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Intrapartum Ultrasound Guidelines

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Intrapartum Ultrasound Guidelines

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1. Purpose and scope

The purpose of this guideline is to review the published techniques of labor ultrasound and their practical applications, to summarise the level of evidence regarding the use of ultrasound in labor; and to provide guidance to practitioners on when ultrasound in labor is clinically indicated and how the sonographic findings may affect labor management. In this guideline we do not imply or suggest that ultrasound in labor is a necessary standard of care.

2. Background and introduction

The assessment and management of a woman in labor is traditionally based upon clinical findings (1-7). The diagnosis of labor arrest and the timing or type of interventions rely mostly on the digital evaluation of cervical dilatation and fetal head station and position (8-17).

However, clinical examinations of station and position are inaccurate and subjective (18-25), especially when a caput succedaneum impairs palpation of the sutures and fontanels.

The use of ultrasound has been proposed as an aid in the management of labor. Several studies have demonstrated that ultrasound examinations are more accurate and reproducible than clinical examinations in the diagnosis of fetal head position and station (19-33) and in the prediction of labor arrest (34-42). Ultrasound examination in labor can, to some extent, predict which women in the second stage of labor are destined for spontaneous vaginal delivery or operative delivery (43-47). Finally, there is growing evidence that ultrasound in labor may predict the outcome of instrumental vaginal delivery (44-48).

Ultrasound in labor can be done transabdominally, mainly for head and spine position (49) or transperineally (TP) for assessment of head station and position at low stations. Several quantitative sonographic parameters have been proposed to assess head station (30-32, 34, 35, 40, 42, 43, 50, 51). Currently, there is no consensus on when ultrasound should be performed in labor, which parameter(s) should be obtained and how the sonographic findings should be integrated in the clinical practice in order to improve the management of the patient.

3. Identification and assessment of evidence

The Cochrane Library and Cochrane Register of Controlled Trials were searched for relevant randomised controlled trials, systematic reviews and meta-analyses. A search of Medline from 1966 to 2017 was also carried out. The date of the last search was 30th of September 2017. In addition, relevant conference proceedings and abstracts were searched.

The databases were searched using the relevant MeSH terms including all sub-headings. This was combined with a keyword search using labor ultrasound, transperineal ultrasound, fetal head station, fetal occiput position, instrumental vaginal delivery

In this document where possible, recommendations are based on, and explicitly linked to, supporting evidence (see appendix). Areas lacking evidence are highlighted and annotated as 'good practice points.'

4. The guideline

4.1 Aims of the ultrasound study in labor ward

In this guideline the use of ultrasound in the woman in labor exclusively addresses fetal head station, position and attitude. All the other applications of ultrasound in labor ward such as the assessment of cervical length or dilatation and the fetal Doppler studies are not covered in this guideline. For the time being, ultrasound should be used as an adjunctive method and not as a substitute for clinically indicated digital vaginal examination.

4.1.a Assessment of FETAL HEAD POSITION

The exact knowledge of the fetal occiput position in labor is of paramount importance:

- Persistent occiput posterior position is associated with higher risk of operative delivery (52) and maternal and perinatal morbidity (53-54)
- The correct determination of the head position is crucial before instrumental delivery. An error in evaluation of head position may result in inappropriate vacuum or forceps placement, increasing potential fetal injury and procedure failure rate (55-58). Failed instrumental delivery followed by Cesarean section is associated with an increased decision-to-delivery interval (59) and an increased risk of maternal (60-61) and fetal trauma (62-65).

Clinicians traditionally determine fetal head position by palpating the sagittal suture, the anterior and posterior fontanels. Several studies have evaluated the accuracy of clinical diagnosis of fetal head position, using ultrasound (19-28) or position tracking technology systems (66) as reference; digital palpation was found to be subjective. Consistently studies show that digital examination for head position is inaccurate with a rate of error ranging from 20 to 70%, when considering ultrasound as the standard. (**LEVEL OF EVIDENCE I-C**)

Clinical evaluation by palpation tends to be less accurate in cases of abnormal head position as occiput posterior and transverse, when medical intervention is more likely to be needed (19, 20, 22, 23). **(LEVEL OF EVIDENCE II-A)**

This inaccuracy may be exaggerated by the presence of caput succedaneum and asynclitism, both of which are more frequently associated with obstructed labor. Several studies have failed to demonstrate a significant difference in accuracy between experienced and inexperienced obstetricians (19, 21, 22), although this finding has been questioned by others (20). **(LEVEL OF EVIDENCE II-B)**

Various studies have demonstrated the superiority of ultrasound alone or in combination with digital examination in the precise determination of the fetal head rotation as compared with traditional digital examination alone. (19-28, 66). **(LEVEL OF EVIDENCE I-C)**

4.1.b Assessment of FETAL HEAD STATION

The fetal head station is the level of the fetal head in the birth canal relative to the plane of the ischial spines (non-cephalic presentations will not be considered in this document). The term "head engagement" is used when the widest part of the head passes into the pelvic inlet or 2/5 of the fetal head or less is palpable abdominally, corresponding to descent of the biparietal plane of the fetal head to a level below that of the pelvic inlet (67). At digital vaginal examination, the fetal head is considered engaged when the leading part of the skull has reached the imaginary line or plane between the maternal ischial spines. This head station is referred to as station 0. Higher or lower head stations are expressed in centimeters above (negative) or below (positive) this reference plane, respectively.

The subjectivity of transvaginal digital assessment of fetal head station was demonstrated by Dupuis et al. (18) **(LEVEL OF EVIDENCE II-B)**. Using a birth simulator equipped with a sensor, the authors placed a fetal head mannequin at defined stations according to the American College of Obstetricians and Gynecologists (ACOG), and a group of examiners of various levels of experience classified the fetal head station as high, mid-pelvis, low and outlet, using palpation. The mean 'category' error was 30% for residents and 34% for obstetricians. More importantly, the wrong diagnosis of a mid-pelvic station rather than a true high-pelvic station accounted for the majority of errors (88 and 67%, by residents and obstetricians, respectively). In clinical practice, such misclassification may result in serious difficulties in the management of labor.

