WAPM Guideline

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Ultrasound in labor: clinical practice guideline and recommendation by the WAPM-World Association of Perinatal Medicine and the PMF-Perinatal Medicine Foundation

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Abstract: This recommendation document follows the mission of the World Association of Perinatal Medicine in collaboration with the Perinatal Medicine Foundation. We aim to bring together groups and individuals throughout the world for standardization to implement the ultrasound evaluation in labor ward and improve the clinical management of labor. Ultrasound in labor can be performed using a transabdominal or a transperineal approach depending upon which parameters are being assessed. During transabdominal imaging, fetal anatomy, presentation, liquor volume, and placental localization can be determined. The transperineal images depict images of the fetal head in which calculations to determine a proposed fetal head station can be made.

Keywords: dystocia; induction of labor; obstructed labor; ultrasound in labor.

Section-1: Introduction

a-Background and rationale for recommendation

Ultrasound is a safe, reliable, non-invasive tool for assessing bone and soft tissue structures. Women undergo routine ultrasound imaging throughout their pregnancy to estimate fetal weight, locate placental position, liquor volume, and Doppler measurements of feto-placental circulation. It has increasingly become more used in the last decade for improving management in labor by providing more accurate and reproducible findings [1–3] of progress in labor. In

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addition, through evidence-based models, it can be used to predict [4, 5] mode of delivery.

Fetal descent and position are commonly determined through digital vaginal examinations by the caregiver. This examination method can be painful [6, 7], associated with ascending infection [8] to the fetus and mother, and largely subjective [9, 10]. Intrapartum ultrasound is better tolerated [11, 12] by women than the traditional method of vaginal examinations and its use has been increasingly researched as an adjunct tool in labor for determination of cervical dilatation, fetal head position and station whilst maintaining sterility. Obstetricians can become competent in basic ultrasound techniques in order to recognise acute clinical emergencies as well as improve the recognition of labor arrest.

Intrapartum evaluation of fetal head position, station and flexion plays a key role in the management of labor. Incorrect assessment of these parameters can increase the risk of maternal and perinatal complications.

In this guideline, we outline skills of intrapartum ultrasound for Obstetricians. These techniques are not time-consuming and can improve the reliability of clinical examinations in labor. Intrapartum ultrasound should be used to correlate alongside findings of an abdominal palpation and digital vaginal examination.

The aim of this examination include; the use of ultrasound evaluation in labor include Identifying singleton or multifetal pregnancy, fetal viability, fetal biometry, amniotic fluid volume, determining factors preventing labor from continuing, low placental location, presentation, ultrasound pelvimetry, fetal occiput and spine position to plan for rotation in the first stage of labor by altering the maternal positioning.

For this purpose, the use of ultrasound is easy, simple and making the evaluation in objective way for managing labor in a convenient manner as non-invasive method of either transabdominal and/or transperineal.

b-Safe machine use and machine cleaning

Ultrasound is a safe tool for imaging fetal and maternal structures throughout pregnancy. Images are produced in real-time using sound waves through a probe (the transducer). Gel is placed directly on the skin as a median to enable sound waves to travel between the object and the probe. Commonly whilst scanning on the labor ward, a low frequency (<4 MHz) wide-sector convex transducer is used.

Probe safe storage

The probe should be stored in the upright vertical position in its slot on the machine, and the cable looped so as to prevent contact with the floor. Ultrasound cables left on the floor are prone to being damaged by footfall or by the wheels of the machine, leading to the unnecessary cost of having to be replaced when inner cables are ruined. Ensure the probe cable does not come into contact with the probe as it is not often disinfected as regularly as the probe. Cross contamination may occur during probe and cable handling.

Power cable

The power cable between the ultrasound machine and the power outlet is especially prone to damage. It should have secure connections and the flex should not be damaged.

Transperineal ultrasound

Cover the ultrasound probe with a sterile cover or with a sterile examination glove (latex/non-latex). Use sterile gel at the contact point between the cover and the maternal perineum. Once the examination is completed, remove the cover and disinfect the probe according to local protocols. This may be by a chemical method, or ultraviolet disinfection [12].

Ultrasound gel

Infections have been reported that have led to severe morbidity, traced back to bacterial colonization in gel bottles. Hence, sterile ultrasound gel in single-use containers should be used during ultrasound examinations in labor where invasive procedures such as intrapartum caesarean delivery or instrumental delivery may follow. If single-use containers are not available, to reduce infection rates, the ultrasound gel bottle should not have direct contact with the skin or the probe. It is best practice to place gel on the surface which will be imaged (maternal abdomen) and not on the probe itself.

c-Method of ultrasound examination

Ultrasound in labor can be performed using a transabdominal or a transperineal approach depending upon which parameters are being assessed. During transabdominal imaging,

fetal anatomy, presentation, liquor volume, and placental localization can be determined. The transperineal images depict images of the fetal head in which calculations to determine a proposed fetal head station can be made.

Transabdominal

The maternal position for transabdominal scanning is supine with a left lateral tilt. The transducer is held superior to the symphysis pubis in the positions as depicted in Figure 1 for either transverse or sagittal images.

Transperineal

The maternal position is semi-recumbent with legs flexed at the hips. The bladder should be emptied prior to commencement of the scan. The transducer is placed between the labia majora or at the level of the posterior fourchette (Figures 2 and 3). Transperineal ultrasound is a non-invasive technique that has been shown in research to be able to measure head descent [13], cervical dilatation [14], and used in predictive modelling in mode of birth during labor. Maternal structures visualised during a transperineal ultrasound include symphysis pubis, pelvic

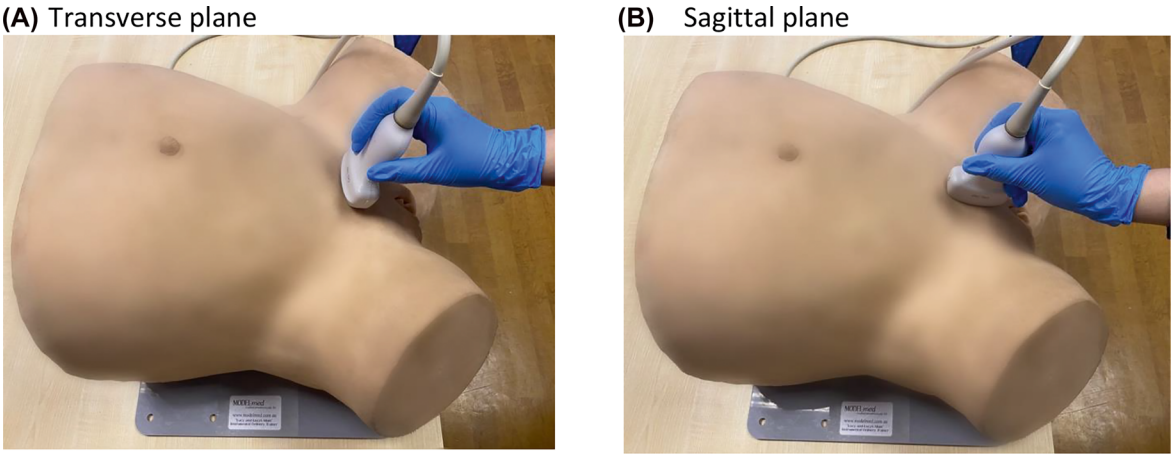

Figure 1: Model representation of transducer positioning for transabdominal views. Landmarks: midline structures, orbits, cerebellum, vertebrae.

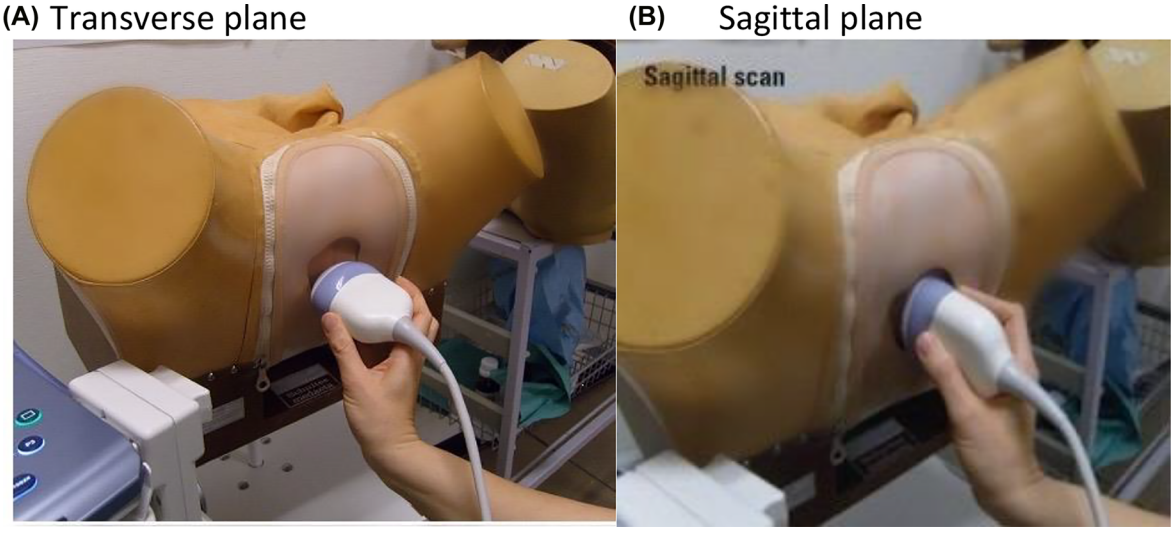

Figure 2: Model representation of transducer positioning to transperineal ultrasound. Landmarks: midline structures.

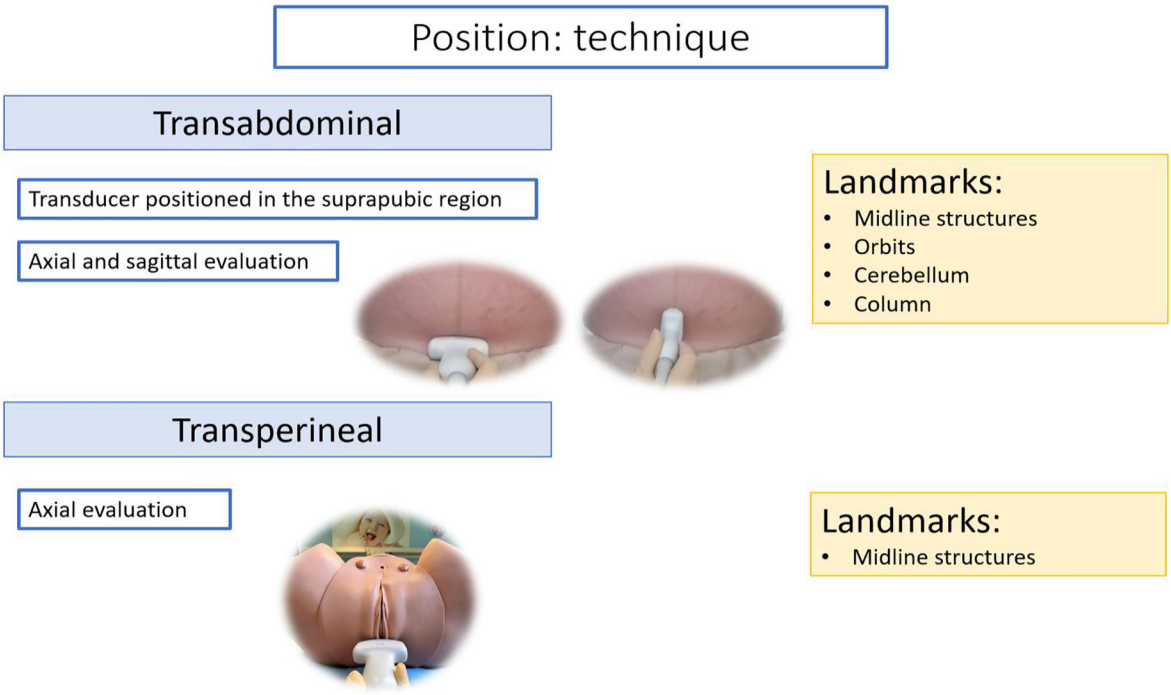

Figure 3: Overview of transducer position during intrapartum ultrasound scanning and identifiable landmarks.

floor muscles, bladder and indwelling catheter balloon. The fetal cranium is depicted in relation to the aforementioned maternal structures.

