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REVIEW ARTICLE

CRITERIA FOR PERFORMING ULTRASONOGRAPHY IN THE SECOND TRIMESTER OF PREGNANCY BASED ON INTERNATIONAL SOCIETY OF ULTRASONOGRAPHY IN OBSTETRICS AND GYNECOLOGY (ISUOG) GUIDELINES

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ABSTRACT

Second trimester routine ultrasound, whose main indication is the study of fetal morphology, is performed between 18 and 22 weeks of gestation, an ideal period to detect growth abnormalities and congenital anomalies. At this stage, gestational age can also be evaluated, until the 22nd week as well as the fetal growth by ultrasonography and Doppler velocimetry. The recommendations of the guideline of the International Society for Ultrasonography in Obstetrics and Gynecology (ISUOG) represent an international reference for the performance of fetal ultrasound, and are intended to reflect about the most appropriate methodology. Thus, the aim of this review was to analyze the criteria and indications for performing ultrasound in the second trimester of pregnancy. This paper was developed on ISUOG's practical guidelines for the routine performance of fetal ultrasound in the second trimester of pregnancy, using the updated literature. The knowledge of fetal development throughout pregnancy and the use of an appropriate ultrasound methodology in the second trimester are, therefore, essential to obtain accurate results.

KEY-WORDS: ULTRASONOGRAPHY, GESTATION, SECOND TRIMESTER, PRENATAL, DIAGNOSTIC IMAGING.

INTRODUCTION

Ultrasonography is a well-established imaging method and widely used in prenatal assessment of fetal growth and anatomy[1-3], as well as in monitoring multiple pregnancies[2,3].

Routine ultrasonography in the second trimester is primarily used to study fetal morphology. It is preferably performed between 18 and 22 weeks of gestation, an ideal period to detect growth abnormalities and congenital anomalies[3-5].

The use of this imaging method as a screening for fetal anomalies in the second trimester of pregnancy can diagnose more than half of the fetal structural anomalies[3,6]. This early diagnosis corroborates with a relevant reduction in perinatal morbidity and mortality due to morphostructural factors[6].

Although part of the malformations can be identified in the first trimester of pregnancy, it is recognized that some fetal malformations have their diagnosis postponed, in view of their later development in pregnancy, being better diagnosed in the second trimester of pregnancy[6-7].

The main indications for ultrasonography in the second trimester of pregnancy are the study of fetal morphology, the diagnosis of fetal growth restriction by ultrasound and Doppler velocimetry, as well as the calculation of gestational age if it has not been performed in the first trimester of pregnancy[2].

The guidelines recommendations represent an international reference for their realization, and are intended to reflect on the practices, considered more appropriate by the International Society of Ultrasonography in Obstetrics and Gynecology (ISUOG), when they were developed[8].

However, the circumstances and medical practices of each service must be considered, and it is advisable to document the cases in which it is impossible to carry out the examination in full according to these recommendations[2]. In this scenario, it is recommended to refer to a tertiary service to complement the exam, in order to minimize the delay in the diagnosis of potential congenital abnormalities and growth disorders using this method.

The adequate performance of fetal ultrasound in the second trimester of pregnancy is of fundamental importance to obtain accurate results that optimize prenatal care and potential necessary conduct[2]. Therefore, it should be offered to all patients at this gestational age so that the most reliable goals in detecting fetal anomalies and complications during pregnancy can be achieved[7].

Thus, the present study aims to analyze the criteria and

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indications for performing ultrasonography in the second trimester of pregnancy.

ULTRASONOGRAPHIC METHODOLOGY IN THE SECOND TRIMESTER OF PREGNANCY

The work was developed in the form of a bibliographic review carried out based on ISUOG's practical guidelines for the performance of the routine of fetal ultrasound in the second trimester.

In the ISUOG guidelines, recommendations are described, ranging from the equipment that must be used to how to evaluate the fetus from a morphostructural point of view.

The ultrasound equipment to be used for the adequate performance of routine ultrasound in the second trimester of pregnancy must acquire images in real time and gray scale[2]. In addition, they must contain transabdominal ultrasound transducers, in the 3–5 MHz band; adjustable acoustic power output controls and output pattern display; freeze frame capabilities, "freeze" mode; electronic cursors and the ability to print and store images[2]. There should be regular maintenance and repair of the equipment[2].