Ultrasound objectively and precisely documents the fetal head station in the birth canal (29-33, 35, 47, 68) **(LEVEL OF EVIDENCE II-B)**.

A series of sonographic parameters have been suggested to describe the fetal head station. These parameters have been demonstrated to have high intra- and interobserver agreement (69-71) **(LEVEL OF EVIDENCE II-B)**.

4.1.c Assessment of fetal head descent (progression)

Some observational studies (36,37, 39, 72, 73) have suggested that repeated ultrasound to assess the change of head station over time ("progression") performs better than digital examination in documenting the fetal head descent and in demonstrating a slow labor or the lack of progress either in the 1st or in 2nd stage **(LEVEL OF EVIDENCE II-B)**

4.1.d Assessment of fetal head attitude

The fetal head attitude is the relationship of fetal head to spine. Ultrasound has proved helpful in visual assessment of the fetal head attitude (74-75) **(LEVEL OF EVIDENCE II-C)** and in the objective diagnosis of fetal head malpresentations in labor (76-80) **(LEVEL OF EVIDENCE III)**

4.2. Technique

Ultrasound assessment in labor may be performed by the transabdominal (TA) or transperineal (TP) approach depending on the parameter of the examination (mainly: position and station) and on the clinical indication. A 2D ultrasound machine with a convex probe, such as used for transabdominal fetal ultrasound for biometry and anatomy, is used. Suggested requirements for labor ward use are quick start and long life and fast rechargeable batteries. A wide sector, low frequency (<4 MHz) insonation is best suited ultrasound in labor.

4.2.a Assessment of FETAL HEAD POSITION

The sonographic assessment of the fetal head position is based upon transabdominal axial and sagittal scanning (81). Placing the ultrasound probe transversely on the maternal abdomen, an axial view of the fetal trunk is obtained at the level of the fetal upper abdomen or the chest. The position of the fetal spine may then be determined. The ultrasound transducer is then moved downwards until it reaches the maternal suprapubic region, visualizing the fetal head. The landmarks depicting fetal occipital position are the two fetal orbits for occiput posterior position, the midline cerebral echo for occiput transverse position and the occiput itself and the cervical spine for occiput anterior position (81) (Figure 1-2). The choroid plexus diverges towards the occiput, which can be helpful in assessing fetal head position (47).

The midline structures in the fetal head may be difficult to see with transabdominal scanning at low fetal station. Combining a transabdominal approach and a transperineal ultrasound approach may be recommended in these cases for exact determination of position.

Position can be described depicting a circle, like a clock (figure 3): positions ≥ 02.30 and ≤ 03.30 hours should be recorded as left occiput transverse (LOT); positions ≥ 08.30 and ≤ 09.30 as right occiput transverse (ROT); positions >03.30 and <08.30 should be recorded as occiput posterior; positions > 09.30 and < 02.30 as occiput anterior (25).

4.2.b Assessment of FETAL HEAD STATION

The sonographic assessment of the fetal head station is based upon transperineal ultrasound, placing the probe between the two labia majora or more caudally at the level of the fourchette with the woman in a semi-recumbent position with the legs flexed at the hips and knees at 45º and 90º degrees, respectively. The transperineal ultrasound may be carried out in the midsagittal or the axial plane. It is essential that the bladder is empty. In the midsagittal plane the following anatomical landmarks are clearly depicted:

- The pubic symphysis joint, as an oblong, irregular echogenic structure. Ideally, the symphysis should be displayed in a horizontal position.
- The fetal skull, with anterior and posterior tabula clearly depicted.

The traditional reference plane of vaginal palpation, the level of the ischial spines, cannot be seen in this view. However, there is a fixed anatomical relationship between the the lower end of the pubic symphysis and the interischial plane: The 'infrapubic line' is an imaginary line originating from the caudal end of the symphysis pubis and perpendicular to its long axis, extending to the dorsal part of the birth canal. In three-dimensional reconstructions of CT data from normal female bony pelvis, the infrapubic line has been shown to be three centimeters above the plane of the ischial spines (42, 84-86).

On the midsagittal transperineal plane, several parameters that use the pubic symphysis as landmark and reference point for quantitative measurements have been proposed. Three parameters indicate head station directly: (1) the "Angle of Progression" (AoP), also called "Angle of descent" (40, 43); (2) the "Progression distance" (PrD) (30); and (3) the transperineal ultrasound head station (41). The "Head Symphysis distance (HSD) is an indirect parameter that changes with descent (51.). The "Head Direction" indicates the direction of the longest recognizable axis of the fetal head with regard to the long axis of the pubic symphysis (42).

With a simple clockwise transducer rotation by 90º, a transverse plane is obtained, in which two additional parameters can be evaluated and measured: the "Head Perineum Distance" (HPD) (34) as a marker of head station, and the "Midline Angle" (MLA) (31) that assesses the rotation of the head.

I Angle of Progression (AoP) or Angle of Descent

The "angle of progression" is the angle between the long axis of the pubic bone and a tangent on lowest edge of the pubis and the deepest bony part of the fetal skull (fig 4). The AoP was first described in 2009 (40, 43) and it has been found to be an accurate and reproducible parameter for fetal head descent assessment (40, 41, 69-70). **(LEVEL OF EVIDENCE II-B)**

Dückelmann et al. have demonstrated that measuring AoP can be learned easily and regardless of the clinician's level of ultrasound experience (72). **(LEVEL OF EVIDENCE II-B)**

Tutschek et al. correlated different parameters, including a comparison of AoP and transperineal ultrasound head station, and found that station 0 correspond to an AoP/AoD of 116° (see table 1) (41).

II Assessment of fetal HEAD DIRECTION

Head direction (HD) is an indirect marker also of head station and was first described by Henrich et al. (42). It is the angle between the longest recognizable axis of the fetal head and the long axis of the pubic symphysis, measured in a midsagittal transperineal view. (fig 5). Head direction was classified categorically as "head down (angles below 0°), "horizontal" (angles 0° to 30°) and "head up" (angle >30°). The authors noted an easily recognizable change in the head direction as the head descends towards the pelvic floor from downward to horizontal to upward. "Head up" immediately before operative vaginal delivery correlated with successful and relatively easy (few tractions) procedure.