Section-2: Ultrasound evaluation before labor or upon admission to the labor ward

Routine ultrasound scanning for pregnant women in labor before admission is considered an integral part of the pre-booking assessment. Moreover, it is of a substantial significance in low resource countries with a high prevalence of walk-ins without antenatal follow up and/or documentation or with very basic antenatal care programs devoid of proper access to U/S machines. In such settings, also, there is an increased likelihood of labor management with no available cardiotocography (CTG) or other means of fetal surveillance. Proper pre-labor assessment is thus essential to avoid unexpected complications e.g. locked twins, fetal anomalies, placenta praevia, malpresentations, impending fetal compromise or intrauterine fetal death.

Ultrasound examination upon admission to labor is indispensable in emergency situations as in cases of antepartum hemorrhage, tetanic uterine contractions to exclude placental abruption, cases of clinical suspicion of rupture uterus or cases of fetal distress requiring Doppler studies.

Induction of labor has become one of the most common interventions in modern obstetrics with a continuously increasing prevalence [14–16].

Failure of induction of labor is associated with maternal, fetal and neonatal risks associated with the emergency cesarean deliveries [17] and is reported to be as high as 15–20% especially in nulliparous women [18, 19].

Ultrasound can be employed to help select women who are eligible for induction of labor, and with a reasonable chance success.

To determine the eligibility of a woman for induction of labor (IOL), ultrasound can be used for proper gestational age determination, for placental and umbilical cord localization and fetal well-being assessment [18].

a-Excluding low lying placenta

A low lying placenta refers to a placenta that lies in close proximity to the internal cervical os or covers it. An undiagnosed low lying placenta can have detrimental effects for the mother and the fetus during labor. A transabdominal ultrasound scan in the sagittal view should be used to identify placental location (Figure 4). The placenta can be characterised by identifying the leading edge of the

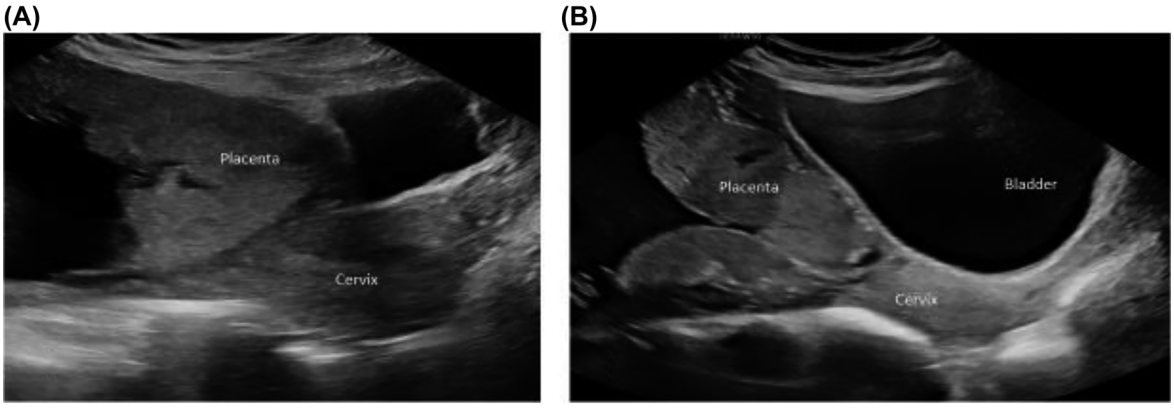

Figure 4: Placenta localization.
(A) Placenta shown overlying the cervix. (B) Placenta abutting the cervix.

placental membrane in relation to the internal cervical os. Less than 20 mm corresponds to a diagnosis of a low-lying placenta.

b-Cervical length (CL) and posterior cervical angle (PCA)

Independent prediction of the induction to delivery interval and the outcome of IOL within 24 h were possible by CL and PCA measurements [20, 21].

To measure the cervical length, the curvilinear transducer applied to the perineum to enable simultaneous visualization of the internal and external os and then measured as the distance along a line representing the whole length of the endocervical canal [22]; (Figure 5).

With the same probe applications, the posterior cervical angle is measured as the angle between a line along the cervical canal, in the mid sagittal plane and another line tangential to the posterior uterine wall [20]; (Figure 6).

Recommendation

The posterior cervical angle provides an accurate measure of the position of the cervix and when the angle is <120° there is prolongation of labor. In women undergoing induction of labor, prediction of outcome can be provided by determining sonographic parameters such as cervical length and posterior cervical angle. Sonographic parameters are superior to the Bishop score in the prediction of the outcome of induction which enables the clinician to

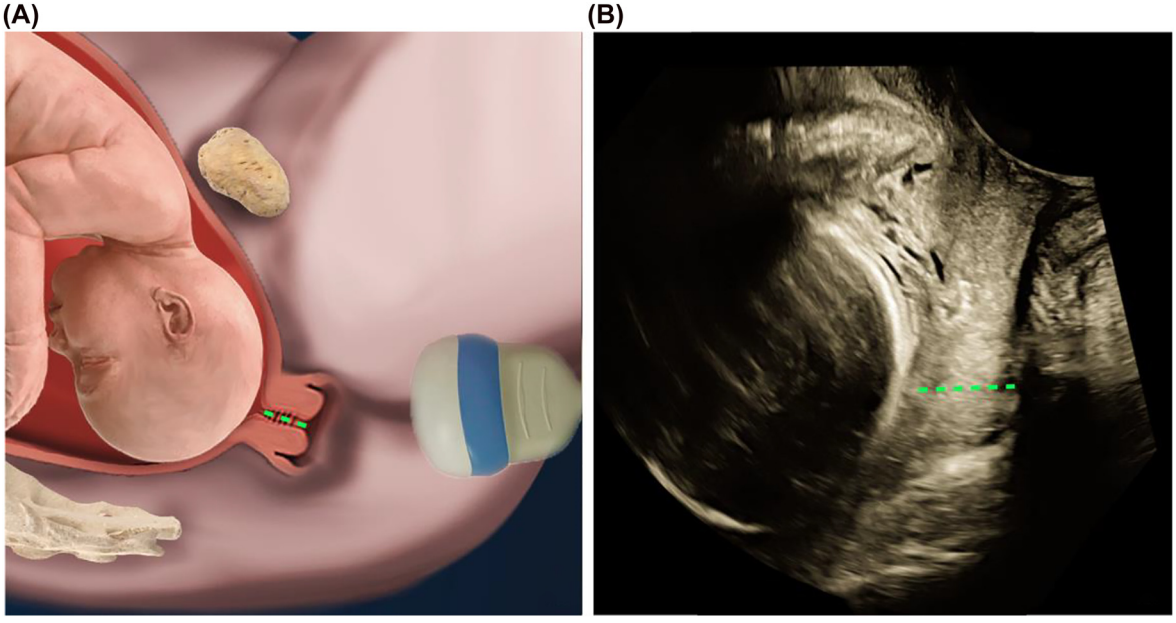

Figure 5: Comparative simulated image (A) for cervical length measurement with the corresponding ultrasound scan image (B).

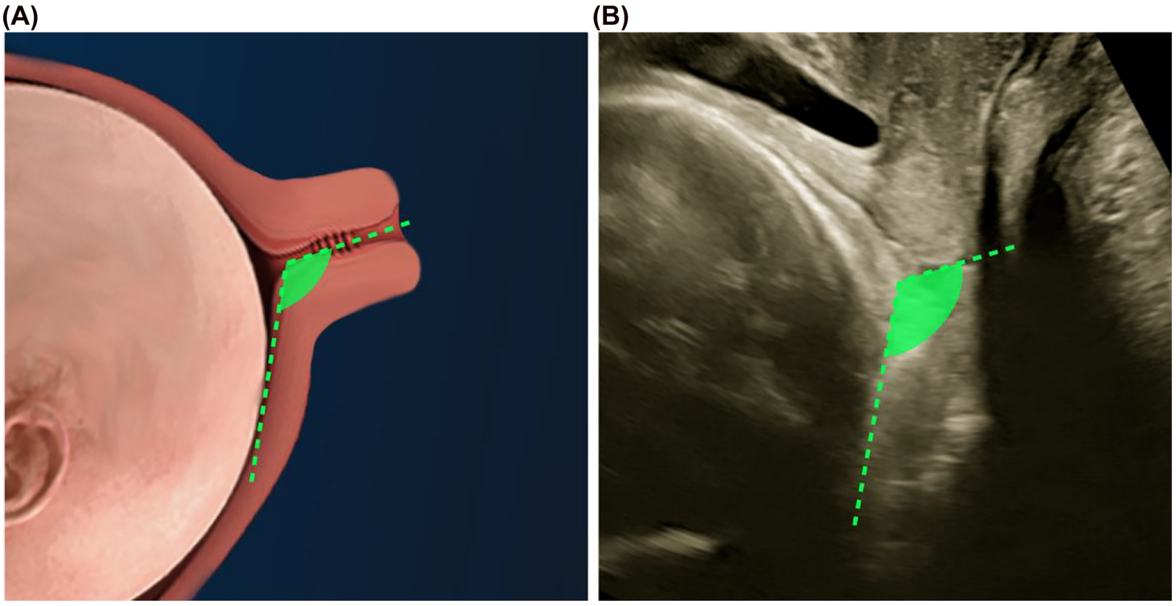

Figure 6: Comparative simulated image (A) for posterior cervical angle measurement with the corresponding ultrasound scan image (B).

provide precise information to plan further management of the pregnancy.

c-Ultrasound pelvimetry

Pre-labor transperineal ultrasound assessment of maternal subpubic arch angle (SPA) was able to identify women at high risk of operative vaginal delivery and an association with the persistence of the different occiput positions throughout birth was demonstrated [23, 24].

SPA is measured as the apex angle between the lines positioned on the pubic rami converging to the center of the symphysis pubis, obtained on an axial view of the outlet [25, 26]; (Figure 7).

