign or T-sign can be determined;
- visualization of the placental cord insertion;
- reporting of distinguishing features (gender, unique markers, position in uterus), as it is critical to label twins correctly[55].

When no first-trimester ultrasound examination has been performed and it is not possible to identify two separate placentae and the fetal gender is the same, the pregnancy should be considered as monochorionic and referred or followed as a high-risk pregnancy. Local guidelines and clinical practice should be followed.

Anatomical survey

Suggested minimum requirements for a basic fetal anatomical survey during the mid trimester of pregnancy are summarized in Table 1. If any anomaly is suspected, then a more detailed examination or referral to an expert center should be considered.

Head

Recommendations

- The basic examination of the skull should include assessment of its size, shape, integrity and bone density (**GOOD PRACTICE POINT**).
- The basic examination of the brain should include two axial planes (transventricular and transthalamic) for assessment of the hemispheres, and an additional axial transcerebellar plane for assessment of the posterior fossa (**GOOD PRACTICE POINT**).

Skull. Four aspects of the fetal skull should be evaluated routinely: size, shape, integrity and bone density. All these characteristics can be visualized at the time of the head measurements, when the brain is evaluated for anatomical integrity also (Figure 2)[56].

- Size: measurements are performed as explained in the biometry section.
- Shape: the skull normally has an oval shape without focal protrusions or defects and is interrupted only by narrow, echolucent sutures. Alterations of shape (e.g. lemon, strawberry, cloverleaf) should be documented and investigated[57,58].
- Integrity: no bony defects should be present. Rarely, brain tissue can extrude through defects, for example, of the frontal or occipital bones.
- Bone density: normally, high skull density manifests as a continuous echogenic structure that is interrupted only by cranial sutures in specific anatomical locations. The absence of this whiteness or unusually clear visualization of the fetal brain should raise suspicion

Table 1 Suggested minimum (and *optional) requirements for basic mid-trimester fetal anatomical survey

Head	Intact cranium Head shape normal Cavum septi pellucidi normal in appearance Choroid plexus normal in appearance Midline falx normal in appearance Thalami normal in appearance Lateral cerebral ventricles normal in appearance Cerebellum normal in appearance Cisterna magna normal in appearance Nuchal fold* normal in appearance
Face	Both orbits and bulbi present Midsagittal facial profile* normal in appearance Nasal bone* normal in appearance Upper lip intact
Neck	Absence of masses (e.g. cystic hygroma)
Chest/heart	Chest and lungs appearing normal in shape/size Heart activity present Four-chamber view of heart in normal position (left chambers on left side) Aortic and pulmonary outflow tracts (relative size and their relationships) normal LVOT view; three-vessel view or three-vessels-and-trachea view normal No evidence of diaphragmatic hernia
Abdomen	Stomach in normal position on left side Bowel normal (not dilated or hyperechogenic) Gallbladder on right side* Both kidneys present, no pyelectasis Urinary bladder normal in appearance Cord insertion site into the fetal abdomen normal
Skeletal	No spinal defects or masses (transverse and sagittal views) Arms and hands present, normal joint position Legs and feet present, normal joint position
Placenta	Placental position and relation to cervix normal No masses present
Umbilical cord	Three-vessel cord* Cord insertion into placenta* normal
Genitalia	Normal male or female genitalia*
Cervix	Cervical-length measurement normal*

*Optional component of checklist: can be evaluated if technically feasible and according to local practice. LVOT, left ventricular outflow tract.