III Ultrasound head station

The transperineal ultrasound head station expresses head station on the conventional scale used for palpatory assessment of labor progress (centimeters above or below the ischial spine plane) and incorporates the curvature of the birth canal. It requires assessment (i) of the head direction (see above) and (ii) of the distance between the infrapubic plane (which is three centimeters above the ischial plane) and the deepest presenting bony part along the line of head direction (figure 6). Transperineal ultrasound head station has been compared with other parameters of fetal head station. While it is more complex to measure (requires an angle and a distance measurement), it was found to correlate linearly with the easily measurable AoP: the relationship between these two parameters allows conversion of AoP measurement directly into centimeters on the conventional palpation scale (tab. 1).

IV Head-perineum distance

Head perineum distance (HPD) was first described by Eggebo et al. (figure 7) (34). The transducer should be placed between the labia majora (in the posterior fourchette), and the soft tissue compressed completely against the pubic bone. The transducer should be angled until the skull contour is as clear as possible, indicating that the ultrasound beam is perpendicular to the fetal skull. Head-perineum distance is measured in a frontal transperineal scan as the shortest distance from the outer bony limit of the fetal skull to perineum. A cineloop can be stored and used to identify the shortest distance possible to obtain between the transducer (perineum) and the fetal skull. This distance represents the remaining part of the birth canal for the fetus to pass. Compression of the soft tissue is not painful for women (36)

HPD cannot be easily converted to the clinical assessment of fetal station from -5 to + 5 because HPD does not follow the curved line through the birth canal (36). Tutschek et al found station 0 to correspond to HPD 36 mm (32), Kahrs et al. to 35mm (47) and Maticot-Baptista et al. found 38 mm corresponding to mid-cavity (87). Limits of agreement is found to be -8,5 to + 12,3 mm (34).

V Midline Angle (MLA)

The midline angle (MLA) differs from the other mentioned parameters as it exploits the angle of head rotation as an indicator of birth progress. The MLA is the angle between the anteroposterior axis of the maternal pelvis and the head midline (fig 8). It was first described by Ghi et al. (31) Using the transperineal approach, on the axial plane the echogenic line interposed between the two cerebral hemispheres (midline) is identified and the angle formed by the midline and the anteroposterior axis of the pelvis is measured. The authors found a significant correlation between head station assessed clinically and rotation assessed by MLA. After exclusion of cases with occiput posterior, a rotation of $\geq 45^{\circ}$ was found at a station of ≤ 2 cm in 70/71 (98.6%) cases and a rotation of $<45^{\circ}$ was found at a station of $\geq +3$ cm in 41/49 (83.7%) cases ($P < 0.001$). **(LEVEL OF EVIDENCE II-B).**

The midline angle was originally described like an angle related to the maternal pelvis, but head position can be categorized as a clock in the same way as described from the transabdominal scanning

VI Additional investigational parameters to assess fetal head station

The following two parameters have been also proposed to measure the fetal head station in labor. However, following their introduction, they have not been widely applied in research studies and in respect with the others their clinical usefulness has not been well established

Progression distance

Progression distance (PD) was first described as an objective measurement of fetal head engagement, measured before onset of labor, by Dietz and Lanzarone (30). It is defined as the minimal distance between the "infrapubic line" and the presenting part (defined as the most distal part of the hyperechogenic curvature signifying the fetal skull) (fig 9). Because AoP is easier to measure than PD and accounts for the curved nature of the birth canal, which PD does not, the former should be preferred as a measure of head station.

Head-Symphysis Distance (HSD)

The Head-Symphysis Distance (HSD) is the distance between the lower edge of the maternal symphysis pubis and the fetal skull, along the infrapubic line (fig 10). As the palpated space between the fetal skull and maternal symphysis pubis is widely used in clinical practice as a proxy of fetal station, the HSD has been proposed by Youssef et al as an indirect marker of fetal head descent (51).

In a cohort of occiput anterior fetuses this parameter has been proved to be reproducible and showed a linear negative correlation with the palpated station, becoming progressively shorter as the head descends towards the pelvic floor. **(LEVEL OF EVIDENCE II-B)**

Furthermore, the HSD has been shown to correlate with the other sonographic measurements of fetal station; it is positively correlated with the HPD and negatively with the angle of progression (tab. 2) (32). HSD can only be measured at stations below the infrapubic line (i.e. >= -3cm).

3. Indications for labor ultrasound evaluation (table 3)

3.1 Slow progress or labor arrest in the 1st stage of labor (Level of Evidence II-B. Grade of Recommendation B)

3.2 Slow progress or labor arrest in the 2nd stage of labor (Level of Evidence II-B. Grade of Recommendation B);

3.3 Ascertainment of the fetal head position and station before considering or performing an instrumental vaginal delivery (Level of Evidence I-C. Grade of Recommendation A)

3.4 Objective assessment of fetal head malpresentation (Level of Evidence III. Grade of Recommendation C)

One study has failed to demonstrate a benefit of routine use of ultrasound in labor for head position only (head station was not measured by ultrasound in this study) among low risk patients, in whom it was associated with a higher risk of caesarean delivery (88) **(Level of Evidence I-C. Grade of Recommendation A)**

Although ultrasound has been demonstrated to be more accurate and reproducible than digital examination in the diagnosis of the fetal head position and station in labor, a knowledge of these findings has not been shown to improve the management of labor and delivery. Because of the rarity of adverse perinatal and maternal outcome during labor, very large randomised studies would be necessary to prove a clinical benefit of intrapartum sonography for the fetus or the mother in respect of severe perinatal or maternal morbidity. However intrapartum US allows more precise determination of position and station and is more acceptable to women than digital examination (72). Its use may be endorsed under the following circumstances as an adjunct to clinical examination:

3.1 Slow progress or labor arrest in the 1st stage of labor

Some consecutive studies have shown that HPD and AoP are more accurate than digital examination in predicting vaginal delivery in nulliparous women with prolonged first stage of labor (36,39) **(Level of Evidence II-B. Grade of Recommendation B).**