Another form of ultrasound pelvimetry is to measure the obstetric conjugate. The curvilinear transducer is longitudinally placed at the level of the symphysis to visualize the interpubic fibrocartilaginous disc. The promontory is then identified as the most prominent segment of the sacral vertebral column. The obstetric conjugate is measured as the distance between the inner

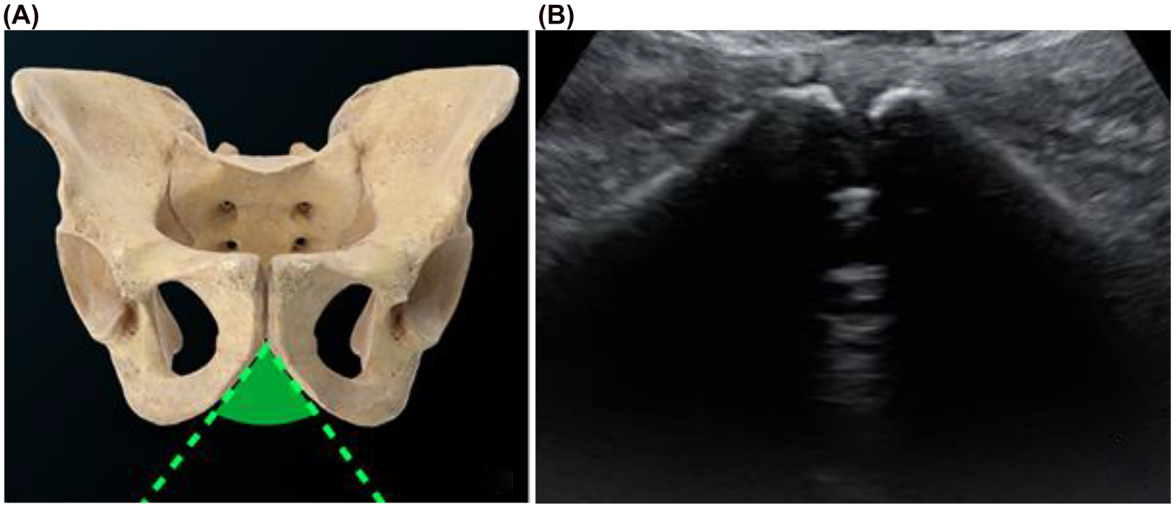

Figure 7: Comparative simulated image (A) for measurement of SPA with the corresponding ultrasound scan image (B).

edge of the interpubic disc sacral promontory [25] (Figure 8).

Recommendation

Ultrasound pelvimetry provides the Obstetrician to evaluate the birth canal for managing the labor process safely and appropriately.

d-Assessment of pelvic floor dimensions and function

The levator hiatus can be measured by transperineal ultrasound on the mid-sagittal view as the distance between the inferior border of the symphysis pubis to the anterior border of the puborectalis muscle (Figure 9).

A correlation between pelvic floor dimension and labor outcome, mainly the duration of the second stage of labor

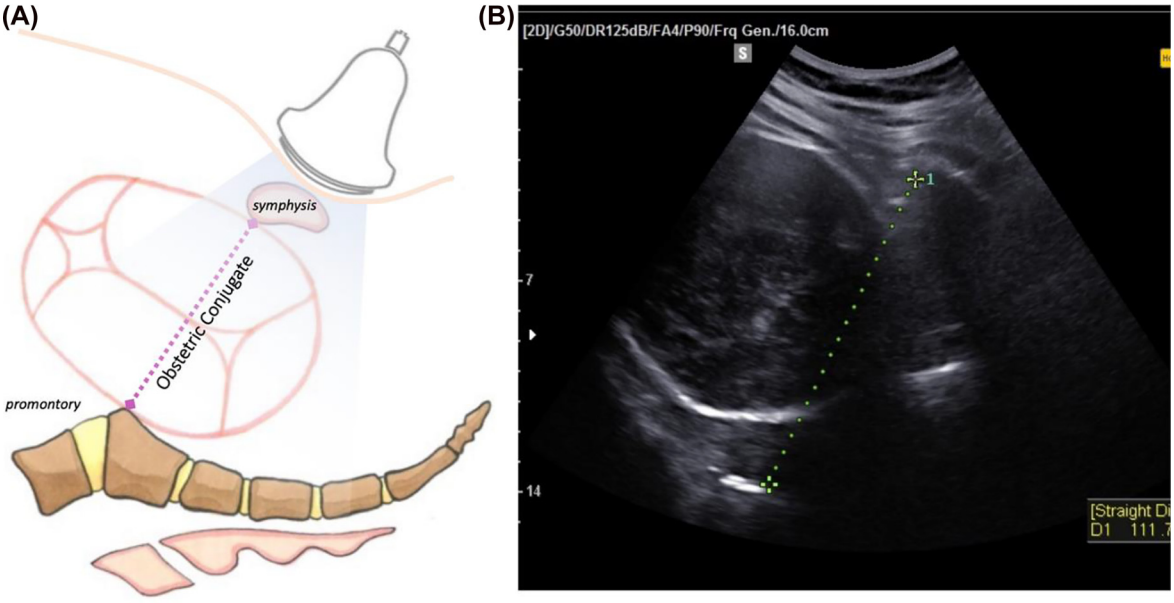

Figure 8: Comparative illustrated image (A) of the obstetric conjugate with the corresponding ultrasound image (B).

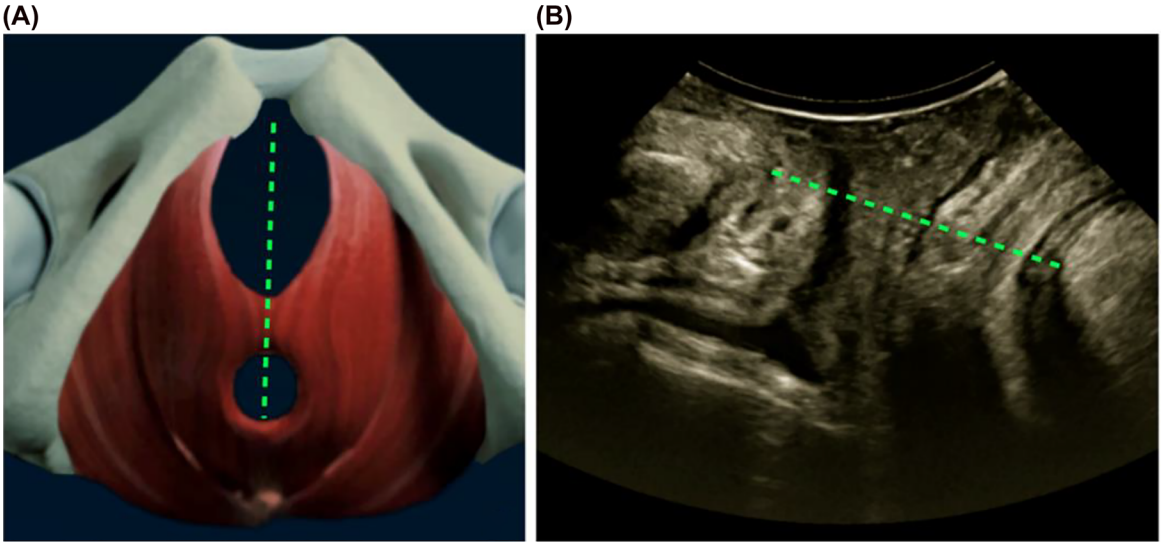

Figure 9: Comparative simulated image (A) for measurement of levator hiatus with the corresponding ultrasound scan image (B).

was reported. Comparing the levator hiatal dimensions of a woman at rest to that at Valsalva allows the identification of women with levator ani co-activation with the potential of visual feedback and coaching to correct the co-activation [26, 27].

e-Fetal presentation and position

It is well established in the literature that clinical examination using abdominal palpation has low sensitivity for determining malpresentations [28]. Transabdominal ultrasound scanning in the sagittal plane is used to identify the fetal presentation [29]. The transducer should be placed in the midline of the maternal abdomen, at the level of the symphysis pubis. In this view, structures visualized include the maternal bladder, lower uterine segment and the internal cervical os. This allows correct visualization of the fetal presenting part by determining its relationship to the cervix and the placenta. Fetal presentation should be assessed in conjunction with fetal lie–longitudinal assessment in relation to the maternal long axis.

The fetal head position is defined as the orientation of the presenting fetal head within the maternal pelvic inlet [30]. The relationship of the fetal occiput to the fetal head can be further described [31].

During a digital vaginal examination in labor, the fetal position is determined by palpation of the cranial suture lines as well as the anterior and posterior fontanels. Inaccuracies exist in this method for the diagnosis of fetal position as the examination is subjective and increases in difficulty during the presence of caput succedaneum in prolonged labor [32]. Determining fetal position has shown to be more prone to error in non-occipital anterior positions [2].

Intrapartum ultrasound is an improved method for determining fetal head position [33]. The assessment of the woman by ultrasound has been recommended to be routinely used prior to commencing an assisted vaginal delivery and where there is clinical uncertainty about the fetal position [34, 35]. A transabdominal or transperineal sonographic approach can be used according to the degree of engagement of the fetal head. In the transabdominal scan, place the transducer in the suprapubic region (Figure 1). The landmarks to evaluate for fetal position are shown in Figures 10–13.

If the fetal head is deeply engaged in the maternal pelvis, the midline structures can be difficult to through a transabdominal scan. A transperineal scan (Figure 2A) can also be performed to obtain images of the fetal position easily and effectively.

A systematic approach to defining fetal position is used amongst Obstetricians. The location of the fetal spine and occiput are used as anatomic landmarks and related to a clock face. Occiput anterior position is situated between 10 and 2 o'clock; occiput posterior position if situated between 4 and 8 o'clock; occiput transverse position if situated between 2 and 4 o'clock (left occiput transverse – LOT), or between 8 and 10 o'clock (right occiput transverse – ROT). Figure 10 outlines this relationship and the classification.

By placing the ultrasound transducer transversely on the maternal abdomen, you can obtain axial views of the fetal trunk. The level of the fetal upper abdomen or thorax can be used to locate the position of fetal vertebrae (Figure 11). The spine position can then be related to a clock face in the same classification as depicted in Figure 10.

It is clinically advantageous to assess the fetal position by performing ultrasound of the fetal head as well as the fetal torso to unequivocally appreciate the fetal descent and rotation throughout labor (Figures 12 and 13). Malpositions are associated with prolonged labor and increased intervention rates, therefore accurate monitoring of progress in labor is beneficial for achieving good fetal and maternal outcomes.

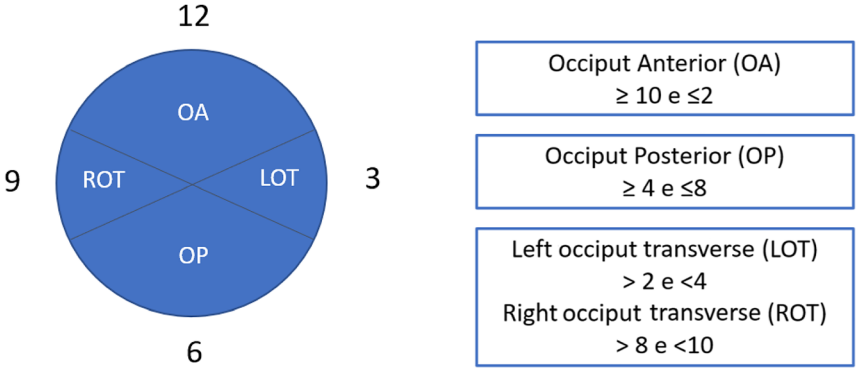

Figure 10: Classification of fetal occiput position [2].