In order to obtain ideal results, it is suggested that routine ultrasounds should be performed by professionals trained in the use of diagnostic ultrasound, who perform fetal ultrasound examinations regularly, respecting quality assurance and control measures and based on standards appropriate reference points for suspicious or abnormal findings[9].

After the examination, a documented report must be made, to be printed and stored, and, in accordance with local practices, made available to the pregnant woman and the health service provider who referred the patient. This document must contain information about the patient's general data; date of the exam and performing professional; relevant clinical indication and information; if there was adequacy or technical limitation; chorionicity in cases of twin pregnancies; appearance of the placenta and its location in relation to the internal cervical orifice (ICO); as well as amniotic fluid and fetal movements as to their normality or abnormality[2]. In the second trimester ultrasound examination, it is also recommended to produce and store images of visualization patterns, as well as movement videos for the documentation of fetal cardiac activity[2].

In addition, fetal biometric measurements, such as biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and length of the femur (FL), and their respective percentiles[2], must be documented.

Regarding the effects of ultrasound on the fetus, the use of this method in its static and real-time modes, B and M respectively, is safe for all stages of pregnancy, since the output acoustic energy is not high enough to produce deleterious effects[10-11].

The calculation of gestational age by ultrasound can be performed in the second trimester until the 22nd week, with a standard deviation of one week, if the crown rump length measurement (CRL), the gold standard for calculating the GA, has not been performed previously[12].

In the period between 18 and 22 weeks, the ultrasound parameters for estimating gestational age and for assessing fetal size are BPD, HC, AC and FL [12-15].

For the measurement of BPD and HC, the symmetrical axial plane of the fetus head should be considered, in which the third ventricle should be visible, in a central position; interhemispheric fissure; choroid plexus and midline structures, such as the thalamus and cavum septum pellucidum (CSP) [2,16-17] (Figure 1). There should be no distortion of the fetal head by adjacent structures or by the pressure exerted by the transducer[8].

The HC can be obtained directly by the ellipse measurement too[11,17], as well as it can be calculated through the measurements of BPD and occipitofrontal diameter (OFD), by the equation HC = (BPD + OFD) x 1,62 [2] (Figure 1). For this, the position of the cursors must follow the technique used to produce the selected nomogram[18 19].

For the BPD, the cursors should be positioned in the largest diameter transversal to the external-external or external-internal interhemispheric fissure in relation to the parietal limits of the skullcap[18-20], being, for some authors, the external-external diameter of choice for the calculation of the HC [20]. For OFD measurements, in the same symmetrical axial plane in which BPD is measured, the cursors are positioned anteroposteriorly in the external-external diameter of the occipital and frontal poles [8-17,21]. Considering the methodological variability in the positioning of the calipers to measure the biparietal diameter, it is advisable that the same methodology be used in all gestational ages.

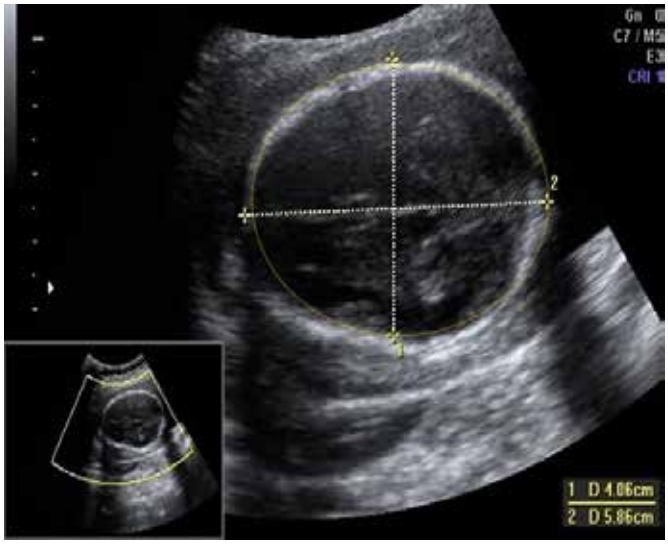

Figure 1: View of the symmetrical axial plane of the fetal head. Cursors positioned to measure BPD (external-internal) and OFD (external-external) and HC.