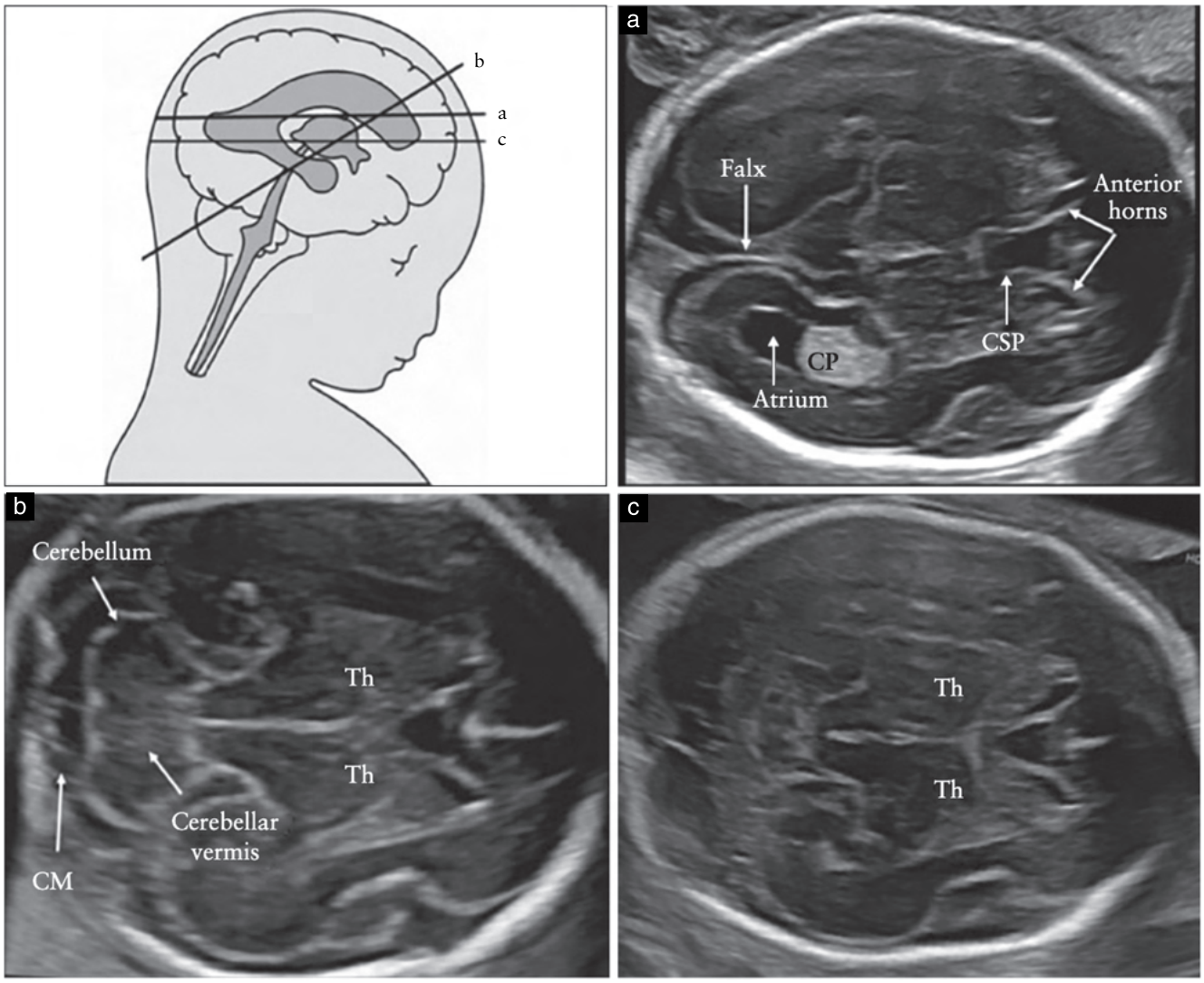

Figure 2 Transverse views of the fetal head, demonstrating standard transventricular (a), transcerebellar (b) and transthalamic (c) scanning planes. The transventricular and transthalamic planes allow assessment of the anatomical integrity of the cerebral hemisphere regions. The transcerebellar plane permits evaluation of the cerebellum and cisterna magna (CM) in the posterior fossa. CP, choroid plexus; CSP, cavum septi pellucidi; Th, thalamus.

of poor mineralization (e.g. osteogenesis imperfecta, hypophosphatasia)[59].

Brain. Standard scanning planes for the basic examination of the fetal brain are described in the updated ISUOG Guidelines[20]. Two axial planes, commonly referred to as the transventricular and transthalamic planes, permit visualization of the cerebral structures relevant to the anatomical integrity of the brain (Figure 2). Imaging artifacts obscure the proximal hemisphere (the one closer to the transducer). A third axial, transcerebellar, plane should be added to evaluate the posterior fossa. The following brain structures should be evaluated:

- lateral ventricles (including choroid plexus);
- cavum septi pellucidi;
- midline falx;
- thalami;
- cerebellum;
- cisterna magna.

Face

Recommendation

- The basic examination of the face should include visualization of the upper lip, assessment of the presence and position of the orbits/eyes, and, if possible, assessment of the fetal profile (**GOOD PRACTICE POINT**).

Evaluation of the fetal face should include visualization of the upper lip in the coronal (frontal) view to detect cleft lip[60] (Figure 3a) and, if feasible, the midsagittal facial profile (Figure 3b). The presence of both orbits and normal position and separation of the eyes should be checked (Figure 3c). Other anatomical landmarks, such as nose, nostrils, palate, maxilla, mandible, tongue[61–63] and ear position and size, may be assessed, but are not part of the routine mid-trimester examination[64]. Three-dimensional ultrasound may be a useful tool for