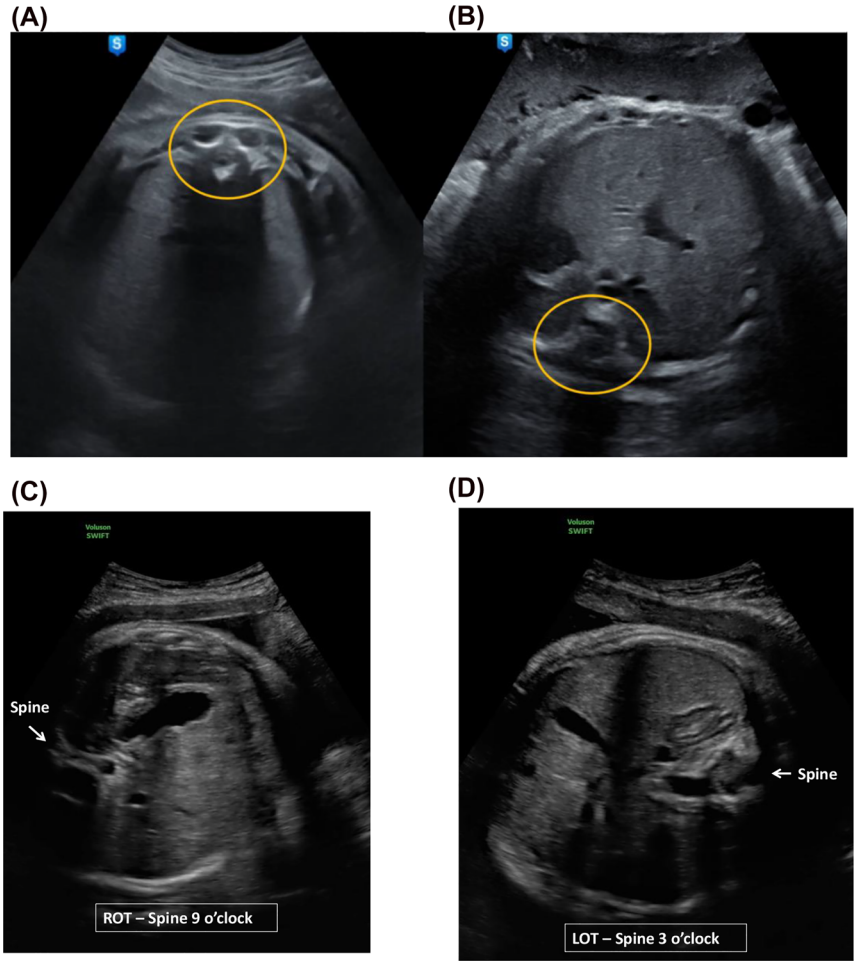

Figure 11: Transabdominal ultrasound imaging in the transverse plane for locating the fetal spine.
(A) anterior; (B) posterior; (C) ROT; (D) LOT.

Recommendation

Ultrasound evaluation before induction or just before labor gives you an opportunity to evaluate and understand the condition of the baby and the birth canal. Therefore you can manage the case at optimum condition and not to have any surprise that puts you and your patient on a difficult position and results.

Section-3: Standard intrapartum ultrasound measurements in labor

Intrapartum ultrasound with the transperineal approach enables detailed visualization of fetal and maternal structures in labor that can be challenging to identify through transabdominal scanning.

a-Fetal head station

Fetal head station is the most important marker of descent which requires identification of the head in relation to the maternal ischial spines in centimetres. On digital vaginal examination, if the deepest bony part is at the level of the ischial spines, this station is defined as ±0 cm. It is determined by placing fingers on the cranium and the ischial spines for a subjective interpretation of the level corresponding to nominal intervals above or below the maternal spine [35–38].

The advantage of transperineal ultrasound examination, on the other hand, is a precise and reproducible assessment of fetal head station [39]. For the transperineal ultrasound examination, the probe is placed between the two labia majora or at the level of the fourchette, with the legs flexed at the hips and knees. In the median plane the two main anatomical landmarks can be seen as pubic symphysis joint and the fetal skull (see Figure 14).

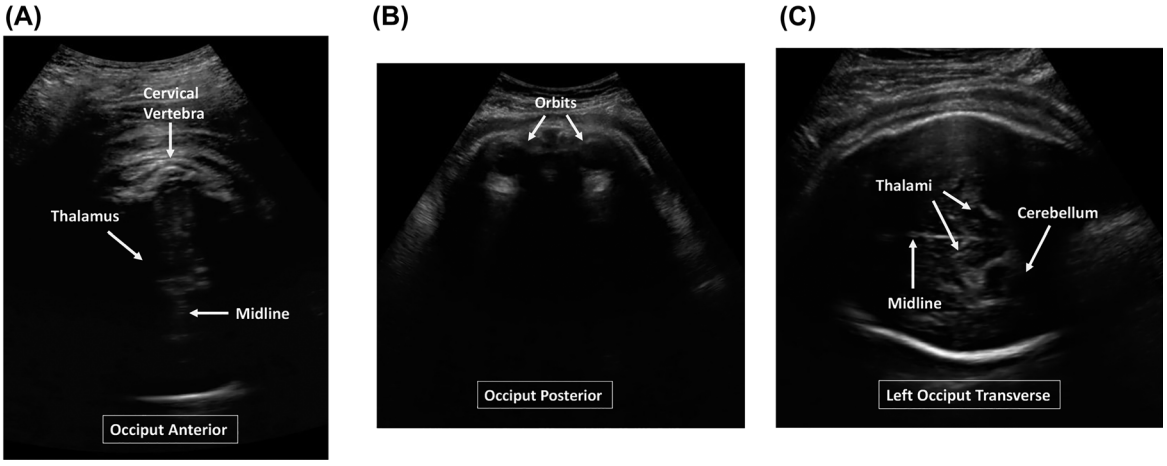

Figure 12: Transabdominal suprapubic ultrasound evaluating for fetal position in transverse plane.
(A) Occiput anterior position illustrating cervical vertebrae at 12 o'clock position and midline cranial structures. (B) Occiput posterior position illustrating both orbits in view at 12 o'clock position. The cervical vertebrae cannot be seen in this view, however correspond to 6 o'clock position. (C) Left occiput transverse position where the cerebellum is at 3 o'clock position and midline cranial structures seen horizontally.

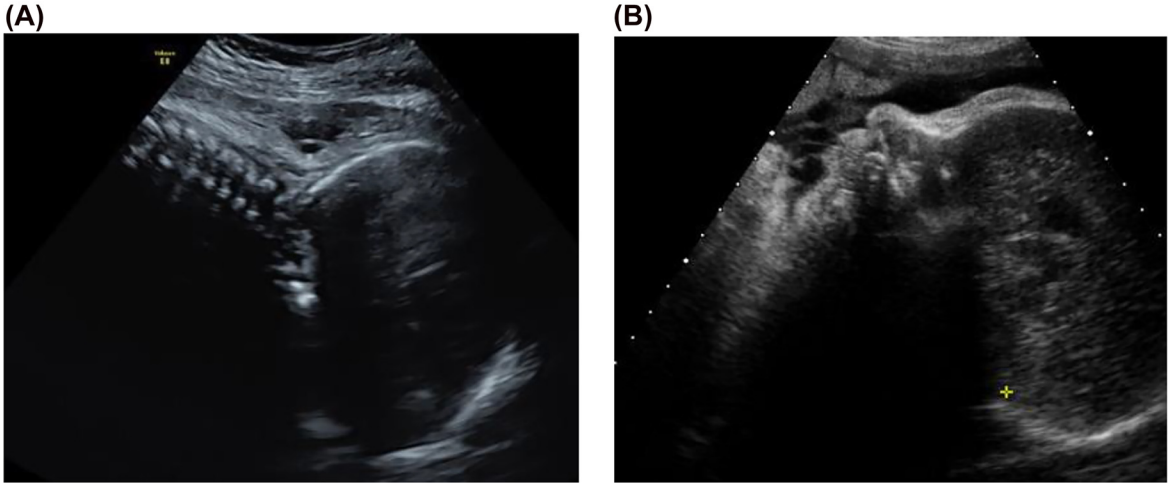

Figure 13: Transabdominal suprapubic ultrasound imaging for fetal position in the sagittal plane.
(A) Occiput anterior position is demonstrated through the cervical spine and fetal occiput correlation. (B) Occiput posterior position is demonstrated through images of fetal facial features anteriorly.

At ultrasound, the ischial spine is not visible, in this median infrapubic view, several parameters for the head station have been proposed that use the pubic symphysis as a reference for quantitative measurements by transperineal ultrasound: Measurement of the head station, the head direction, the head-perineum distance (HPD) and the angle of progression (AoP) have been used to correlate to the fetal head descent [40, 41] which indicate head station indirectly. Predictive modelling for mode of birth has been proposed by utilising transperineal ultrasound measurements, however all information regarding fetal position and head station should be considered during an assessment [42].

a1-Head station measurement

At ultrasound examination, the ischial spine is not visible but indirectly can be estimated which is 3 cm below to the perpendicular line to the lower margin of the pubic bone, which is a fixed anatomical relationship [39] (Figure 14). Therefore the measurement of the head station is a method of measurement such as the relation of the deepest bony

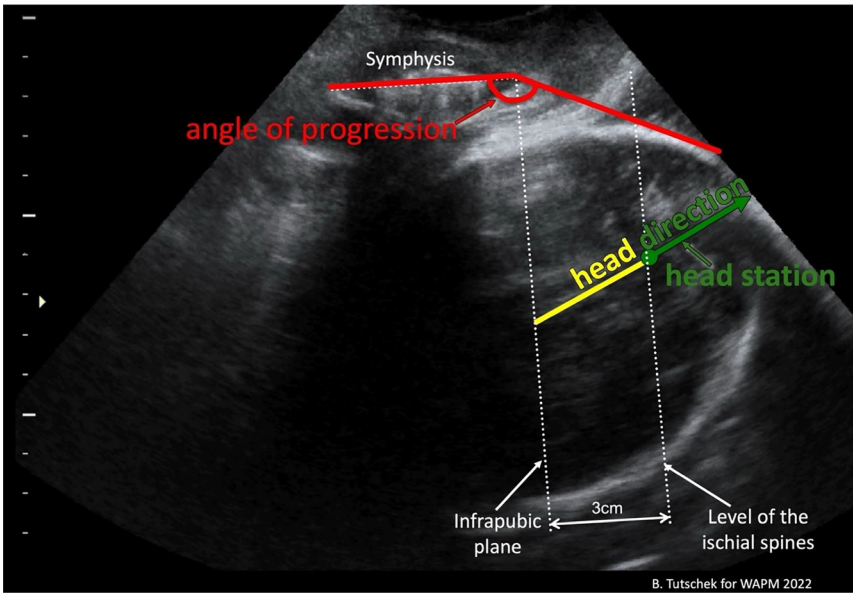

Figure 14: Ultrasound head station and head direction.
Head direction is the angle formed by the longest visible axis of the fetal head with the pubic symphysis. It is an indirect marker of head station as it increases with descent along the curved birth canal. "Head up" means that the head direction is pointing upwards (>30°) with regard to the pubic axis. The ultrasound-measured head station requires assessment of head direction and is measured as the distance deepest part of the bony contour below the level of the ischial spines, corresponding to classical palpation.

part of the fetal head to the perpendicular line to the lower margin of the pubic bone minus 3 cm. This method is an objective evaluation of the head station but a little bit time consuming.

a2-Head direction

Head direction which indicates head station indirectly but more easy and quick method to evaluate the head station. The head direction is head down in case of the wider diameter of the head above the ischial spines, head horizontal in case of the wider diameter of the head at the ischial spines, and head up in case of the wider diameter of the head above the ischial spines, head horizontal in case of the wider diameter of the head below the ischial spines.