The shape of the fetal head, characterized by the cephalic index (biparietal diameter / occipitofrontal diameter x 100), may be abnormal, as in brachycephaly and dolichocephaly. Such variations adversely affect the accuracy of BPD in predicting gestational age, and, in these cases, the measurement of the HC is of no value in comparative studies with AC in assessments of fetal growth restriction[13,22].

For the calculation of gestational age, it is advisable to use the combination of measures HC, AC and FL. This approach improves accuracy in calculating gestational age[13,22].

The AC is measured in the transverse plane of the fetal abdomen, showing the stomach and venous sinus, either directly using the ellipse measurement tool or calculated from linear measurements perpendicular to each other, the abdominal anteroposterior diameter (APD) and the transverse abdominal diameter (TAD) [2] (Figure 2). To measure the APD, the cursors are placed on the outer edges of the abdominal contour, from the back to the spine to the anterior abdomen wall. To measure TAD, the cursors are placed on the outer edges of the widest laterolateral diameter of the abdomen. The AC is then calculated using the formula: AC = (APD + TAD) x 1.57 [2].

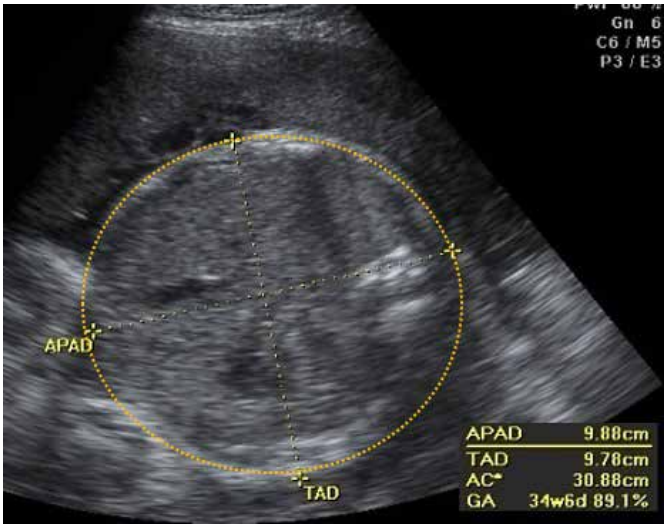

Figure 2: Measurement of abdominal circumference (AC) in the transverse plane of the fetal abdomen. The AC measurement was obtained by the equation AC = (APD + TAD) x 1.57.

The FL is measured on the longest axis of the femoral diaphysis[23]. The measurement should include both visible ends of the bone, and the femur should be positioned at an angle <45° to the horizontal, occupying more than half of the total image of the ultrasound device[1] (Figure 3).

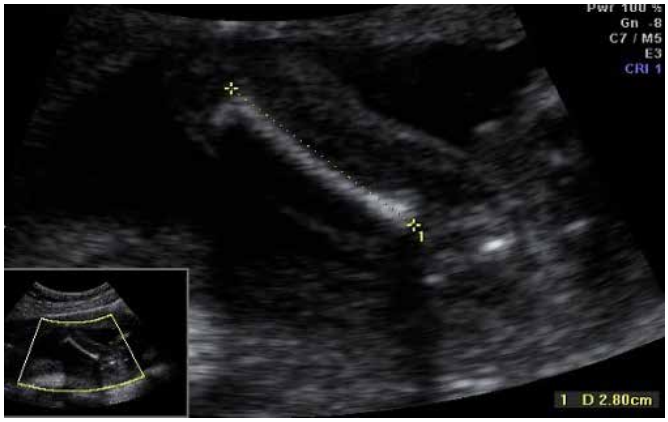

Figure 3: Measurement of the length of the femur (FL) on the longest axis of the femoral diaphysis.

CHARACTERIZATION OF THE ECOGRAPHIC EXAMINATION IN THE SECOND TRIMESTER OF PREGNANCY

Estimated fetal growth and weight

Second trimester ultrasound measurements can also be used to identify size abnormalities[2] as well as to estimate weight as a baseline parameter to monitor fetal growth and track intrauterine growth problems[2,24]. In addition, in term fetuses, the estimated fetal weight provides a good estimate of the actual birth weight[24].