In the largest multicentric trial conducted on 150 women (39), if the HPD was <40 mm the likelihood of Cesarean delivery was 7% whereas it went up to 82% if the HPD was >50 mm. In the same study if the AoP was $>110^{\circ}$ the likelihhod of Cesarean delivery was 12% whereas it rose up to 62% if the AoP was $<100^{\circ}$

In a more recent study of the same population of 150 women with prolonged first stage of labor (37) the authors have shown that the OP position compared with non OP position was significantly associated with the risk of caesarean section (38% vs 17% p 0.01). **(Level of Evidence II-B. Grade of Recommendation B).**

Several case reports or small series (76-80) have shown that in patients with prolonged 1st or 2nd stage of labor transabdominal or transperineal ultrasound may identify different types of head malpresentation as a cause of labor arrest including deflexed presentation (brow or face) or asynclitism **(Level of Evidence III. Grade of Recommendation C).**

3.2 Slow progress or labor arrest in the 2nd stage of labor

There is a paucity of studies specifically addressing the usefulness of ultrasound in predicting the chance of spontaneous vaginal delivery compared with that of an abdominal or operative vaginal delivery in patients with prolonged 2nd stage. In 62 women with prolonged 2nd stage examined by transperineal ultrasound, Masturzo et al (73) have found that a favourable head direction (“head up”) was associated to spontaneous vaginal delivery in the vast majority of cases (16/20 or 80%) compared with the downward (4/20 or 20%) or horizontal (9/22 or 41%) head direction **(Level of Evidence II-B. Grade of Recommendation B).**

3.3 Ascertainment of the fetal head position and station before instrumental vaginal delivery

In a recent randomized controlled trial (28) it has been demonstrated that the use of ultrasound prior to the instrumental vaginal delivery is significantly more accurate than digital examination alone in the diagnosis of fetal head position (incorrect US diagnosis in 1.6% vs. 20.2% in the digital examination group) **(Level of Evidence I-C. Grade of Recommendation A).**

The study did not show significant differences in maternal or fetal morbidity. However, the main outcome in the study was the accuracy of determining fetal position, and the study was not powered to detect differences in the occurrence of adverse events (89).

In a RCT (90) Wong has demonstrated that when fetal head position was determined by US compared with by palpation the suction cup placement was significantly closer to the flexion point **(Level of Evidence I-C. Grade of Recommendation A).**

Head direction predicts the outcome of instrumental vaginal delivery (42). When evaluated before vacuum extraction in protracted labor, the “head up” sign was a positive predictor of successful vacuum extraction. Among 11 women with a head-up sign and an occiput anterior position, all of them had successful simple (5/11) or moderately difficult (6/11) vacuum extractions. On the other hand, among the six occiput anterior fetuses with head horizontal or down, there was only one simple vacuum extraction and the only case of failed extraction was observed in this group. The predictive value of the head up sign for vaginal delivery as well as its good intra- and inter-observer agreement were subsequently confirmed by others (41) **(Level of Evidence III. Grade of Recommendation C).**

The angle of progression has been investigated as a predictor of a successful vacuum delivery in 41 fetuses in OA position. A cut off value of 120° was found to predict an easy and successful vacuum extraction in 90% of women (43) **(Level of Evidence II-B. Grade of Recommendation B).**

In 52 women with OA fetuses submitted to vacuum delivery the combination of head up sign, midline angle <45° and a progression angle >120° were found to be significant sonographic predictors of a successful procedure (45).

Cuerva et al have assessed the role of ultrasound in predicting the outcome of forceps delivery in 30 non OP fetuses (46). They found that the smaller the angle of progression and the shorter the progression distance, the higher was the risk of failure. An angle of progression <138° and a progression distance <4.8 cm were the strongest predictors of the 9 complicated procedures (defined as more than 3 tractions, failed procedure, maternal or neonatal trauma) **(Level of Evidence II-B. Grade of Recommendation B).**

A large recent study (44) investigated the relationship between the angle of progression (immediately prior to instrument application) and the vacuum failure rate in 235 women. In 30 women vacuum failed (12%) compared with the 205 with successful vacuum. Failed vacuum delivery was associated with a significantly smaller median AoP (136.6 vs 145.9); interestingly, the palpated head station did not vary between the two groups (2 vs 2 cm) **(Level of Evidence II-B. Grade of Recommendation B).**

In an European prospective study (47) transperineal ultrasound and the duration of vacuum extraction in a cohort of women with slow progress in the second stage of labor were assessed. Among the 222 women included, the duration of vacuum extraction was significantly shorter in women with HPD ≤25 mm and the rate of Cesarean delivery was significantly lower among cases with HPD ≤35 mm vs those with HPD >35 mm (3.9% vs 22.0% p <0.01). The rate of Cesarean delivery was 35% if HPD >35 mm was combined with occiput posterior postion. Furthermore, the incidence of umbilical artery pH<7.1 was significantly higher in the infants submitted to vacuum delivery with HPD >35 mm.

In a prospective cohort study including 659 women the head perineum distance (here called perineum skull distance) was measured prior to operative vaginal delivery (48). HPD measurement of ≥40 mm was significantly associated with the occurrence of a difficult extraction after adjustment for parity, presentation type, and fetal macrosomia (odds ratio, 2.38; 95% confidence interval, 1.51-3.74; P = .0002). Based on the receiver operating characteristic curve analyses, perineum-to-skull ultrasound distance was a more accurate predictor of difficult operative delivery than digital vaginal examination (P = .036).

3.4 Visual confirmation of fetal head malpresentation

Deflexed cephalic presentations or asynclitism are a major cause of obstructed labor (13,14) and estimated to account for one third of Caesarean deliveries due to labor arrest (4-6, 8-10, 15-17). In these cases the diagnosis is traditionally based upon digital examinationin labor (91-93) although the use of ultrasound to support the clinical diagnosis has been recently reported (76-80). **(Level of Evidence III. Grade of Recommendation C).**

4. Summary

Ultrasound in active labor is not widely applied yet, even though studies have shown that ultrasound is more precise and reproducible than clinical examinations. Only ultrasound allows objective measurement and proper documentation of those findings obtained during the examination. Several sonographic parameters can be used during labor to assess mainly head station and position.