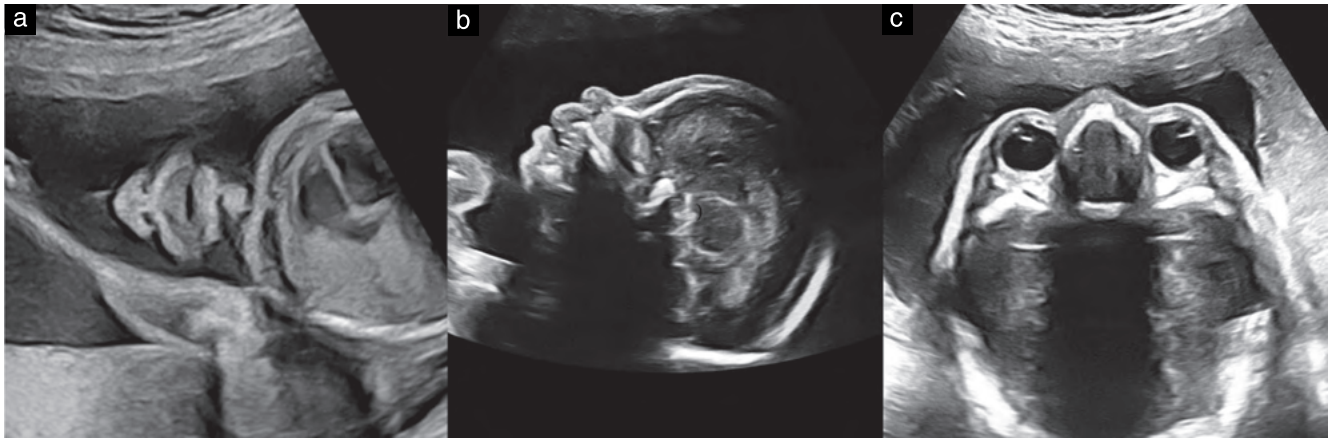

Figure 3 Ultrasound imaging of the fetal face. (a) The mouth, lips and nose are typically evaluated in a coronal view. (b) If technically feasible, a midsagittal facial profile should be obtained, as it provides important diagnostic clues for bilateral cleft lip, frontal bossing, micrognathia and nasal-bone anomalies. (Note that examination of the nasal bone is optional.) (c) Both fetal orbits should appear symmetrical and intact, with eyes separated by approximately the diameter of one orbit.

examination of the fetal face[65], although this is not part of the routine evaluation.

Neck

Recommendation

- The presence of obvious neck masses should be documented (**GOOD PRACTICE POINT**).

The neck normally appears as cylindrical, with no protuberances, masses or fluid collections. Obvious neck masses, such as cystic hygromas, goiter or teratomas, should be documented[66].

Thorax

Recommendation

- The basic examination of the thorax should include assessment of its shape and transition to the abdomen, the shape of the ribs, the texture of the lungs and, when feasible, visualization of the diaphragm (**GOOD PRACTICE POINT**).

The shape of the thorax should be regular, with a smooth transition to the abdomen[67]. The ribs should have normal curvature, without deformity. Both lungs should appear homogeneous and without evidence of mediastinal shift or masses[68]. The diaphragmatic interface can often be visualized as a hypoechoic dividing line between the thoracic and abdominal content (e.g. between heart and stomach or lung and liver)[69,70].

Heart

Recommendations

- The examination of the heart should start with assessment of its situs, axis and rhythm (**GOOD PRACTICE POINT**).
- The anatomical examination of the heart should include the four-chamber view, the outflow tract views and the three-vessel view (**GOOD PRACTICE POINT**).

Fetal cardiac screening is performed for the detection of congenital heart disease during the mid-trimester scan (Figure 4)[71]. A single acoustic focal zone and relatively narrow field of view can help to maximize frame rates. Images should be magnified until the heart fills at least one-third to one-half of the ultrasound display screen.

The scanning procedure should begin with a four-chamber view of the fetal heart. A normal, regular heart rate typically ranges from 120 to 160 bpm. The heart is positioned in the left chest (as is the fetal stomach) if the *situs* is normal. A normal heart is usually no larger than one-third of the area of the chest and is without pericardial effusion. The heart axis deviates by approximately $45 \pm 20°$ (2 SD) towards the left side of the fetus[72]. Routine cardiac screening should also assess the aortic and pulmonary outflow tracts to detect cardiac malformations beyond those achievable using the four-chamber view alone (Figure 4a). Normal-appearing great vessels are approximately equal in size and should cross each other as they exit their respective ventricular chambers (Figure 4b,c). Routine assessment of the cardiac outflow tracts in addition to the four-chamber view increases the screening performance for identifying conotruncal anomalies, such as tetralogy of Fallot, transposition of the great arteries, double-outlet right ventricle and truncus arteriosus communis. The three-vessel view and closely related three-vessels-and-trachea view may improve detection of outflow tract, aortic arch and systemic vein anomalies (Figure 4d,e)[73–77]. For a more detailed description of fetal cardiac screening, please refer to the ISUOG Guidelines for the fetal cardiac examination[71].

Abdomen

Recommendations

- The presence, situs and shape of the stomach should be examined (**GOOD PRACTICE POINT**).