Fetal weight is estimated throughout pregnancy based on measurements of healthy fetuses[24]. The most accurate estimates are based on at least three fetal measurements: BPD or HC, as an index of the size of the head; AC, as an index of body circumference and FL, as an index of the vertical length of the fetus[25]. The estimated fetal weight is calculated using the formula [log10EFW = 1.326 + 0.0107 x HC + 0.0438 x AC + 0.158 x FL - 0.00326 x AC × FL5] [24]. However, it should be considered that population differences or differences subtle in imaging and measurement techniques can change the shape of the optimal equation or the values of its coefficients[25].

Assessment of amniotic fluid (AF)

Another important parameter in the prenatal assessment of the second trimester is the identification of abnormal amounts of AF. The abnormality of the volume, both the decrease and the increase, are associated, among other factors, with congenital anomalies and increased perinatal morbidity and mortality[26]. Patients with deviation from normality should have a more detailed anatomical evaluation and clinical follow-up[2].

Current ultrasound techniques to estimate the volume of the AF include the amniotic fluid index (AFI) or Phelan test and the measurement of the largest vertical pock-

et27,28. The Phelan test is based on anatomical shields, so that, using the umbilical scar as a reference point, the uterus is transversely divided into two parts, upper and lower and the black line is the reference that divides the uterus into left portions and right27,28 (Figure 4). With the transducer perpendicular to the ground, the largest vertical pocket in each quadrant is then measured and the sum of the values of the four pockets is the AFI28 measurement (Figure 5).

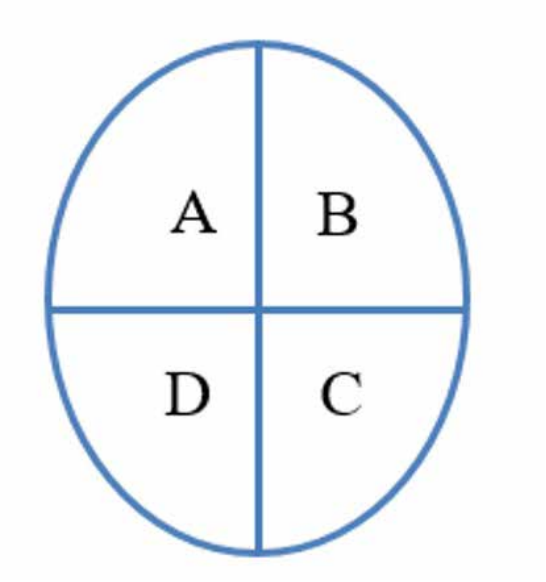

Figure 4: Representative illustration of the imaginary division of the maternal abdomen into four quadrants (A, B, C, D) to perform the Phelan test[28].

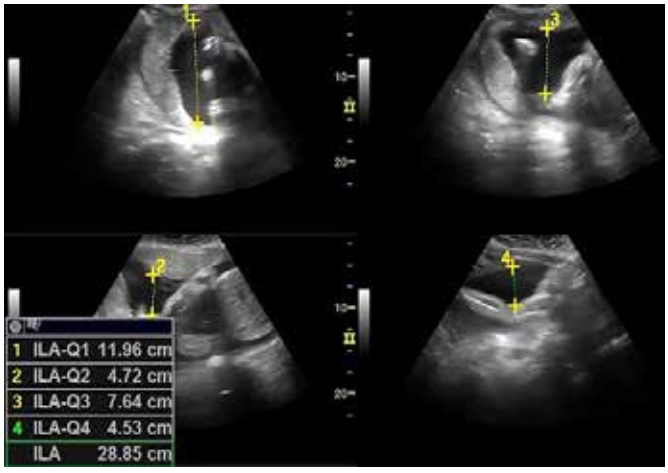

Figure 5: Measurement of the amniotic fluid index using the Phelan method[28].

The largest vertical pocket is also measured in a location that does not contain umbilical cord or fetal extremities. However, unlike the Phelan test, only one measurement should be considered, the largest one[29] (Figure 6).

Figure 6: Measurement of the largest vertical pocket

According to a systematic review of the literature, published in the Cochrane Library in 2008, there is no evidence of superiority between the AFI methods and measurement of the largest pocket in preventing negative pregnancy outcomes, including admission to a neonatal intensive care unit and a 5th minute Apgar lower than [7]. However, it was observed that the use of the AFI method was related to a significant increase in cases of oligohydramnios, as well as to the induction rates of labor and cesarean sections, being, therefore, the measurement of the largest pocket in the evaluation of the volume of amniotic fluid during fetal surveillance is currently the best choice[30].