1. Head station, e.g. by AoP or HPD, can be measured objectively for an assessment of current status and as a baseline for longitudinal measurements. It can also help decide if successful operative vaginal delivery (OVD) is likely. Head station must be assessed transperineally, not transabdominally. HPD is easy to measure and reproducible. AoP (in degrees) measures exactly the same as head station expressed in centimeters from -2cm and +5cm (a direct conversion is possible) and has the potential to link US data to traditional assessment by palpation. HPD and AoP/head station correlate linearly (for high station to +1).

2. Head (and spine) position are more accurately assessed by transabdominal ultrasound than by digital palpation. The knowledge of head position in suspected delay or arrest of labor is important. Before operative vaginal delivery (OVD) when palpation is notoriously unreliable, the knowledge of head position is essential.

3. The MLA is assessed by transverse TP ultrasound and may be an important parameter before deciding if OVD can be attempted safely.

4. Head direction is assessed TP and may be an important parameter before deciding if OVD can be attempted safely.

The following situations will likely benefit from ultrasound in labor:

A. The need to assess status/progress of labor 1st/2nd stage. We would recommend to measure either AoP or HPD transperineally and to assess head position transabdominally.

B. The need to assess the “status” before deciding to do or before performing OVD: We would recommend to assess head position by TA US. Under these circumstances we also suggest to measure fetal station by TP US. The most reliable sonographic parameters to predict the outcome of the procedure are HPD and AoP. MLA and/or head direction may be also evaluated to predict further the likelihood of success of the extraction.

SUMMARY BOX:

What we know and what we don't

- We know that ultrasound allows more precise examination of fetal position and station than clinical examination.
- We know that women prefer ultrasound to digital examinations in labour.
- We know that transabdominal ultrasound is most commonly used for fetal lie and position, and transperineal ultrasound can be used for head station.
- We don't know how this knowledge impacts on the management of labor, maternal and neonatal outcomes.

5. **Report**

If an ultrasound examination is performed in labor, its results should be added to the clinical notes of the patient. For each sonographic evaluation the following data should be noted:

- Fetal viability and heart rate
- Presentation of the fetus (cephalic, transverse, breech, oblique)
- Whether any part of the placenta is seen between the presenting part and cervix

- Occiput and spine position

Based upon the judgement of the clinician, the following TP US parameters can be added in the second stage and, especially before OVD

(At rest or during contraction with maternal pushing; this should be noted)

- Angle of progression (AoP)
- Head-perineum distance (HPD)
- Head direction with respect to the pubic symphysis
- Midline angle (MLA)

This guideline was produced on behalf of the International Society of Obstetricians and Gynecologists (ISUOG) by:

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References

1) Friedman E. The graphic analysis of labor. Am J Obstet Gynecol 1954;68: 1568-75.

2) Friedman EA. Primigravid labor; a graphicostatistical analysis. Obstet Gynecol. 1955;6(6):567-89.

3) Friedman EA. Labor in multiparas; a graphicostatistical analysis. Obstet Gynecol. 1956;8(6):691-703

4) Zhang J, Troendle JF, Yancey MK. Reassessing the labor curve in nulliparous women. Am J Obstet Gynecol. 2002;187(4):824-8.

5) Zhang J, Landy HJ, Branch DW, et al. Contemporary patterns of spontaneous labor with normal neonatal outcomes: Consortium on safe labor. Obstet Gynecol 2010;116: 1281-7.

6) Segel SY, Carreno Ca Fau - Weiner SJ, Weiner Sj Fau - Bloom SL, Bloom Sl Fau - Spong CY, Spong Cy Fau - Varner MW, Varner Mw Fau - Rouse DJ, et al. Relationship between fetal station and successful vaginal delivery in nulliparous women. Am J Perinatol. 2012;29(9):723-30.

7) Hamilton EF, Simoneau G, Ciampi A, Warrick P, Collins K, Smith S, et al. Descent of the fetal head (station) during the first stage of labor. Am J Obstet Gynecol. 2015.

8) American College of Obstetricians and Gynecologists, Society for Maternal-Fetal Medicine, Caughey AB, Cahill AG, Guise JM, et al. Safe prevention of the primary cesarean delivery. Am J Obstet Gynecol. 2014;210(3):179-93.

9) Barber EL, Lundsberg LS, Belanger K, Pettker CM, Funai EF, Illuzzi JL. Indications contributing to the increasing cesarean delivery rate. Obstet Gynecol. 2011;118(1):29-38.

10) Spong CY, Berghella V, Wenstrom KD, Mercer BM, Saade GR. Preventing the first cesarean delivery: summary of a joint Eunice Kennedy Shriver National Institute of Child Health and

Human Development, Society for Maternal-Fetal Medicine, and American College of Obstetricians and Gynecologists Workshop. Obstet Gynecol. 2012;120(5):1181-93

11) Cohen WR. Influence of the duration of second stage labor on perinatal outcome and puerperal morbidity. Obstet Gynecol. 1977;49(3):266-9

12) Leveno KJ, Nelson DB, McIntire DD. Second-stage labor: how long is too long? Am J Obstet Gynecol. 2016 Apr;214(4):484-489. Cohen WR, Friedman EA. Perils of the new labor management guidelines. Am J Obstet Gynecol. 2015;212(4):420-7.

13) Stitely ML, Gherman RB. Labor with abnormal presentation and position. Obstet Gynecol Clin North Am. 2005;32(2):165-79.

14) Boyle A, Reddy UM, Landy HJ, Huang CC, Driggers RW, Laughon SK. Primary cesarean delivery in the United States. Obstet Gynecol. 2013;122(1):33-40.

15) Shin KS, Brubaker KL, Ackerson LM. Risk of cesarean delivery in nulliparous women at greater than 41 weeks' gestational age with an unengaged vertex. American Journal of Obstetrics and Gynecology. 2004;190(1):129-34.

16) Oboro VO, Tabowei TO, Bosah JO. Fetal station at the time of labor arrest and risk of caesarean delivery. J Obstet Gynaecol. 2005;25(1):20-2.

17) ACOG Practice Bulletin Number 49, December 2003: Dystocia and augmentation of labor.