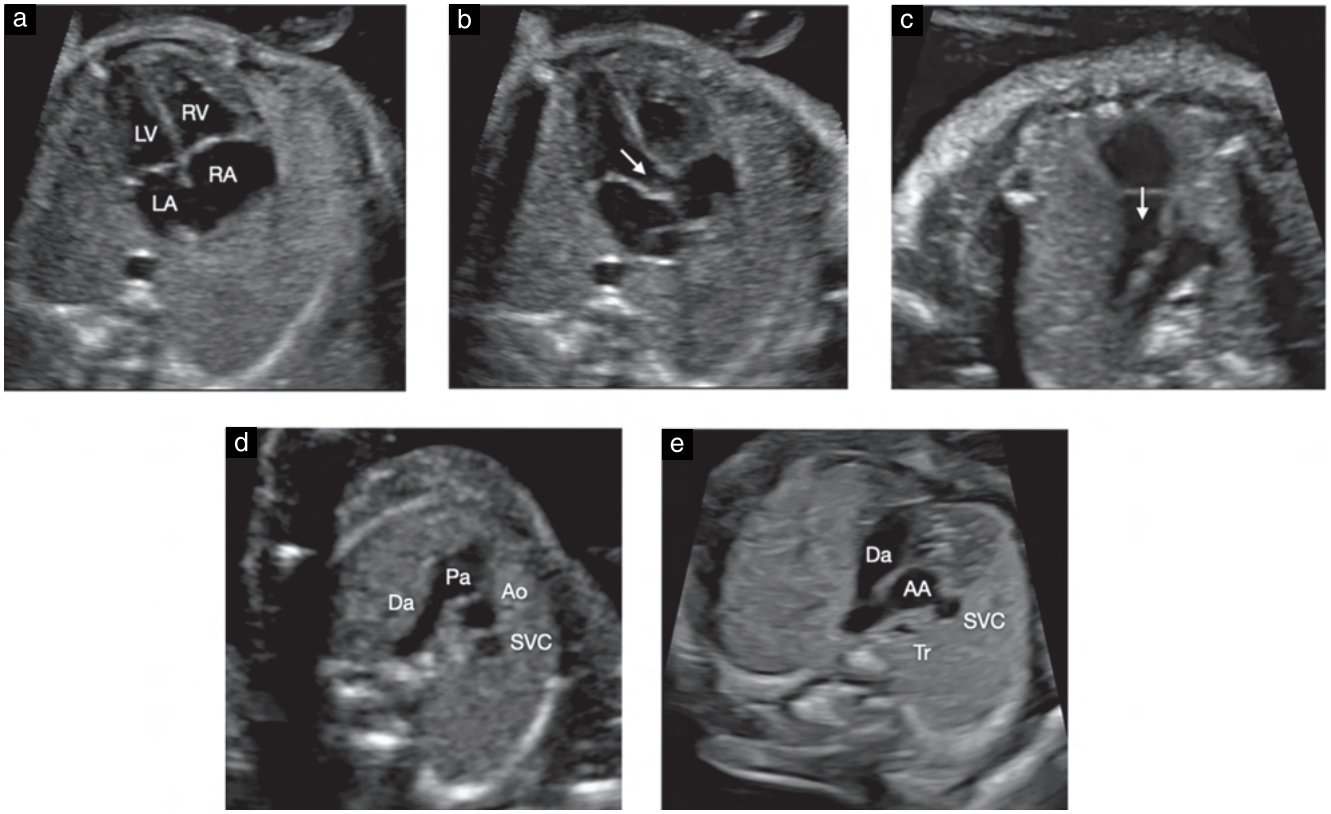

Figure 4 Representative scan planes for mid-trimester fetal cardiac screening. Determination of cardiac *situs* with the fetal stomach and the fetal heart in the same left-sided position (not shown). The four-chamber view (4CV) (a) includes two atria, left and right (LA and RA), and two ventricles, left and right (LV and RV), with offset atrioventricular valves and intact ventricular septum. The left ventricular outflow tract (b) (arrow) and right ventricular outflow tract (c) (arrow) are imaged routinely. Both arterial outflow tracts are approximately equal in size and exit their respective ventricles by crossing over each other in normal fetuses. The three-vessel view (d) (pulmonary artery (Pa), ascending aorta (Ao) and right superior vena cava (SVC)) and three-vessels-and-trachea view (e) (ductal arch (Da), aortic arch (AA), right superior vena cava (SVC) and trachea (Tr)) are documented in addition to the 4CV.

- From left to right, the stomach, umbilical vein and gallbladder should be visualized. Assessment of the gallbladder is optional (**GOOD PRACTICE POINT**).
- The fetal umbilical cord insertion site should be examined (**GOOD PRACTICE POINT**).
- Abnormal fluid collections in or around the bowel should be documented (**GOOD PRACTICE POINT**).
- Increased echogenicity of the bowel, equal to that of bone, should prompt referral (**GOOD PRACTICE POINT**).