Fetal Movement

Normal fetuses generally adopt a relaxed position and show regular movements, with no specific movement patterns in the second trimester of pregnancy[2].

Motor ultrasound assessment is limited to detecting the presence of any motility[31]. However, the presence of motility does not exclude anomalies[31], and the temporary absence or reduction in fetal movements should not be considered as a risk factor[2].

In cases where the movements are performed with the participation of all parts of the body and with variable speed and amplitude, this excludes many high-risk situations[31]. Unusual restriction of movement of all parts of the fetal body or persistent abnormal positioning may suggest abnormal fetal conditions, such as multiple congenital contractures. The lack of normal fetal movement should therefore lead to detailed motor ultrasound examination, as well as careful analysis of the joints[31,32].

Doppler ultrasound

Doppler ultrasonography of uterine arteries at 24 weeks can be a useful screening test for pre-eclampsia, placental abruption or delivery of a baby small for gestational age[3].

However, the application of Doppler ultrasound techniques of the umbilical artery or the combination of Doppler ultrasound of the umbilical artery and uterine in low-risk pregnancies is currently not recommended as part of the routine examination in the second trimester. This is due to the fact that the exam does not change the outcomes and prenatal, obstetric and neonatal interventions[33].

It should be emphasized that the prediction of preeclampsia by means of uterine Doppler velocimetry of the uterine arteries is better indicated in the first trimester of pregnancy, being restricted, in the second trimester, to patients who did not perform this exam at the best indicated gestational age[33].

Nevertheless, Doppler studies of the umbilical artery should be incorporated into fetal monitoring protocols in high-risk pregnancies, such as women with hypertensive disorders and small fetuses for gestational age, due to the risk of placental insufficiency[34]. In this regard, the work on the evaluation of growth restriction is emphasized, using Doppler velocimetry of the umbilical and cerebral fetal middle arteries[35].

Multiple pregnancies

The visualization of the insertion of the placental cord, as well as the distinguishing characteristics between the fetuses (gender and position in the uterus) are additional elements that should be included in the ultrasound of the second trimester in the evaluation of multiple pregnancies[2].

The determination of chorionicity must be made before 13 + 6 weeks of gestation using the thickness of the membrane at the insertion site of the amniotic membrane in the placenta, identifying the "T" sign for the diamniotic monochorionics, the "λ" (lambda) sign for the dichorionic and the number of placental masses [36,37] (Figures 7-8). For pregnant women who present themselves for the first time after 14 weeks of gestation, chorionicity must be determined by the same ultrasound signals and by the discrepancy of fetal sex [2,37].

Figures 7 and 8. (7): Lambda sign evidenced in transabdominal ultrasonography of dichorionic diamniotic pregnancy37. (8): Slender interamniotic junction forming the "T" sign at transabdominal ultrasonography of monochorionic diamniotic pregnancy 37.

Abnormalities of the insertion of the umbilical cord into the placenta, such as the velamentous cord insertion, are more common in multiple pregnancies[2] and may be associated with various complications of pregnancy, such as IUGR, vasa previa, abnormal patterns of fetal heart rate, low Apgar scores in 1st and 5th minutes and also fetal exsanguination during labor [2,38]. The marginal insertion of the cord may also be associated with a slight reduction in birth weight and premature labor[39].

Despite being effectively seen in just over half of the cases in clinical practice, it is recommended to try to visualize the cord insertion, as part of the routine of obstetric ultrasound, since the identification of marginal and velamentous insertion can change the obstetric management in childbirth and, consequently, improve the fetal result[39].

BASIC STUDY OF FETAL MORPHOLOGY

Head

In the morphological study of the fetal head, skull and brain are examined paying attention to the main structures.

For the assessment of the anatomical integrity of the brain, the structures to be evaluated are the lateral ventricles, including choroidal plexuses, cavum septum pellucidum, midline fissure, thalamus, cerebellum and cisterna magna (Figure 9). Two axial planes allow the visualization of these relevant brain structures, the transventricular and the transtalamic plane. A third axial transcerebellar plane can be added to assess the posterior fossa[2].