The head direction (head down, head horizontal or head up) indicates the direction of the longest recognizable axis of the fetal head with respect to the long axis of the pubic symphysis [39]. It is particularly useful for a quick assessment as an upwards head direction ("head up sign") indicates a favorable station before operative vaginal delivery (Figure 14).

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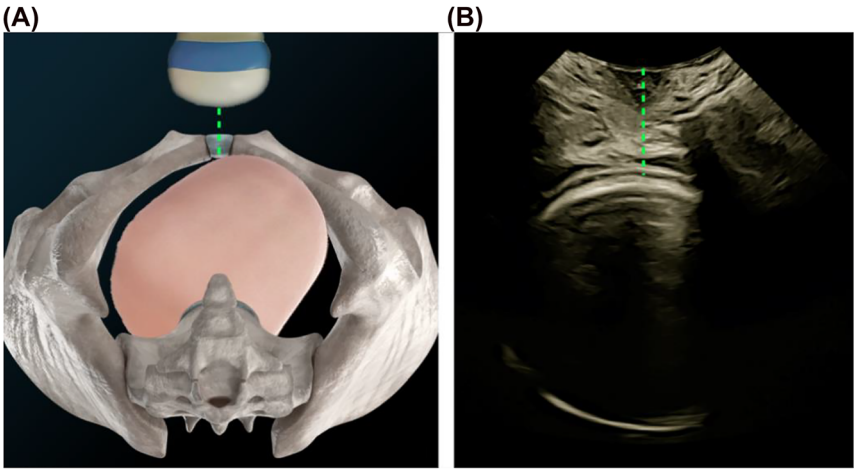
a3-Head-perineum distance (HPD)

The head-perineum distance (HPD) is measured using transperineal ultrasound with the transducer placed transversely between the labia majora (Figure 2A). The soft tissue should be compressed completely against the pubic bone during the scan. The transducer should be angled until the fetal skull contour is as clear as possible [40, 43], indicating that the ultrasound beam is perpendicular to the fetal skull (Figure 15A). A measurement is taken in the midline from the transducer to the leading edge of the fetal cranium (Figure 15B). The resulting measurement (HPD) is the shortest distance between the perineum (the transducer) and the outer bony limit of the fetal skull. Although the distance represents the part of the birth canal yet to be passed by the fetus, it is measuring a straight line and does not take the pelvic curve into consideration [44]. Taking this into consideration, studies by Tutschek et al. [36] found head station at zero corresponded to a HPD measurement of 36 mm and Kahrs et al. [45] found head station at zero corresponded to a HPD of 35 mm. These can be considered when relating HPD with fetal head descent.

The advantages of hear perineum distance for the clinicians are that is fast to obtain and easy to measure resulting particularly useful in emergency situation such as before an operative vaginal delivery. The major limitation is the difficulty of standardize the operator pressure in maternal soft tissue



Technique:
Transducer positioned transversely in the posterior fourchette
Compress the soft tissues
Freeze the image

Figure 15: Comparative simulated image with transperineal ultrasound depicting measurement of head-perineum distance. (A) Simulation model demonstrating approach for (B) Ultrasound image for measurement.

a4-Angle of progression (AoP)

The angle of progression (AoP) is the angle between the long axis of the pubic bone and a line from the lowest edge of the pubis drawn tangential to the deepest bony part of the fetal skull [45]. The angle of progression is measured using a transperineal ultrasound approach in mid-sagittal scan (Figure 2B) and the method for obtaining measurements is described in Figure 16. The anatomic landmarks visualized during this scan include the pubic symphysis bone, as an oblong, irregular, echogenic structure (ideally displayed in a horizontal position) and the fetal skull (Figure 17). The angle enlarges with the progressive descent of the fetal head in the birth canal, and therefore originally was called angle of head descent. Numerous studies [46–49], have correlated AoP between 110 and 120° to the digital assessment equivalent of the level of ischial spines (zero).

The advantage of the angle of progression for the clinicians is to provide a reliable assessment of head station. The limitation is that a proper visualization of the pubic bones is required.

Recommendation

Regarding the head station, head direction (such as head-up sign) or head-perineum distance easy, quick way to evaluate or may be better take the measurement the angle of progression.

b-Caput succedaneum and cranial molding

The presence of caput (a soft tissue swelling) and molding (overlapping of fetal cranial bones) in labor contributes to the difficulty in assessment of fetal head position and station. An objective visual method for describing its presence can be portrayed with transperineal ultrasound in a sagittal plane (Figure 18). The presence of these factors may influence an Obstetrician's decision when considering an operative vaginal birth.

Recommendation

The advantage of this examination gives an opportunity to the clinician not to take wrong impression about the head station

c-Fetal head rotation – midline angle (MLA)

The midline angle specifically describes fetal head rotation, as opposed to descent, as a marker of progress in labor. The measurement is obtained using transperineal ultrasound in the transverse plane. The midline of the fetal head is identified and a linear marker is set at this point for reference. An angle is taken between the fetal midline structures and the anteroposterior axis of the maternal

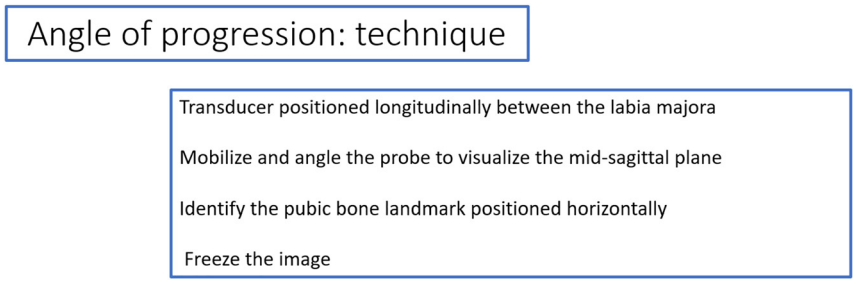


Figure 16: Summary of technique in measuring AoP.

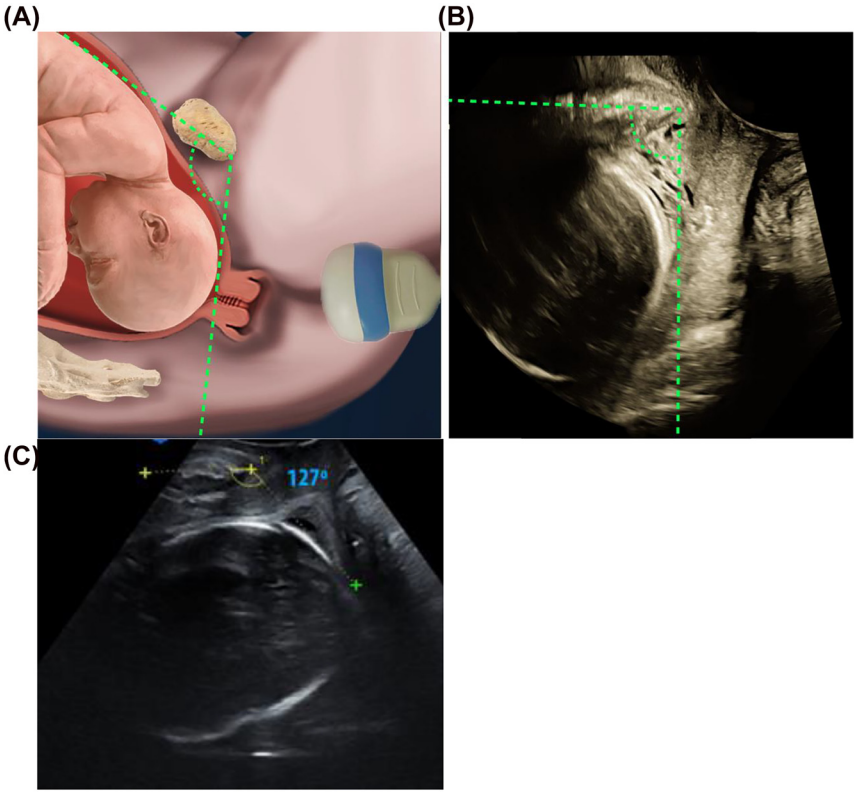


Figure 17: Comparative simulated image. (A) Simulation model depicting anatomical landmarks to measure, (B–C) Corresponding transperineal ultrasound scan image for measuring. Transducer is positioned longitudinally.

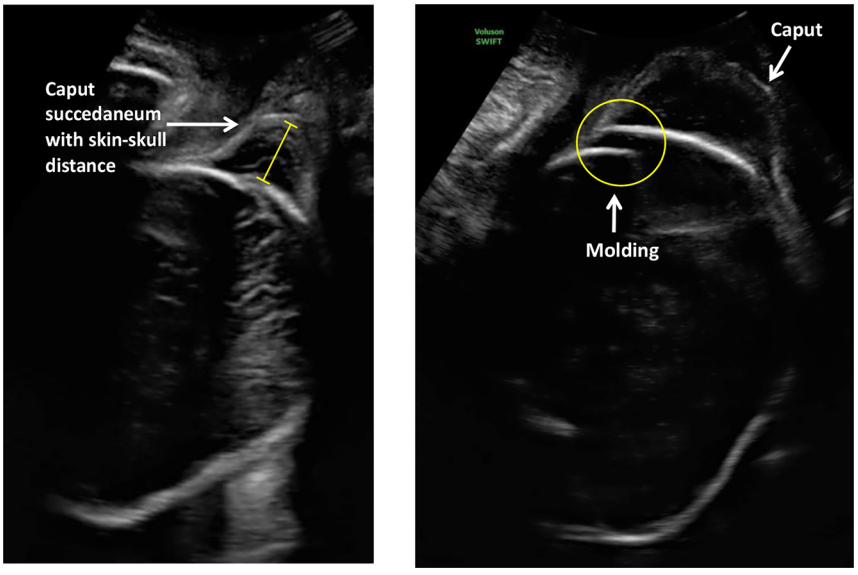


Figure 18: Transperineal ultrasound depiction of caput succedaneum and cranial molding.

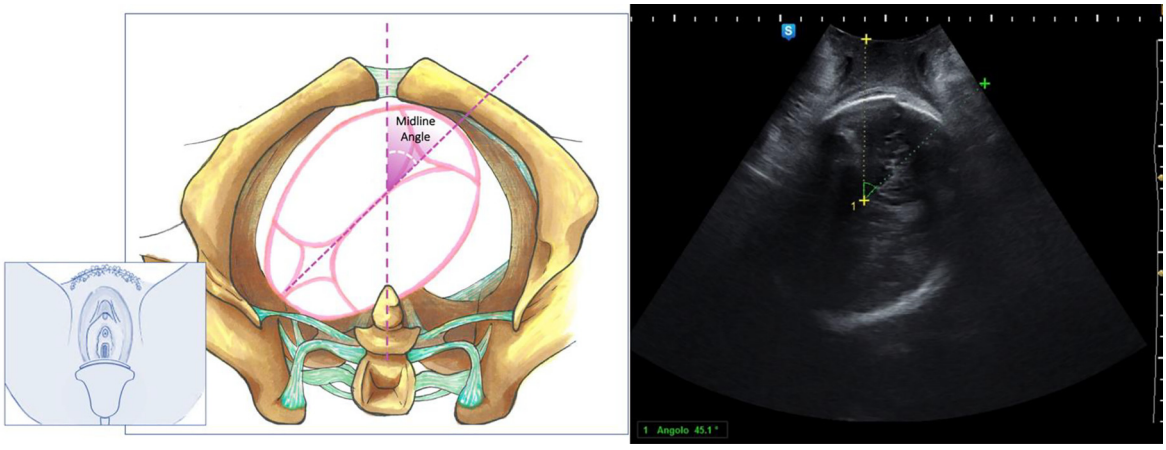


Figure 19: Schematic model and corresponding transperineal ultrasound measurement of MLA.

pelvis (Figure 19). A clinical significance is present between head station and fetal head rotation [39].