Abdominal-organ *situs* should be determined[78]. The fetal stomach should be clearly visible in its normal position on the left side and should occupy about one-third of the left half of the transverse section of the fetal abdomen used for AC measurement. Any abnormality in the position/location of the stomach or any significant deviation in size (persistent non-visualization or barely visible stomach, stomach expanding beyond the midline or presence of the 'double bubble') should prompt referral. Three hypoechoic structures should be identified in the upper fetal abdomen: from left to right, the stomach, umbilical vein and gallbladder (assessment of the gallbladder is optional). An abnormal location of any of these structures may be associated with a congenital anomaly (e.g. persistent right umbilical vein, heterotaxy, portohepatic shunt). The bowel should be contained within the abdomen. The fetal umbilical cord insertion site (Figure 5a) should be examined for evidence of a ventral wall defect, such as omphalocele or gastroschisis. Abnormal fluid collections in or around the bowel (e.g. ascites, enteric cysts, obvious bowel dilatation) should be documented. Increased echogenicity of the bowel, equal to that of bone, should also be a reason for referral; in order to avoid false positives, ultrasound grayscale gain should be decreased to check whether, under these circumstances, the suspected bowel remains more echoic than adjacent bones, such as the iliac crest[79].

Kidneys and bladder

Recommendations

- The fetal bladder and both kidneys should be visualized (**GOOD PRACTICE POINT**).
- If either bladder or renal pelvis appears enlarged, a detailed assessment should follow (**GOOD PRACTICE POINT**).

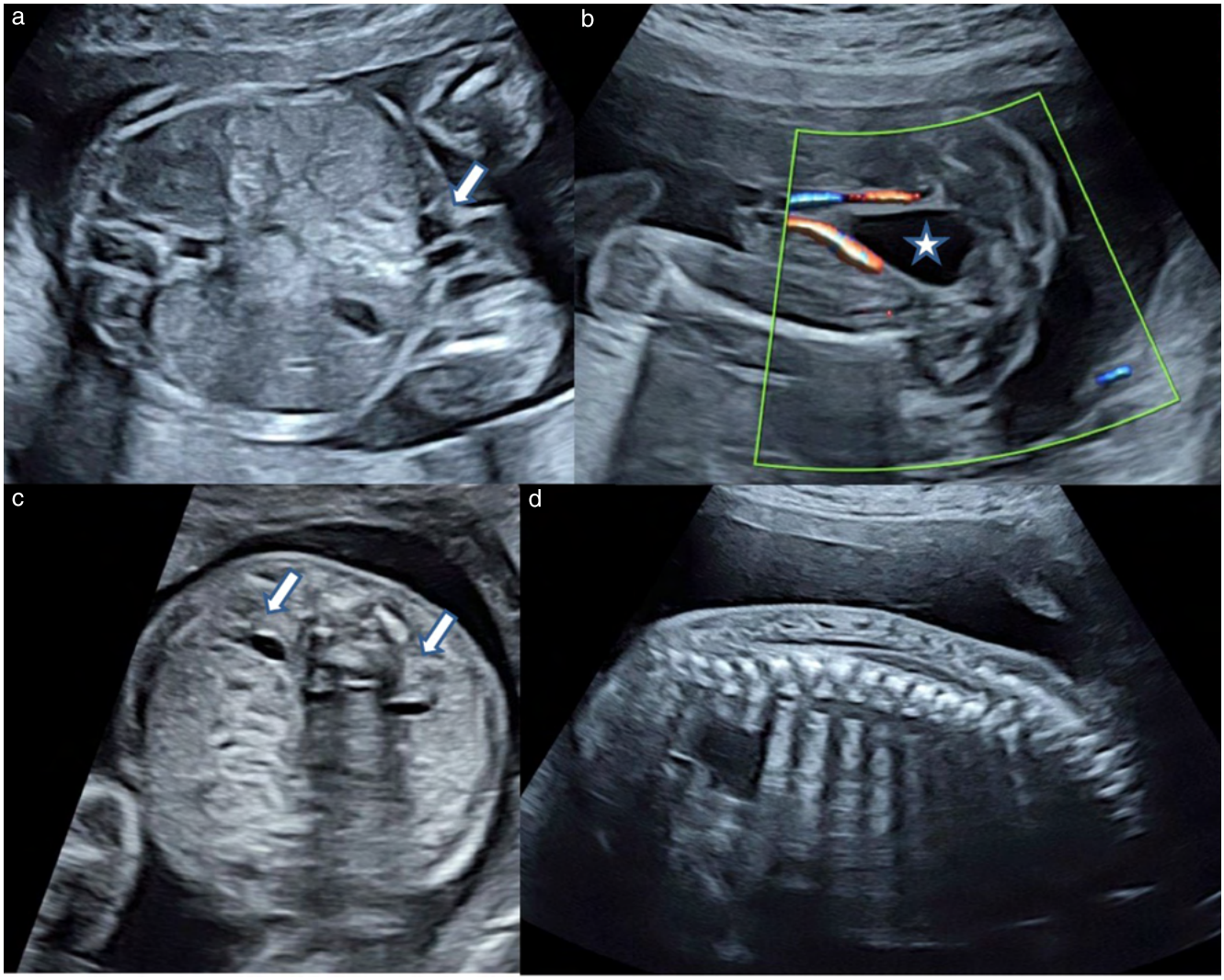

Figure 5 Ultrasound imaging of the fetal cord insertion site and bladder, with umbilical arteries, kidneys and spine. The umbilical cord insertion site into the fetal abdomen (a, arrow) provides information about the presence of ventral wall defects, such as omphalocele or gastroschisis. The fetal bladder (b, ☆) and both kidneys (c, arrows) should be identified. Axial and longitudinal views of the spine (c,d) including a clearly visible intact skin line provide effective screening for spina bifida, especially when these scanning planes are abnormal in the presence of frontal skull deformation and an obliterated cisterna magna.