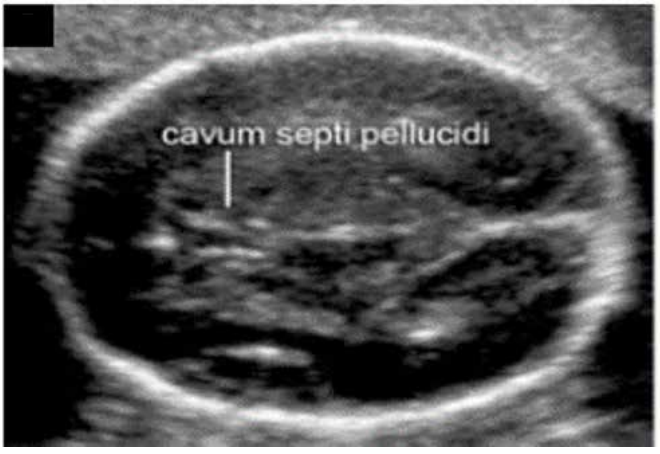

Figure 9: View of the transverse plane of the fetal head showing the transventricular plane and the cavum septum pellucidum[2].

Prenatal ultrasound diagnosis of major structural abnormalities can have a substantial impact on perinatal care due to the relatively high incidence of brain malformations and uniformly poor prognosis. At week 22, some significant abnormalities are prone to prenatal diagnosis, including agen-

esis of the corpus callosum, ventriculomegaly, and some abnormalities of the posterior fossa, such as cerebellar abnormalities and the size of the cisterna magna[40].

Regarding the study of the fetal skull, four areas should be routinely evaluated: size, shape, integrity and bone density (Table 1), which can be viewed at the time of head measurements and when the brain is assessed for anatomical integrity[2].

Fetal Skull	
Size	Measurements made according to biometric study
Format	Oval, without focal protrusion. Anomalies must be documented and investigated.
Integrity	No bone defects should be present. Rarely, brain tissue can extrude through defects in the frontal or occipital bones
Density	Hyperechogenic structure remains interrupted only by narrow echolucent sutures. Skull easily depressed by manual pressure with the transducer and loss of echogenicity raise suspicion of poor bone mineralization.

Table 1: Routine evaluation of the fetal skull[2].

Face

The fetal facial examination with ultrasound is done mainly in the routine screening for the presence of facial anomalies and in the analysis of facial features to accurately delineate the anomaly[41].

The minimal evaluation of the fetal face must include visualization of the upper lip to describe a possible cleft lip abnormality[2] (Figure 10). The facial cleft, the most common facial congenital anomaly, can concurrently affect the lip and palate, although the other half is equally divided between isolated lip and palate abnormalities[42].

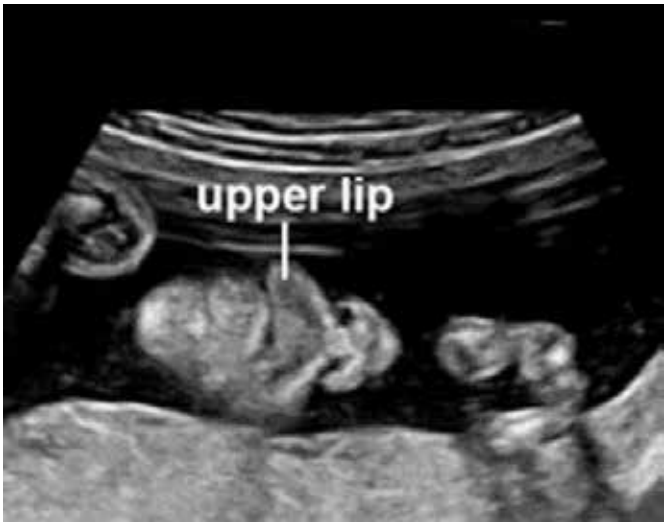

Figure 10: Ultrasound image of the fetal face in which it is evaluated, in the coronal section, mouth, lips and fetal nose[2].

In a screening scenario, the examination protocol must compromise between high sensitivity and reasonable examination time, so that a systematic examination of at least two views, the middle sagittal plane and the anterior coronal plane[41], is performed. If technically feasible, other facial features that can be assessed include the median facial profile, orbits, nose and nostrils[2].

In each of the ultrasound study planes of the fetal face, specific analyzes are possible (Table 2).