18) Dupuis O, Silveira R, Zentner A, Dittmar A, Gaucherand P, Cucherat M, Redarce T, Rudigoz RC. Birth simulator: reliability of transvaginal assessment of fetal head station as defined by the American College of Obstetricians and Gynecologists classification. Am J Obstet Gynecol. 2005 Mar;192(3):868-74.

19) Dupuis O, Ruimark S, Corrine D, Simone T, Andre D, Rene- Charles R. Fetal head position during the second stage of labor: comparison of digital and vaginal examination and

transabdominal ultrasonographic examination. Eur J Obstet Gynecol Reprod Biol 2005; 123: 193–197.

20) Akmal S, Kametas N, Tsoi E, Hargreaves C, Nicolaides KH. Comparison of transvaginal digital examination with intrapartum sonography to determine fetal head position before instrumental delivery. Ultrasound Obstet Gynecol 2003; 21: 437–440

21) Sherer DM, Miodovnik M, Bradley S, Langer O. Intrapartum fetal head position I: comparison between transvaginal digital examination and transabdominal ultrasound assessment during the active stage of labor. Ultrasound Obstet Gynecol 2002; 19: 258–263

22) Sherer DM, Miodovnik M, Bradley KS, Langer O. Intrapartum fetal head position II: comparison between transvaginal digital examination and transabdominal ultrasound assessment during the second stage of labor. Ultrasound Obstet Gynecol 2002; 19: 264–268.

23) Souka AP, Haritos T, Basayiannis K, Noikokyri N, Antsaklis A. Intrapartum ultrasound for the examination of the fetal head position in normal and obstructed labor. J Matern Fetal Neonatal Med 2003; 13: 59–63.

24) Kreiser D, Schiff E, Lipitz S, Kayam Z, Avraham A, Achiron R. Determination of fetal occiput position by ultrasound during the second stage of labor. J Matern Fetal Med 2001; 10: 283–286.

25) Akmal S, Tsoi E, Nicolaides KH. Intrapartum sonography to determine fetal occipital position: interobserver agreement. Ultrasound Obstet Gynecol 2004; 24: 421–424.

26) Chou MR, Kreiser D, Taslimi MM, Druzin ML, El-Sayed YY. Vaginal versus ultrasound examination of fetal occiput position during the second stage of labor. Am J Obstet Gynecol 2004; 191: 521–524.

27) Ramphul M, Kennelly M, Murphy DJ. Establishing the accuracy and acceptability of abdominal ultrasound to define the foetal head position in the second stage of labour: a validation study. Eur J Obstet Gynecol Reprod Biol. 2012 Sep;164(1):35-9.

28) Ramphul M, Ooi PV, Burke G, Kennelly MM, Said SA, Montgomery AA, Murphy DJ. Instrumental delivery and ultrasound: a multicentre randomised controlled trial of ultrasound assessment of the fetal head position versus standard care as an approach to prevent morbidity at instrumental delivery. BJOG. 2014 Jul;121(8):1029-38

29) Sherer DM, Abulafia O. Intrapartum assessment of fetal head engagement: comparison between transvaginal digital and transabdominal ultrasound determinations. Ultrasound Obstet Gynecol. 2003 May;21(5):430-6.

30) Dietz HP, Lanzarone V. Measuring engagement of the fetal head: validity and reproducibility of a new ultrasound technique Ultrasound Obstet Gynecol 2005; 25: 165-168.

31) Ghi T, Farina A, Pedrazzi A, Rizzo N, Pelusi G, Pilu G. Diagnosis of station and rotation of the fetal head in the second stage of labor with intrapartum translabial ultrasound. Ultrasound Obstet Gynecol 2009; 33: 331–336.

32) Tutschek B, Torkildsen EA, Eggebo TM. Comparison between ultrasound parameters and clinical examination to assess fetal head station in labor. Ultrasound Obstet Gynecol 2013 Apr; 41 (4): 425-9.

33) Duckelmann AM, Bamberg C, Michaelis SA, Lange J, Nonnenmacher A, Dudenhausen JW, Kalache KD. Measurement of fetal head descent using the ‘angle of progression’ on transperineal ultrasound imaging is reliable regardless of fetal head station or ultrasound expertise. Ultrasound Obstet Gynecol 2010; 35: 216–222.

34) Eggebø TM, Gjessing LK, Heien C, Smedvig E, Økland I, Romundstad P, Salvesen KÅ. Prediction of labor and delivery by transperineal ultrasound in pregnancies with prelabor rupture of membranes at term. Ultrasound Obstet Gynecol 2006; 27: 387-391.

35) Eggebø TM, Heien C, Økland I, Gjessing LK, Romundstad P, Salvesen KÅ. Ultrasound assessment of fetal head-perineum distance before induction of labor. Ultrasound Obstet Gynecol 2008; 32: 199-204.

36) Torkildsen EA, Salvesen KÅ, Eggebø TM. Prediction of delivery mode with transperineal ultrasound in women with prolonged first stage of labor. Ultrasound Obstet Gynecol 2011; 37: 702–708.

37) Eggebø TM, Hassan WA, Salvesen KÅ, Torkildsen EA, Østborg TB, Lees CC. Prediction of delivery mode by ultrasound-assessed fetal position in nulliparous women with prolonged first stage of labor. Ultrasound Obstet Gynecol. 2015 Nov;46(5):606-10

38) Eggebø TM, Wilhelm-Benartzi C, Hassan WA, Usman S, Salvesen KA, Lees CC. A model to predict vaginal delivery in nulliparous women based on maternal characteristics and intrapartum ultrasound. Am J Obstet Gynecol. 2015 Sep;213(3):362.e1-6.

39) Eggebø TM, Hassan WA, Salvesen KÅ, Lindtjørn E, Lees CC. Sonographic prediction of vaginal delivery in prolonged labor: a two-center study. Ultrasound Obstet Gynecol. 2014 Feb;43(2):195-201. doi: 10.1002/uog.13210. Epub 2013 Dec 22.

40) Barbera AF, Pombar X, Perugino G, Lezotte DC, Hobbins JC. A new method to assess fetal head descent in labor with transperineal ultrasound. Ultrasound Obstet Gynecol 2009; 33: 313–319.