Further parameters to represent head descent in the maternal pelvis can be measured including midline-angle (MLA). The advantage of this method is to understand the progress of the head in the pelvis objectively because the digital examination is not giving a reliable method of establishing the progress and head descent.

Recommendation

If you want to evaluate the head rotation in the birth canal, take the measurement of midline angle which gives you an opportunity to manage the labor objectively.

d-Flexion/deflexion

The fetal head flexion facilitates the engagement and the progression of fetal head in the birth canal, exposing the suboccipito-bregmatic diameter, that is shorter than the occipito-frontal diameter. Even though fetal head hyperextension is a common cause of dystocia, clinical diagnosis is difficult and imprecise, therefore the exact prevalence of this condition is unknown. The fetal head flexion can be quantitively defined by the occiput-spine angle (OSA) for fetuses with occiput anterior and transverse position and by the chin-to-chest angle (CCA) for the fetuses with occiput posterior position [31, 50–52]. In the incidence of vaginal deliveries, a wide OSA and a narrow CCA are seen [53].

Recommendation

In cases of suspected dystocia (such as deflexion abnormalities), take the measurement for occiput-spine angle or chin-to-chest angle. Therefore the advantage of this examination is to make better and objective clinical decision to predict the dystocia for proper management.

Occiput-spine-angle (OSA) – flexion/deflexion

The occiput-spine angle (OSA) corresponds to the angle between a line drawn tangential to the cervical spine and a second line drawn tangential to the occiput (Figures 20–22). This represents the degree of head flexion in the maternal pelvis in an occipital anterior or occipital transverse fetal head position. Through quantifying the relationship between the fetal occiput and the spine, the Obstetrician can evaluate normal process of labor and detect early signs of obstruction [49]. In the presence of fetal head deflexion, the outcome of a cesarean delivery is increased [31].

- ✓ **Transducer placed longitudinally at the suprapubic level**
- ✓ **Move and angle the transducer to visualize the cervical spine and the fetal occiput**
- ✓ **Freeze the image**

Figure 20: Summary of OSA-Occiput-spine angle technique.

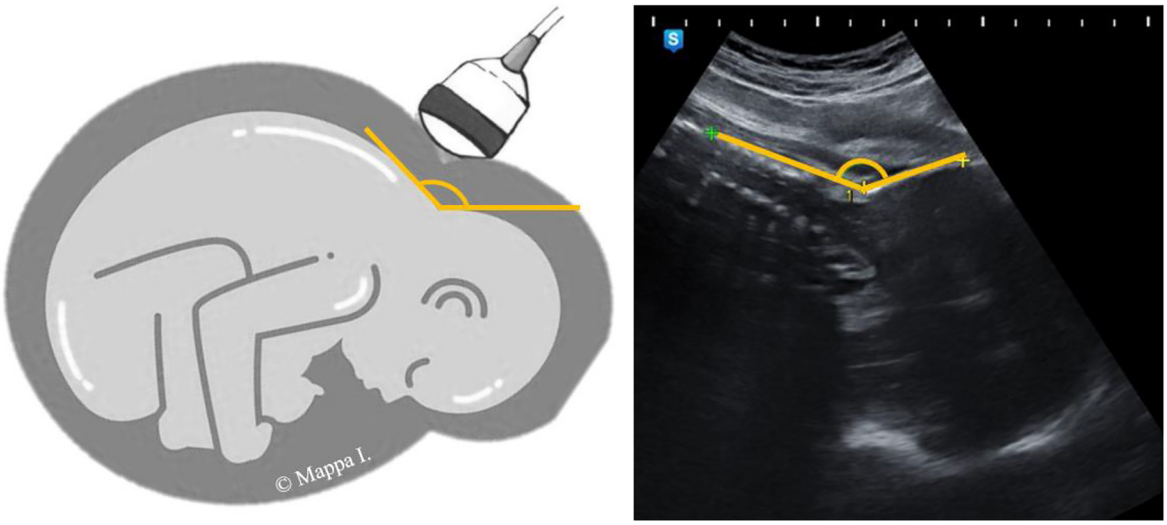


Figure 21: Schematic representation of OSA measurement and corresponding ultrasound image. (Transducer placed longitudinally at the suprapubic level and mobilize and angle the transducer to visualize the cervical spine and the fetal occiput).

Chin-to-chest angle (CCA) – flexion/deflexion

The chin-to-chest angle (CCA) is defined as the angle between the intersection of a line passing by the long axis of the sternum and a second line drawn tangential to the skin that covers the inferior limit of oral cavity up to the chin (Figures 23–25). In the occiput posterior fetal position, this is an alternative measure to OSA to describe fetal head flexion.

e-Second stage of labor

According to the World Health Organization (WHO), the definition of second stage labor is the interval between the initiation of full cervical dilatation and birth of the baby. Adverse outcomes for both the mother and her baby have been associated with a prolonged duration in second stage of labor as well as higher likelihood of requiring an assisted birth [53–55]. The recommended duration of this stage in labor still remains debated worldwide. An Obstetrician assesses the cause of the delay in labor and may propose an operative vaginal delivery (vacuum, forceps or caesarean section).

A study of prolonged labor in 150 women, measured transperineal ultrasound distance of HPD ≤40 mm and the AoP ≥ 110° corresponded to an outcome of a spontaneous vaginal delivery in 92 and 88% of women respectively which demonstrates promising data on the utility of these values for prediction of type of birth [56].

Transperineal measurement of HPD both during at rest and during active second stage was able to quantify fetal head descent and thus illustrate that minimal descent was associated with longer duration of second stage and higher chance of CS [57]. Furthermore, a recent systematic review supports ultrasound prediction in labor by demonstrating an AoP between 108 and 119° at the beginning of second stage of labor was associated with a successful vaginal birth [58].

During second stage, a proposed algorithm model using the concept of a “traffic light” by incorporating both clinical and sonographic parameters is useful to consider [59–61]. It may guide clinicians on their decision on the choice of assisted vaginal delivery and alert junior Obstetricians to consider senior assistance prior to commencing delivery. Asynclitism is often underdiagnosed. It could be as common as 15% in second stage of labor amongst nulliparous women. A simple rule for diagnosis is that the midline echo could not be seen easily at the head-perineum distance plane [62]. Obstetricians should be aware of this condition, especially when encountering fetuses in non-OA position before attempting instrumental deliveries.

Recommendation

Intrapartum ultrasound can be used during all stages of pre-labor and labor for diagnosis of malpositions and understand underlying mechanisms of labor arrest. In this manner, ultrasound alongside clinical findings, can improve clinical care. Through evaluation of fetal position, station and rotation, the Obstetrician can oversee labor progress and make objective judgements over intended clinical interventions.

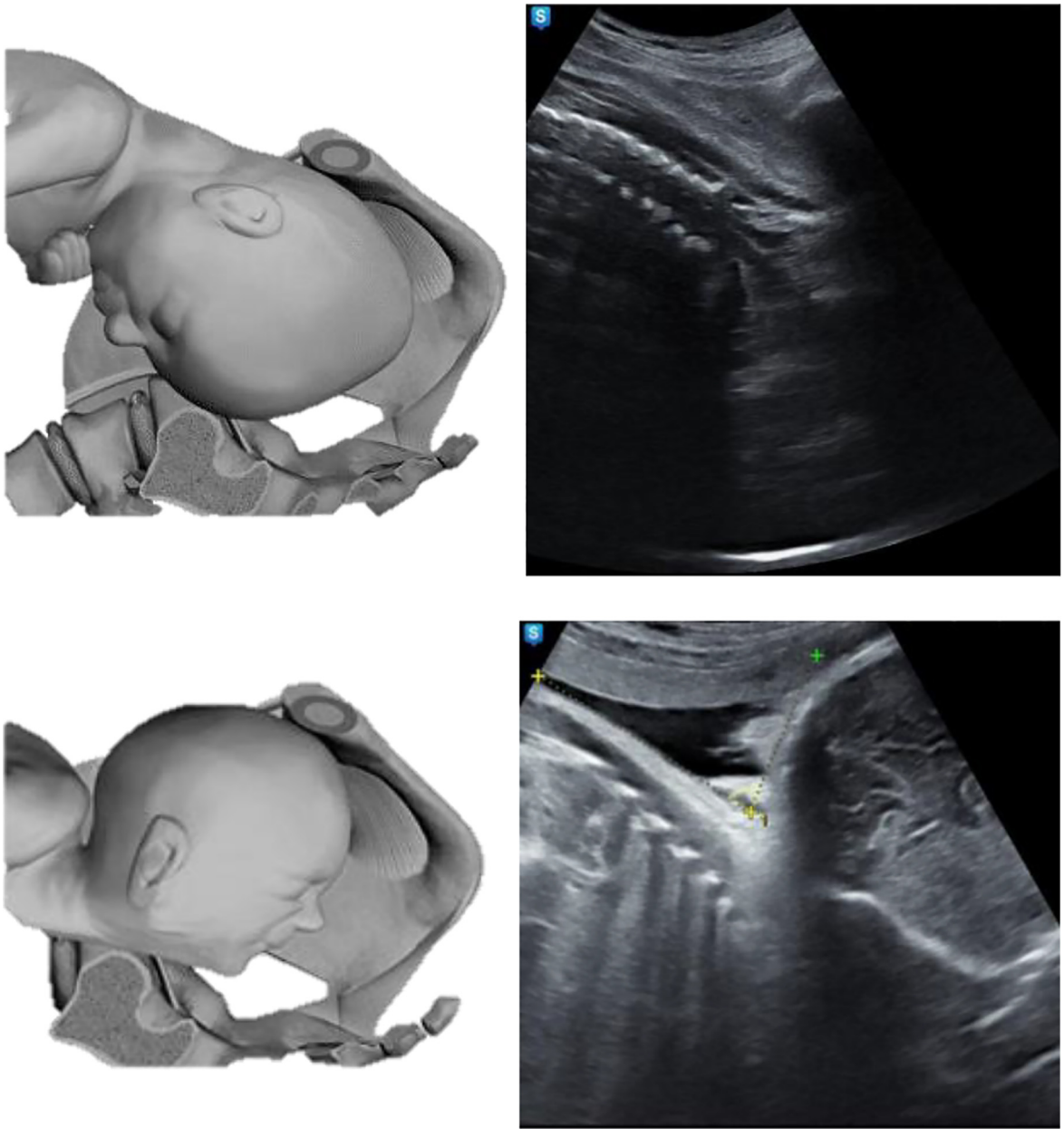


Figure 22: Assessment of the occiput-spine angle (OSA) in fetuses with occiput anterior position.
Modified by Bellussi et al. Fetal head deflexion at ultrasound evaluation increases the risk of cesarean delivery. AJOG MFM 2020.

The "chin-to-chest" angle: technique

Transducer placed longitudinally at suprapubic level

Move and angle the transducer to visualize the fetal face profile and the sternum longitudinally

Freeze the image

Figure 23: Summary of CCA technique.