Medium sagittal plane	Dysmorphology research of the facial profile and measurement of biometric parameters, such as facial angles and nasal bone length
Anterior Coronal Plane	Essential for research of rupture in the lip continuity, deformation of the nostril curvature and defective alignment of the alveolar crest
Axial plane	Analysis of eyes, lips, maxilla, tongue and mandible

Table 2: Purpose of certain ultrasound planes for studying the fetal face[39].

Nape

The study of the fetal neck usually demonstrates a cylindrical structure without bulges, masses or fluid collections. Obvious cervical masses, such as cystic hygromas or teratomas, should be documented[2].

In addition to teratomas, cystic hygroma has differential diagnoses of cervical meningocele, cephalocele and, even, suspicion of increased nuchal translucency, associated with chromosomal abnormalities such as Turner (45,X) and Down syndromes.[42]

Chest

In the study of the chest, the shape must be regular with a smooth transition to the abdomen[2]. The ribs, whose ossification begins at the end of the first trimester, should have normal curvature without deformities[2, 43].

Both lungs must appear homogeneous, with echogenicity that is clearer than the liver and without evidence of displacement or mediastinal masses[2,43]. Normal lung size data are important for assessing lung development and the presence of a cystic mass in the fetal thorax should alert the sonographer to consider, in the differential diagnosis, congenital thoracic abnormalities, such as diaphragmatic hernia, macrocystic adenomatoid malformation of the lung, or more rare conditions, such as esophageal duplication or neurenteric cyst[43-44].

The diaphragmatic interface can often be viewed as a thin, hypoechoic and arched dividing line between the thoracic and abdominal contents, which usually shows a dome on each side and becomes detectable approximately from the 10th to the 11th week of gestation[2,43].

Heart

The fetal cardiac examination is ideally performed between 18th and 22nd weeks of gestation. Heart rate and

regular rhythm should be confirmed at a normal rate of 120 to 160 beats per minute. Mild bradycardia and tachycardia can be temporarily observed in normal fetuses in the second trimester[45].

The fetal heart must be located in the left thorax, on the same side of the stomach, deviated by about 45 ° ± 20 ° with the apex pointing to the left of the fetus, and it is generally no larger than one third of the chest area[43,45].

The basic cardiac screening exam is based on the visualization of the four fetal cardiac chambers, whose elements of study are, in addition to the cardiac situs, the atria and ventricles, interatrial and interventricular septum, margins of the foramen ovale and atrioventricular valves (Figure 11). Some views may reveal a small hypoechogenic border around the fetal heart that should not be confused with pericardial effusion[45].

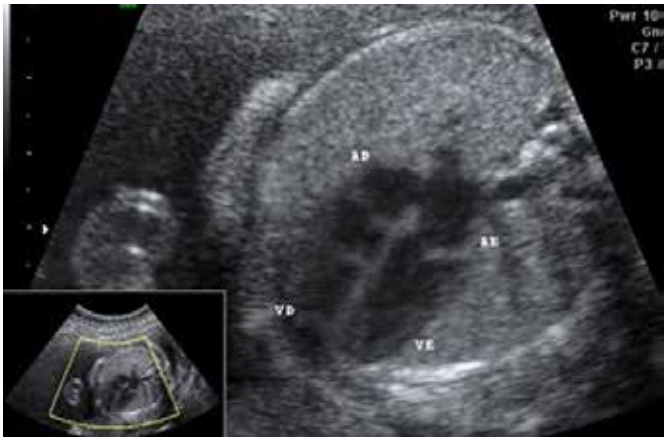

Figure 11: Image of the four cardiac chambers with both ventricles and atria.

If technically feasible, routine visualization of the aortic and pulmonary outflow tract should be attempted as part of extended basic cardiac assessment, which requires, at a minimum, that the large normal vessels are approximately the same size and that they intersect at angles straight after leaving their respective ventricular chambers[46]. These additional views are more likely to identify conotruncal anomalies, such as tetralogy of Fallot, transposition of the great arteries, double-outlet right ventricle and truncus arteriosus[5, 45].

Suspected cardiac abnormalities will require a more comprehensive assessment using fetal echocardiography[5,45].

Abdomen

Under normal conditions, the stomach should be identified to the left of the spine[2]. The gallbladder, a fluid-filled structure, should also be assessed for its position, which is opposite the stomach, in the upper right abdomen[43] (Figure 12). Any other cystic structures seen in the abdomen should request referral for a more detailed examination[2].