41) Tutschek B, Braun T, Chantraine F, Henrich W. A study of progress of labor using intrapartum translabial ultrasound, assessing head station, direction, and angle of descent. BJOG 2011;118:62–69.

42) Henrich W, Dudenhausen J, Fuchs I, Kamena A, Tutschek B. Intrapartum translabial ultrasound (ITU): sonographic landmarks and correlation with successful vacuum extraction. Ultrasound Obstet Gynecol 2006; 28: 753–760.

43) Kalache KD, Duckelmann AM, Michaelis SA, Lange J, Cichon G, Dudenhausen JW. Transperineal ultrasound imaging in prolonged second stage of labor with occipitoanterior presenting fetuses: how well does the ‘angle of progression’ predict the mode of delivery? Ultrasound Obstet Gynecol 2009; 33: 326–330.

44) Bultez T, Quibel T, Bouhanna P, Popowski T, Resche-Rigon M, Rozenberg P. Angle of fetal head progression measured using transperineal ultrasound as a predictive factor of vacuum extraction failure. Ultrasound Obstet Gynecol. 2016 Jul;48(1):86-91

45) Sainz JA, Borrero C, Aquise A, Serrano R, Gutiérrez L, Fernández-Palacín A. Utility of intrapartum transperineal ultrasound to predict cases of failure in vacuum extraction attempt and need of cesarean section to complete delivery. J Matern Fetal Neonatal Med. 2016;29(8):1348-52

46) Cuerva MJ, Bamberg C, Tobias P, Gil MM, De La Calle M, Bartha JL. Use of intrapartum ultrasound in the prediction of complicated operative forceps delivery of fetuses in non-occiput posterior position. Use of intrapartum ultrasound in the prediction of complicated operative forceps delivery of fetuses in non-occiput posterior position. Ultrasound Obstet Gynecol 2014 Jun;43(6):687-92.

47) Kahrs BH, Usman S, Ghi T, Youssef A, Torkildsen EA, Lindtjørn E, Østborg TB, Benediktsdottir S, Brooks L, Harmsen L, Romundstad PR, Salvesen KÅ, Lees CC, Eggebø TM. Sonographic prediction of outcome of vacuum deliveries: a multicenter, prospective cohort study. Am J Obstet Gynecol. 2017 Jul;217(1):69.e1-69.e10.

48) Kasbaoui S, Séverac F, Aïssi G, Gaudineau A, Lecointre L, Akladios C, Favre R, Langer B, Sananès N. Predicting the difficulty of operative vaginal delivery by ultrasound measurement of fetal head station. Am J Obstet Gynecol. 2017 May;216(5):507.e1-507.e9.

49) Blasi I, D'Amico R, Fenu V, Volpe A, Fuchs I, Henrich W, Mazza V. Sonographic assessment of fetal spine and head position during the first and second stages of labor for the diagnosis of persistent occiput posterior position: a pilot study. Ultrasound Obstet Gynecol. 2010 Feb;35(2):210-5.

50) Barbera AF, Imani F, Becker T, Lezotte DC, Hobbins JC. Anatomic relationship between the pubic symphysis and ischial spines and its clinical significance in the assessment of fetal head engagement and station during labor. Ultrasound Obstet Gynecol 2009; 33: 320–325.

51) Youssef A, Maroni E, Ragusa A, De Musso F, Salsi G, Iammarino MT et al. Fetal head-symphysis distance: a simple and reliable ultrasound index of fetal head station in labor. Ultrasound Obstet Gynecol 2013 Apr; 41 (4): 419-24.

52) Carseldine WJ, Phipps H, Zawada SF, Campbell NT, Ludlow JP, Krishnan SY, De Vries BS. Does occiput posterior position in the second stage of labor increase the operative delivery rate? Aust N Z J Obstet Gynaecol. 2013 Jun;53(3):265-70.

53) Wu JM, Williams KS, Hundley AF, Connolly A, Visco AG. Occiput posterior fetal head position increases the risk of anal sphincter injury in vacuum-assisted deliveries. Am J Obstet Gynecol. 2005 Aug;193(2):525-8

54) Pearl ML, Roberts JM, Laros RK, Hurd WW. Vaginal delivery from the persistent occiput posterior position. Influence on maternal and neonatal morbidity. J Reprod Med 1993; 38: 955–961.

55) Gei AF, Smith RA, Hankins GD. Brachial plexus paresis associated with fetal neck compression from forceps. Am J Perinatol 2003; 20: 289–291.

56) Mola GD, Amoa AB, Edilyong J. Factors associated with success or failure in trials of vacuum extraction. Aust N Z J Obstet Gynaecol 2002; 42: 35–39.

57) Vacca A, Keirse MJNC. Instrumental vaginal delivery. In: Chalmers I, Enkin M, Keirse MJN, editors. Effective care in pregnancy and childbirth. Oxford: Oxford University Press; 1989. p. 1216–1233.

58) Dupuis O, Silveira R, Dupont C, Mottolese C, Kahn P, Dittmar A, Rudigoz RC. Comparison of "instrument-associated" and "spontaneous" obstetric depressed skull fractures in a cohort of 68 neonates. Am J Obstet Gynecol. 2005 Jan;192(1):165-70.

59) Ramphul M, Kennelly MM, Burke G, Murphy DJ. Risk factors and morbidity associated with suboptimal instrument placement at instrumental delivery: observational study nested within the Instrumental Delivery & Ultrasound randomised controlled trial ISRCTN 72230496. BJOG. 2015 Mar;122(4):558-63

60) Donnelly V, Fynes M, Campbell D, Johnson H, O'Connell PR, O'Herlihy C. Obstetric events leading to anal sphincter damage. Obstet Gynecol. 1998 Dec;92(6):955-61.

61) MacLennan AH, Taylor AW, Wilson DH, Wilson D. The prevalence of pelvic floor disorders and their relationship to gender, age, parity and mode of delivery. BJOG. 2000 Dec;107(12):1460-70.

62) Olagundoye V, MacKenzie IZ. The impact of a trial of instrumental delivery in theatre on neonatal outcome. BJOG 2007; 114: 603–608.