The fetal bladder and both kidneys should be visualized (Figure 5b,c). If either the bladder or renal pelvis appears enlarged, a measurement should be documented. A renal pelvis ≥ 7 mm indicates a need for reassessment in the third trimester[80,81]. The fetal bladder should not reach the level of the umbilical cord insertion. At 18 and 22 weeks, the 95th centile for the longitudinal bladder measurement is 14 and 23 mm, respectively[82]. An abnormally enlarged fetal bladder or persistent failure to visualize the bladder should prompt referral for a more detailed assessment.

Spine

Recommendation

- The basic examination of the fetal spine should include transverse and sagittal views (**GOOD PRACTICE POINT**).

A satisfactory examination of the fetal spine requires expertise and meticulous scanning, and the results are very dependent upon fetal position. Complete evaluation of the fetal spine in every plane is not part of the basic examination, although transverse (Figure 5c) and sagittal (Figure 5d) views are usually informative. The most frequent severe spinal anomaly, open spina bifida, is usually associated with a characteristic cerebellar deformity and an obliterated cisterna magna[83]. Other views of the fetal spine may identify other spinal malformations, including vertebral anomalies and sacral agenesis[20].

Limbs and extremities

Recommendations

- The presence of all four extremities should be documented (**GOOD PRACTICE POINT**).

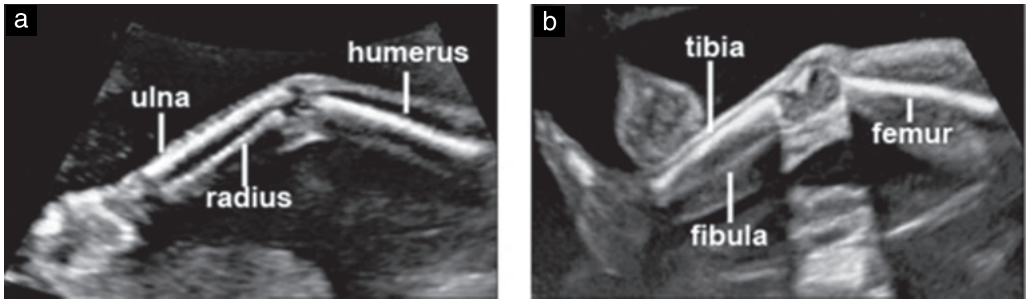

Figure 6 Sonography of the fetal upper (a) and lower (b) extremities. The presence or absence of the upper and lower limbs should be documented routinely unless they are poorly visualized due to technical factors.

- The presence of all long bones and their symmetry, length, shape, alignment, position and movement should be assessed (**GOOD PRACTICE POINT**).
- Counting fingers or toes is not required as part of the routine mid-trimester scan (**GOOD PRACTICE POINT**).
- The measurement of one femur is usually sufficient, unless there is suspicion of abnormality (**GOOD PRACTICE POINT**).

The presence or absence of both arms and hands (Figure 6a) and both legs and feet (Figure 6b) should be documented using a systematic approach[84]. All four limbs should be surveyed, noting presence of all long bones and their symmetry, length, shape, alignment, position and movement. Counting fingers or toes is not required as part of the routine mid-trimester scan. Usually, measurement of one femur is sufficient, but if there is concern, then all long bones should be measured and measurements compared with standardized charts[85]. Suspected deviations from normal at the standard examination should prompt a more detailed examination[86] and expert evaluation and counseling for possible skeletal dysplasia and genetic and non-genetic syndromes.

Genitalia

Recommendation

- Although examination of the fetal genitalia for sex determination is not part of the routine mid-trimester scan, their normal appearance should be checked (**GOOD PRACTICE POINT**).

Characterization of external genitalia to determine fetal gender is not considered part of the routine mid-trimester scan. Reporting of gender should be considered only on parental request and in the context of local practice and regulations. However, the normal appearance of the external genitalia should be checked.

Placenta

Recommendations

- The relationship of the placenta with the internal cervical os should be examined (**GOOD PRACTICE POINT**).

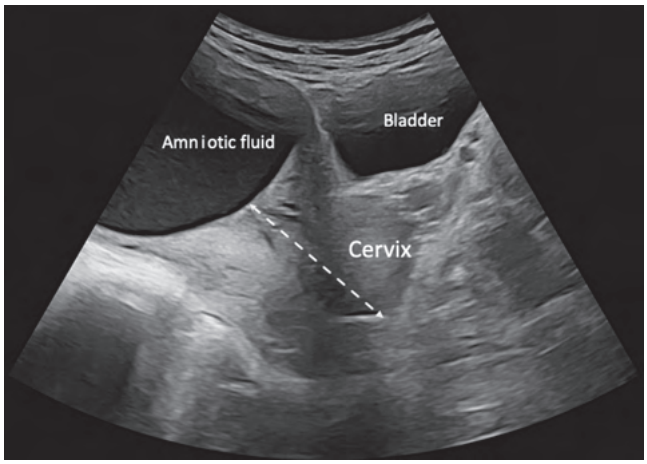

Figure 7 Placental position should be determined in relation to the maternal cervix (dashed arrow).