Figure 12: Ultrasound evaluation of the fetal abdomen in which the fetal stomach and venous sinus are visualized.

Abnormal relationship between abdominal and thoracic organs is a useful indicator for the diagnosis of situs inversus, whose primary indicators are the stomach located contralateral to the apex of the heart and the gallbladder located to the left of the umbilical vein[46].

The intestine, a less echogenic and uniform structure than the liver, must be contained in the abdomen and the umbilical cord must be inserted into the intact abdominal wall[2,43] (Figure 13). Abnormal collections of intestinal fluids, such as enteric cysts and intestinal dilation, as well as defects in the insertion of the umbilical cord, such as omphalocele and gastroschisis, must be documented[2].

Figure 13: Ultrasound evaluation of the fetal abdomen in which the umbilical cord insertion site can be seen2.

Kidneys and bladder

The fetal bladder and both kidneys must be identified (Figure 14). Measurement must be documented in cases of possible expansion[2].

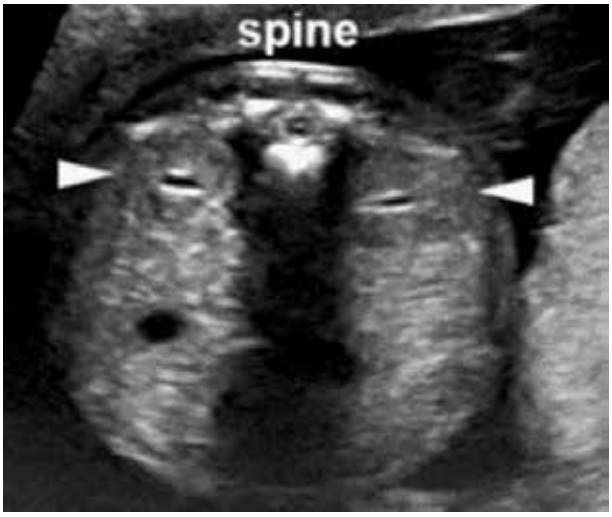

Figure 14: Ultrasound evaluation of fetal kidneys2.

Spine

Detailed spinal assessment is an important component of fetal morphological examination that requires precision (Figure 15). The transverse plane is, in general, the most sensitive to detect a defect of the vertebral column and allows the examination of each segment of the spine. However, the complete and detailed evaluation of the fetal spine in each projection is not part of the basic examination[4,47].

In addition, skin that covers the intact spine in transverse or longitudinal sections should be demonstrated[4,47]. One should look for discontinuities, which are related to spina bifida, in addition to searching for sacral agenesis and caudal regression syndrome [2,47] (Figure 15).

Figure 15: Ultrasound evaluation of the fetal spine.

Limbs

The presence of arms and hands, legs and feet must be reported. Finger counting is not part of the routine of the second trimester exam[2].

Once a malformation of the limb is suspected, the precise diagnosis will influence the management and genetic counseling and the prognosis will depend on whether it is isolated or part of a known syndrome[48].

Placenta

Determining the placental location and its relationship to the internal cervical orifice (ICO), is one of the main objectives of routine second trimester transabdominal ultrasonography[49] (Figure 16). Placental grade should be reported, possible placental masses, chorioangiomas, hemorrhages and cysts should be reported, as well as myometrial invasion or placental accretism should be investigated.

Figure 16: Ultrasound image of the placental location and its relationship to the internal cervical orifice (ICO) [2].

Placenta previa, which reach or occlude the ICO, should be followed up until the third trimester, as they are among the main causes of vaginal bleeding in this period and are associated with an increased risk of maternal, fetal and perinatal morbidity and mortality[2,49-50].

The rates of placenta previa and placenta accreta are related to advanced maternal age and the number of previous cesarean deliveries[49,51]. In these cases, the placenta should be examined for findings that confirm these diagnoses, the most sensitive for placenta accreta being the presence of multiple linear and irregular placental gaps that show arterial or mixed flow[51].

In the basic ultrasound study of the second trimester, it is also necessary to document uterine fibroids and adnexal masses that may interfere with the pregnancy outcome. The

characterization of fetal sex is not mandatory[2].

CONCLUSION

We conclude, therefore, that knowledge of fetal development throughout pregnancy and the use of appropriate ultrasound methodology, in the second trimester, are essential in detecting fetal changes and obtaining accurate results.

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