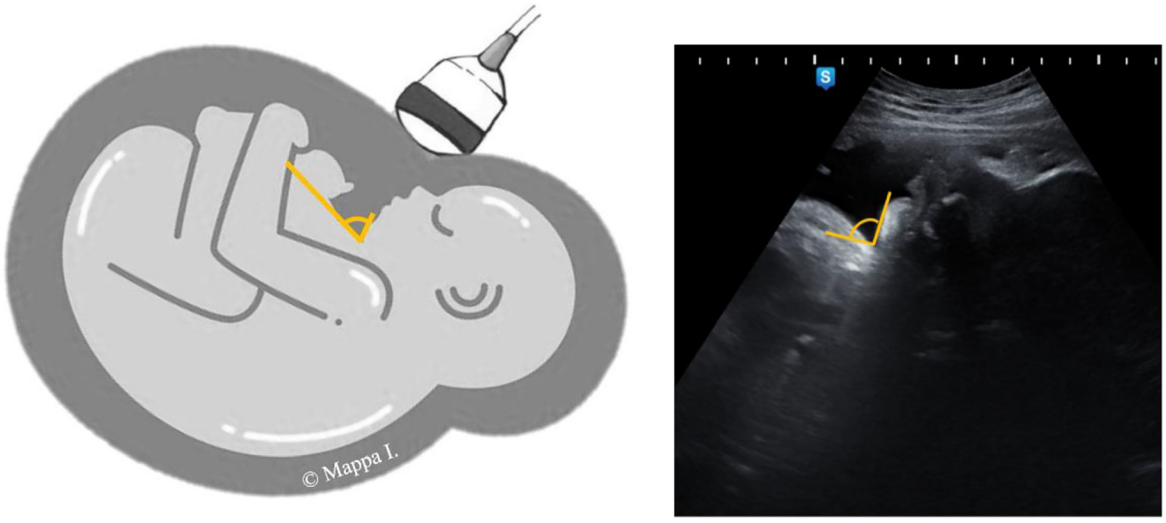


Figure 24: Measurement of "chin-to-chest" angle (CCA) in fetuses with occiput posterior position: placement of transducer, illustration, measurement.

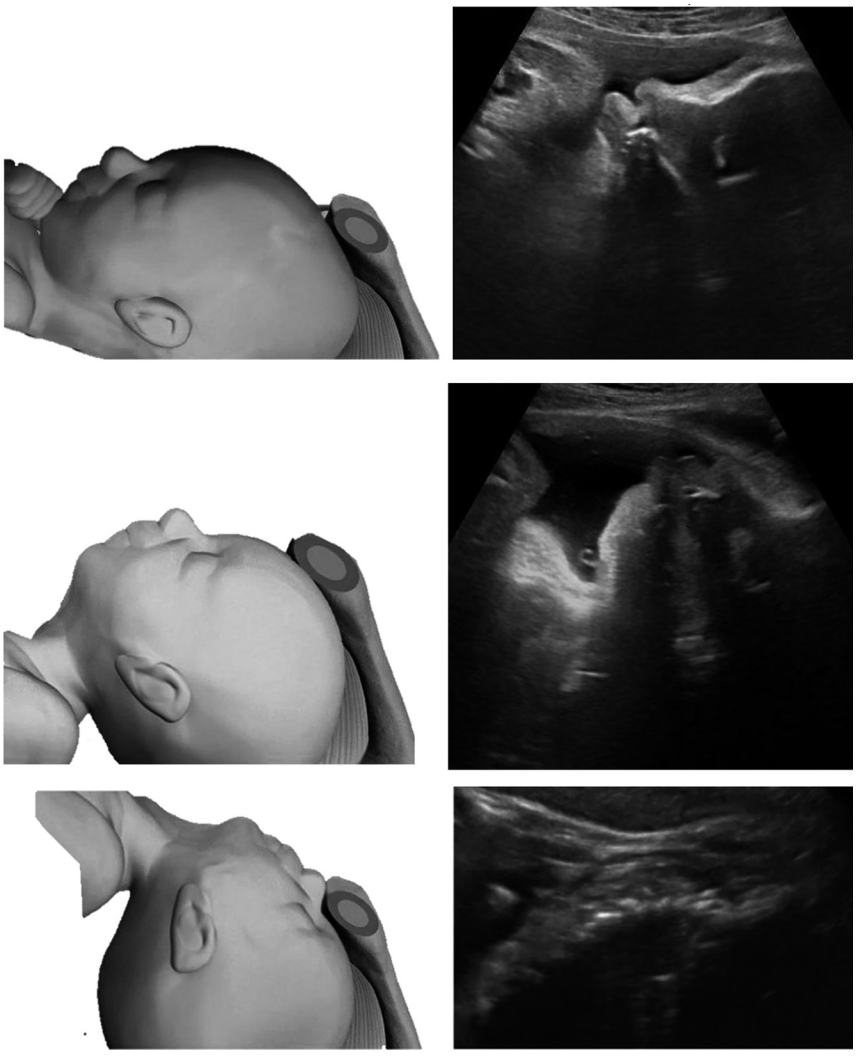


Figure 25: Visual assessment of the "chin-to-chest" angle (CCA) in fetuses with occiput posterior position modified by Bellussi et al.
Fetal head deflexion at ultrasound evaluation increases the risk of cesarean delivery. AJOG MFM 2020.

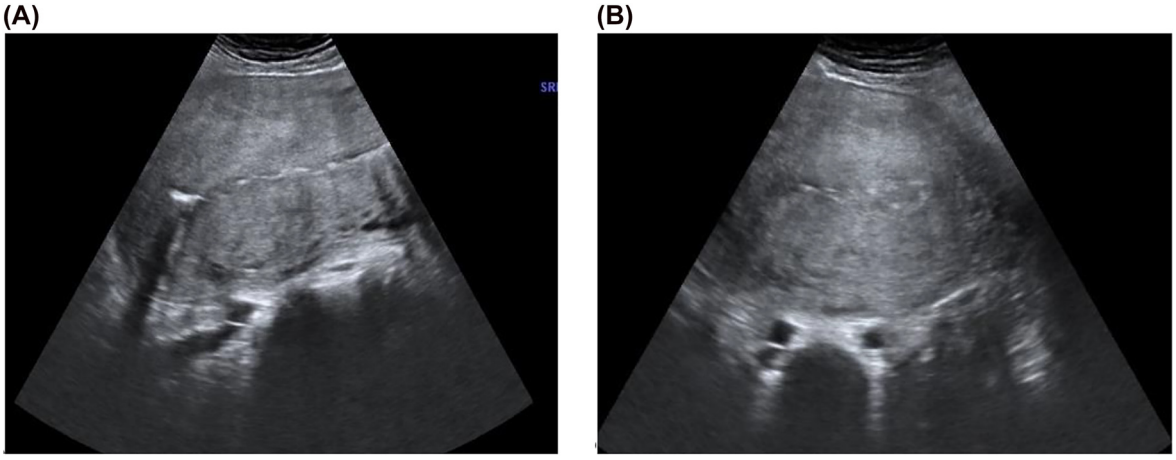


Figure 26: Normal uterus immediately after uncomplicated spontaneous birth with complete placental delivery.
(A) Uterus in longitudinal section with a linear cavity, without coagula and without placental remnants. (B) Cross section of the same uterus at the level of the common iliac artery.

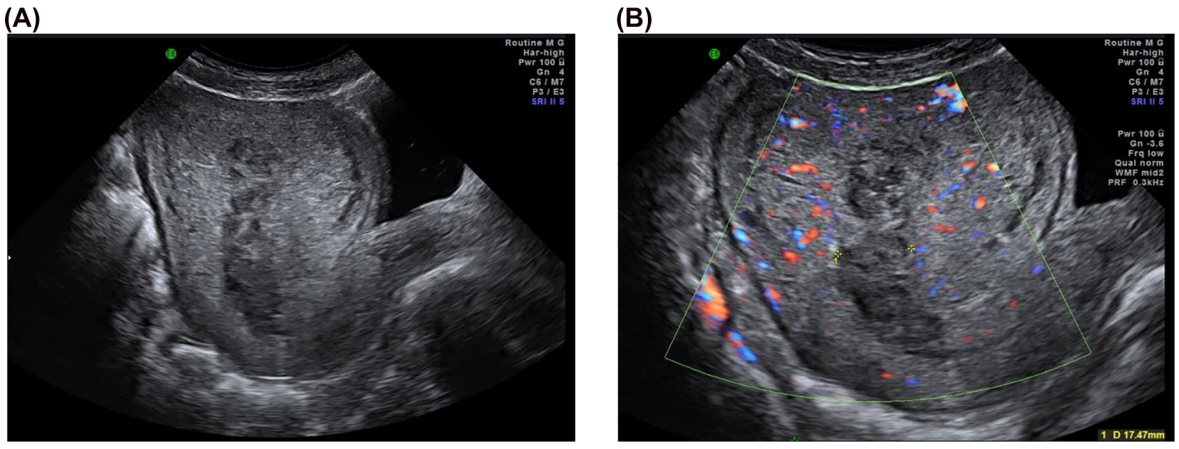


Figure 27: Normal uterine involution one week after delivery.
(A) Uterus with normal postpartum flow in the cavity. The cavity is slightly dilated and physiologically contains some blood. (B) Color Doppler sonography shows perfusion in the myometrium only, but not in the cavity.

Section 4: Ultrasound examination after delivery

a-Checking the anatomy

Applications of postpartum sonography (Figures 26 and 27) include the exclusion of placental remnants immediately after birth in the context of postpartum hemorrhage, the possible need for ultrasound-guided curettage and the exclusion of uterine rupture in vaginal birth after previous cesarean section. After primary cesarean section without opening of the cervix lochial stasis can lead to lower abdominal pain and in these cases a significant intrauterine blood collection can be detected on ultrasound. Sonography is also used for the diagnosis of intra-abdominal or abdominal wall hematomas, and other rare causes of persistent or acute postpartum bleeding such as placental polyps, arterio venous malformations and pseudo-aneurysms [63, 64].

b-Postpartum bleeding

In postpartum bleeding, immediate sonography helps to distinguish between uterine atony and bleeding caused by tissue (placental retention) or trauma.

In placental retention, the placenta is not born within 30–60 min. It is the second most common cause of postpartum hemorrhage (PPH) after uterine atony. A completely

or partially separated retained placenta impairs uterine contraction and often leads to increased bleeding. In such cases, the placenta must be separated manually or removed instrumentally, preferably under ultrasound guidance. The sonographic surveillance during such procedures reduces the risk of complications, for example uterine perforation or the incomplete emptying of remnants.

After manual or instrumental removal of the placenta or placental remnants, the sonographically empty cavity of the uterus can be imaged and documented (Figure 28).

In the case of uterine atony resistant to uterotonics, which often occurs after manual and instrumental emptying of the cavity, the insertion of an intrauterine chitosan tamponade or of a balloon (Bakri balloon) has proven to be effective (Figure 29). The correct position of the tamponade or balloon can be confirmed sonographically. The secondary accumulation of blood in the uterine cavity can also be detected.