- If the distance between the lower placental edge and the internal os is $\leq$ 15 mm on transvaginal scan, a follow-up examination in the third trimester is recommended (**GRADE OF RECOMMENDATION: C**)
- If placenta accreta is suspected at the routine mid-trimester scan, a more detailed evaluation is suggested (**GOOD PRACTICE POINT**).

The placental location (Figure 7), its relationship with the internal cervical os (usually using transabdominal insonation) and its appearance should be assessed and described. Examples of abnormal placental findings include the presence of hemorrhage, multiple anechoic cysts (distinct from normal lacunae) in triploidy, and placental masses, such as chorioangioma. In most cases, in the routine mid-trimester examination, transabdominal ultrasonography permits clear definition of the relationship between the placenta and the internal cervical os. If the lower placental edge reaches or overlaps the internal os, a follow-up examination in the third trimester is recommended[87–89]. Although there is little evidence for the optimal cut-off for reassessment of a low-lying placenta[90], recently suggested cut-offs for likely placental migration for an anteriorly and a posteriorly located placenta were 5 mm and 15.5 mm, respectively, from the internal os, using transvaginal imaging at the mid-trimester scan[91]. 'Migration' of low-positioned

placentae (i.e. growth of the uterine wall between the placental edge and the internal os) during pregnancy is frequent, and follow-up in the third trimester will confirm normal placental position in most cases[92]. Women with a history of uterine surgery and low anterior placenta or placenta previa are at risk for placenta accreta spectrum disorders. In these cases, the placenta should be examined for findings such as: lack of the hypoechoic myometrial line below the placenta; large and irregular placental lacunae; interruption of the hyperechoic line between the uterine serosa and the bladder; reduced thickness (< 1 mm) of the myometrium underlying the placenta; and placental bulge[93,94]. Although placenta accreta may be suspected during a routine mid-trimester scan, a more detailed evaluation is usually required to examine this possibility further[87,93].

Screening for vasa previa

Recommendation

- In the presence of risk factors for vasa previa, a targeted examination using a transvaginal approach is recommended, depending on experience and resources (**GRADE OF RECOMMENDATION: B**).

Vasa previa, defined as unprotected fetal vessels running through the fetal membranes, over or within 2 cm of the internal cervical os, is found in approximately 0.5 per 1000 pregnancies in the general population. Risk factors for vasa previa include twin pregnancy, conception by assisted reproductive technology, a low-lying or bilobed placenta, succenturiate placental lobes and velamentous cord insertion[95]. If such risk factors are identified, a targeted examination is suggested, given that prenatal knowledge of vasa previa significantly increases survival and decreases perinatal morbidity[96]. This can be done using a transvaginal approach with color Doppler imaging[88,97,98]. Similarly, when the transabdominal scan suggests the possibility of placenta previa or shortened/dilated maternal cervix, using transvaginal sonography with color Doppler imaging may also be of benefit. There is, however, ongoing debate regarding whether routine screening for velamentous cord insertion and/or vasa previa should be performed at the mid-trimester scan; the evidence is of limited quality and fails to take into account the consequences of over-diagnosing such anomalies[47,88]. Furthermore, not all medical practices may have sufficient experience in transvaginal sonography or the resources for proper disinfection procedures.

Cervix, uterus and adnexa

Recommendations

- When feasible, transvaginal CL measurement should be performed at the mid-trimester scan in the context of screening for preterm birth (**GRADE OF RECOMMENDATION: C**).
- This assessment requires additional consent from the woman, appropriate operator training and auditing of the results (**GOOD PRACTICE POINT**).

Several studies have demonstrated a strong correlation between short transvaginal sonographic CL, usually defined as < 25 mm, especially before 24 weeks, and subsequent preterm birth. CL measurements can be performed as part of the routine mid-trimester scan, by transvaginal imaging, which requires separate consent from the woman, appropriate operator training[3] and auditing of the results. Meta-analyses of randomized controlled trials of women with singleton gestation, no prior spontaneous preterm birth and transvaginal sonographic CL < 25 mm before 24 weeks have shown that administration of vaginal progesterone significantly decreases the risk of preterm birth and neonatal morbidity[99–101]. Two cost-effectiveness analyses have shown that measurement of CL in the mid trimester and progesterone supplementation in women with a short cervix appears to be a cost-effective screening strategy for preterm birth[102,103]. For these reasons, transvaginal ultrasound CL measurement is commonly recommended in the general population[104–106].

In women with singleton gestation, a short cervix and prior spontaneous preterm birth, cerclage is associated with significant decrease in the risk of preterm birth and neonatal morbidity and mortality[107]. Several medical societies recommend serial transvaginal sonographic CL measurement at 16–23 weeks in this population[104,105,108,109].

The 'ISUOG Practice Guidelines: role of ultrasound in the prediction of spontaneous preterm birth' (in prep.) will provide more guidance and details.

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APPENDICES

Appendix 1 Grades of recommendation and levels of evidence used in ISUOG Guidelines

Classification of evidence levels	
1++	High-quality meta-analyses, systematic reviews of randomized controlled trials or randomized controlled trials with very low risk of bias
1+	Well-conducted meta-analyses, systematic reviews of randomized controlled trials or randomized controlled trials with low risk of bias
1–	Meta-analyses, systematic reviews of randomized controlled trials or randomized controlled trials with high risk of bias
2++	High-quality systematic reviews of case–control or cohort studies or high-quality case–control or cohort studies with very low risk of confounding, bias or chance and high probability that the relationship is causal
2+	Well-conducted case–control or cohort studies with low risk of confounding, bias or chance and moderate probability that the relationship is causal
2–	Case–control or cohort studies with high risk of confounding, bias or chance and significant risk that the relationship is not causal
3	Non-analytical studies, e.g. case reports, case series
4	Expert opinion
Grades of recommendation	
A	At least one meta-analysis, systematic review or randomized controlled trial rated as 1++ and applicable directly to the target population; or a systematic review of randomized controlled trials or a body of evidence consisting principally of studies rated as 1+ applicable directly to the target population and demonstrating overall consistency of results
B	Body of evidence including studies rated as 2++ applicable directly to the target population and demonstrating overall consistency of results; or extrapolated evidence from studies rated as 1++ or 1+
C	Body of evidence including studies rated as 2+ applicable directly to the target population and demonstrating overall consistency of results; or extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4; or evidence extrapolated from studies rated as 2+
Good practice point	Recommended best practice based on the clinical experience of the guideline development group

Appendix 2 Mid-trimester fetal ultrasound scan report form for singleton pregnancy

Patient: **ID number:**

Date of birth (DD/MM/YYYY):
Referring physician:

Date of exam (DD/MM/YYYY):
Sonographer / Supervisor:
Ultrasound machine:
Indication for scan and relevant clinical information:

Gestational age (W + D):
Based on: *LMP / Previous US / Other* :

Technical conditions: *Good / Limited by:*
Singleton / Multiple (use 1 sheet/fetus)
=> Chorionicity:

PLACENTA: Position:
Relation to cervical os: ☐ clear ☐ covering ___ mm from os
Appearance ☐ Normal ☐ Abnormal*
Umbilical cord ☐ Normal ☐ Abnormal*
AMNIOTIC FLUID: ☐ Normal ☐ Abnormal*
☐ AFI (optional): ☐ DVP (optional)
FETAL MOVEMENT: ☐ Normal ☐ Abnormal*

MEASUREMENTS	mm	Percentile (References)
Biparietal diameter		
Head circumference		
Abdominal circumference		
Femur diaphysis length		
EFW (Hadlock et al.):		
Other:		
Other:		
Cervical length (optional)		

***Abnormal findings (please detail):**

CONCLUSION:
☐ Normal and complete examination.
☐ Normal but incomplete examination.
Elements not seen: ……
☐ Abnormal examination:
Plans: ☐ No further ultrasound scans required.
☐ Follow up planned in ….. weeks.
☐ Referred to ……
☐ Other:

REMARKS AND DETAILED FINDINGS:
(Describe here any abnormal findings)

SONOGRAPHIC APPEARANCE OF FETAL ANATOMY: (N=Normal; Ab=Abnormal*; NV=Not visualized) Gray=optional	N	Ab*	NV
Head			
Intact cranium / normal shape			
Cavum septi pellucidi			
Midline falx			
Thalami			
Lateral ventricle			
Cerebellum			
Cisterna magna			
Face			
Upper lip			
Midsagittal profile (optional)			
Orbits and bulbs			
Nasal bone (optional)			
Neck / Nuchal fold			
Thorax			
Shape			
Heart			
Heart activity			
Size			
Cardiac axis and situs			
Four-chamber view			
Left ventricular outflow tract			
Right ventricular outflow tract			
3VV and 3VT			
Abdomen			
Stomach			
Bowel			
Kidneys			
Urinary bladder			
Abdominal cord insertion			
Gallbladder (optional)			
Cord vessels (optional)			
Spine			
Limbs			
Right arm (incl. hand)			
Right leg (incl. foot)			
Left arm (incl. hand)			
Left leg (incl. foot)			
Gender (optional): ☐ M ☐ F			
Other:			

	Produced	Printed	Stored
No. of images			

For multiple pregnancy, specify chorionicity and fill out one sheet for each fetus (labeled Fetus A, B, C, . . .) and, in the remarks section, identify type of twinning and fetal/placental position.