Postpartum and post-operatively, abdominal sonography is also helpful to detect hematomas and to determine their size (Figure 30): they can be separate from the uterus, for example in the case of a uterine rupture. In the case of persistent postoperative vaginal bleeding after curettage, free abdominal fluid or a localized hematoma can be

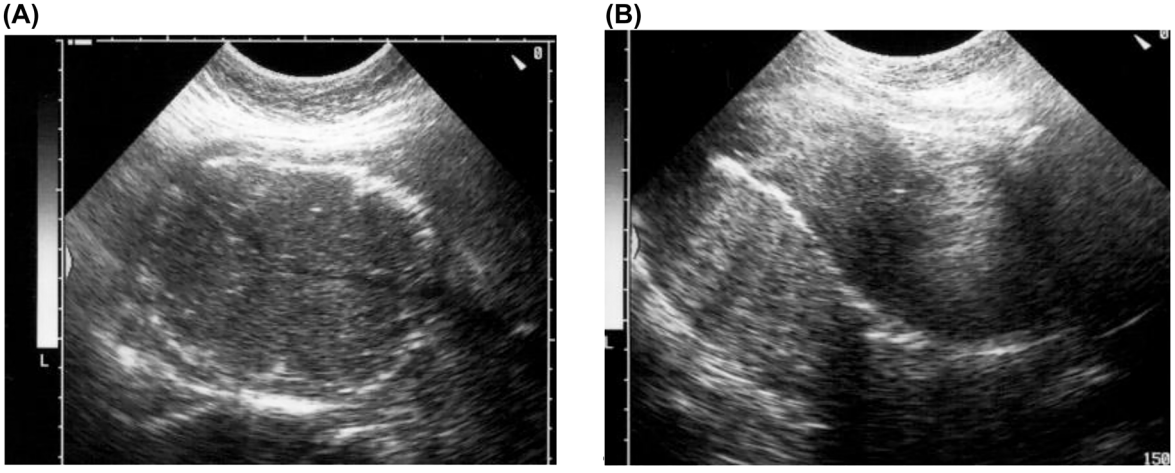


Figure 28: Placental retention, manual placental release.
(A) Unseparated placenta in the uterine cavity (cross-section). (B) Final image of the uterus after complete removal of the placenta (longitudinal section).

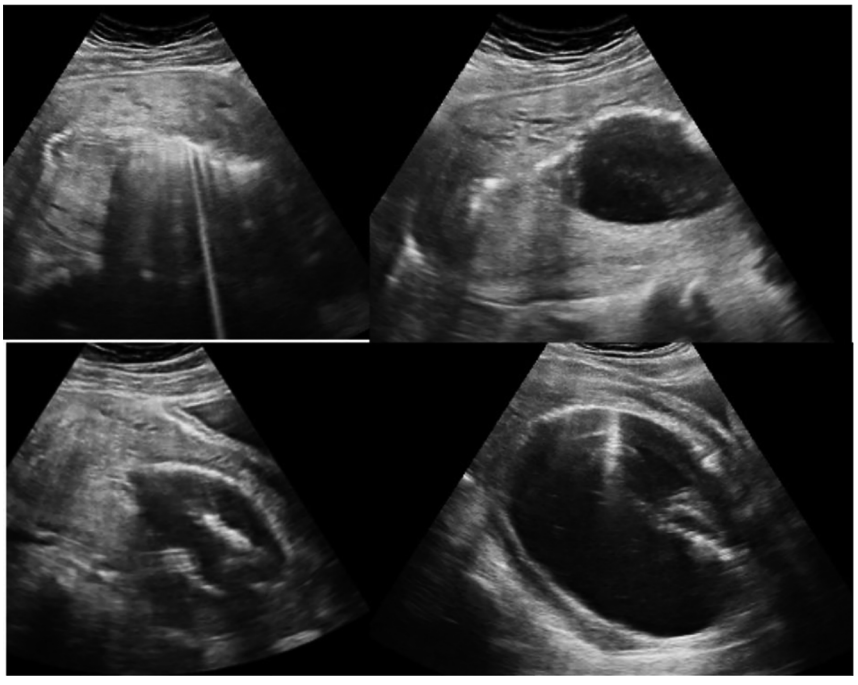


Figure 29: Application of Bakri balloon.

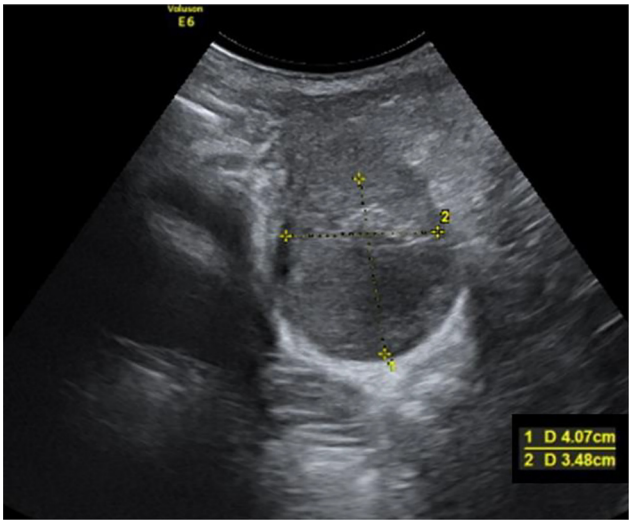


Figure 30: Postpartum hematoma by transabdominal ultrasound.

detected next to the rupture site in the abdomen, and the volume of blood loss can be better estimated and correlated with circulatory parameters and hemoglobin levels [65, 66].

Uterine compression sutures are used as an alternative to a tamponade in cases of therapy-resistant bleeding during a cesarean [67, 68]. These sutures can be visualized by ultrasound and followed up in the postoperative course weeks later.

c-Doppler studies

Both B-scan imaging and color Doppler sonography of the placenta can help to detect a pathological placental period. The absence of placenta separation signs and the persistence of blood flow between the myometrium and placenta in color Doppler may be an indication of abnormally

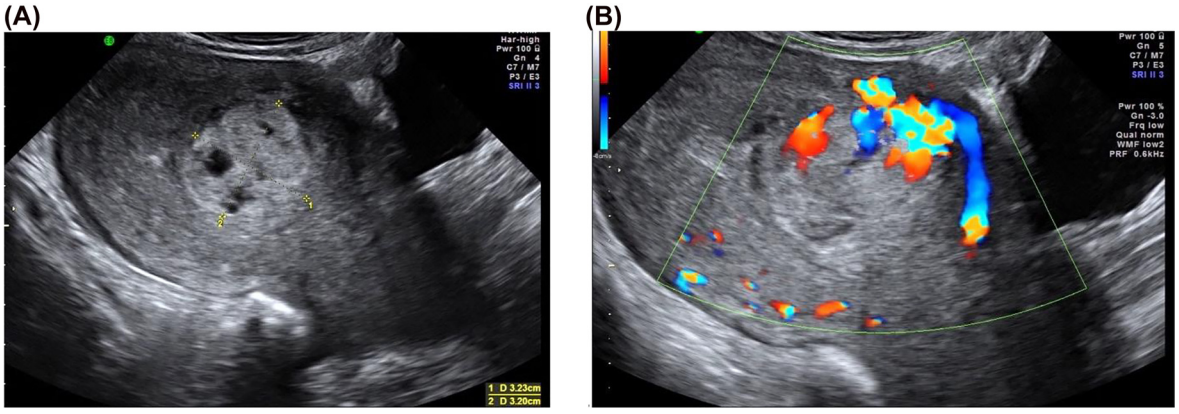


Figure 31: Placental remnant after spontaneous delivery.
(A) In a clinical examination due to increased postpartum flow two weeks after spontaneous delivery a placental residue was found. (B) Evidence of perfusion in the placental residue, which originates from the anterior wall.

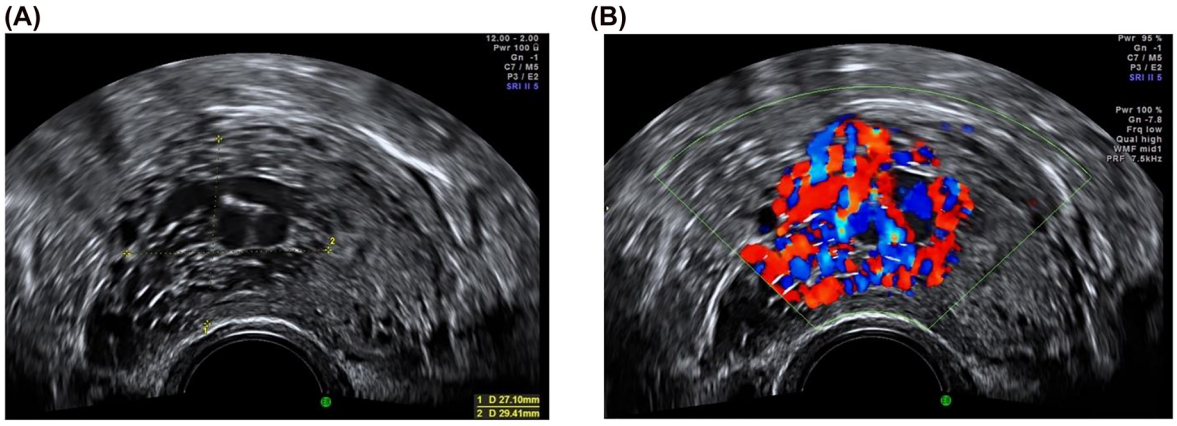


Figure 32: Uterine arterio-venous vessel malformation (AVM).
(A) Cystic mass in the myometrium. (B) Color Doppler sonography reveals a dense vascular mass in the myometrium with turbulent flow typical of uterine AVM.

invasive placenta (AIP), such as placenta accreta, increta or percreta (Figure 31). In some cases, the patient may benefit from ultrasound-guided curettage to selectively remove cotyledons implanted at a deeper focal point, and in other cases, to act cautiously in the case of AIP with a very thin myometrium and the danger of perforation. At the end of the procedure, an ultrasound image can be used to document the successful performance of the intervention and confirm the empty cavity.

The detection of perfusion, using color Doppler, in an intracavitary mass is diagnostic of placental remnants [66]. Cotyledons cannot always be distinguished from organized blood clots or a submucous myoma by the B-mode image alone. Increased blood flow to the myometrium in the area of the adherent placental residue is typical, but absent in blood clots and in older or detached non-perfused placental remnants. Increased vaginal bleeding after a caesarean section in the puerperium can also indicate placental remnants.

Arterio-venous malformations (AVM) are a rare differential diagnoses of pathological postpartum uterine bleeding [69]. They occur after uterine trauma (surgery) or are, rarely, congenital; they may occasionally become symptomatic postpartum for the first time. In B-Mode Ultrasound a cystic mass in the myometrium is visible and color Doppler sonography reveals a dense vascular mass in the myometrium with turbulent flow typical of uterine AVM. Correctly diagnosing a symptomatic AVM is essential to avoid the accidental provocation of increased bleeding during an attempted curettage (Figure 32).

d-Pelvic floor after delivery

Perineal sonography can be used to assess the pelvic floor and sphincter anatomy. Internal and external sphincters and the levator ani can be examined not only statically but also dynamically (when the pelvic floor is tensed and relaxed). Sonographically it appears as a local interruption of continuity of the soft tissue mantle or vaginal sidewall. This new application of postpartum sonography is increasingly being used for the early diagnosis of occult or clinically significant pelvic floor and sphincter damage.

Recommendation

In a case of any suspected postpartum pathology, the us of ultrasound examination is always to keep you safe and to give you better management of postpartum period.

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Informed consent: Informed consent was obtained from all individuals included in this study.
Ethical approval: The local Institutional Review Board deemed the study exempt from review.

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