63) Towner D, Castro MA, Eby-Wilkens E, Gilbert WM. Effect of mode of delivery in nulliparous women on neonatal intracranial injury. N Engl JMed 1999; 341: 1709–1714.

64) Alexander JM, Leveno KJ, Hauth J, Landon MB, Thom E, Spong CY, Varner MW, Moawad AH, Caritis SN, Harper M, Wapner RJ, Sorokin Y, Miodovnik M,O'Sullivan MJ, Sibai BM, Langer O, Gabbe SG; National Institute of Child Health and Human Development Maternal–Fetal Medicine Units Network. Fetal injury associated with cesarean delivery. Obstet Gynecol 2006; 108: 885–890.

65) Murphy DJ, Liebling RE, Patel R, Verity L, Swingler R. Cohort study of operative delivery in the second stage of labor and standard of obstetric care. BJOG 2003; 110: 610–615

66) Nizard J, Haberman S, Paltieli Y, Gonen R, Ohel G, Le Bourthe Y, Ville Y. Am J Obstet Gynecol 2009; 200:404.e1-5. Determination of fetal head station and position during labor: a new technique that combines ultrasound and a position-tracking system

67) Cunningham F, MacDonald PC, Gant NF, Leveno KJ, Gilstrap LC 3rd, Hankins GDV, et al. Anatomy of the reproductive tract. In: Licht J, editor. Williams obstetrics. Stamford (CT): Appleton & Lange; 1997

68) Bamberg C, Scheuermann S, Slowinski T, Dückelmann AM, Vogt M, Nguyen-Dobinsky TN, Streitparth F, Teichgräber U, Henrich W, Dudenhausen JW, Kalache KD. Relationship between fetal head station established using an open magnetic resonance imaging scanner and the angle of progression determined by transperineal ultrasound. Ultrasound Obstet Gynecol 2011; 37: 712-716.

69) Ghi T, Contro E, Farina A, Nobile M, Pilu G. Three-dimensional ultrasound in monitoring progression of labor: a reproducibility study. Ultrasound Obstet Gynecol 2010 Oct; 36 (4): 500-6

70) Molina FS, Terra R, Carrillo MP, Puertas A, Nicolaides KH. What is the most reliable ultrasound parameter for assessment of fetal head descent? Ultrasound Obstet Gynecol. 2010; 36: 493-9.

71) Youssef A, Bellussi F, Montaguti E, Maroni E, Salsi G, Morselli-Labate AM et al. Agreement between two- and three-dimensional methods for the assessment of the fetal head-symphysis distance in active labor. Ultrasound Obstet Gynecol 2013 Sep 4.

72) Dückelmann AM, Michaelis SA, Bamberg C, Dudenhausen JW, Kalache KD. Impact of intrapartal ultrasound to assess fetal head position and station on the type of obstetrical interventions at full cervical dilatation. J Matern Fetal Neonatal Med. 2012 May;25(5):484-8

73) Masturzo B, De Ruvo D, Gaglioti P, Todros T. Ultrasound imaging in prolonged second stage of labor: does it reduce the operative delivery rate? J Matern Fetal Neonatal Med. 2014 Oct;27(15):1560-3.

74) Eggebo TM, Heien C, Okland I, Gjessing LK, Smedvig E, Romundstad P, et al. Prediction of labor and delivery by ascertaining the fetal head position with transabdominal ultrasound in pregnancies with prelabor rupture of membranes after 37 weeks. Ultraschall Med. 2008;29(2):179-83

75) Ghi T, Bellussi F, Azzarone C, Krsmanovic J, Franchi L, Youssef A, Lenzi J,Fantini MP, Frusca T, Pilu G. The "occiput-spine angle": a new sonographic index of fetal head deflexion during the first stage of labor. Am J Obstet Gynecol. 2016 Jul;215(1):84.e1-7

76) Lau WL, Cho LY, Leung WC. Intrapartum translabial ultrasound demonstration of face presentation during first stage of labor. J Obstet Gynaecol Res. 2011;37(12):1868-71.

77) Lau WL, Leung WC, Chin R. Intrapartum translabial ultrasound demonstrating brow presentation during the second stage of labor. Int J Gynaecol Obstet. 2009;107(1):62-3.

78) Ghi T, Maroni E, Youssef A, Cariello L, Salsi G, Arcangeli T, et al. Intrapartum three-dimensional ultrasonographic imaging of face presentations: report of two cases. Ultrasound Obstet Gynecol. 2012;40(1):117-8

79) Malvasi A, Stark M, Ghi T, Farine D, Guido M, Tinelli A. Intrapartum sonography for fetal head asynclitism and transverse position: sonographic signs and comparison of diagnostic performance between transvaginal and digital examination. J Matern Fetal Neonatal Med. 2012 May;25(5):508-12.

80) Ghi T, Bellussi F, Pilu G. Sonographic diagnosis of lateral asynclitism: a new subtype of fetal head malposition as a main determinant of early labor arrest. Ultrasound Obstet Gynecol. 2015 Feb;45(2):229-31

81) Youssef A, Ghi T, Pilu G. How to perform ultrasound in labor: assessment of fetal occiput position. Ultrasound Obstet Gynecol. 2013 Apr;41(4):476-8

82) Akmal S, Tsoi E, Howard R, Osei E, Nicolaides KH. Investigation of occiput posterior delivery by intrapartum sonography. Ultrasound Obstet Gynecol 2004; 24: 425-428.

83) Rane SM, Guirgis RR, Higgins B, Nicolaides KH. The value of ultrasound in the prediction of successful induction of labor. Ultrasound Obstet Gynecol. 2004 Oct;24(5):538-49.

84) Armbrust R, Henrich W, Hinkson L, Grieser C, Siedentopf JP. Correlation of intrapartum translabial ultrasound parameters with computed tomographic 3D reconstruction of the female pelvis. J Perinat Med. 2016 Jul 1;44(5):567-71.

85) Arthuis CJ, Perrotin F, Patat F, Brunereau L, Simon EG. Computed tomographic study of anatomical relationship between pubic symphysis and ischial spines to improve interpretation of intrapartum translabial ultrasound. Ultrasound Obstet Gynecol. 2016 Dec;48(6):779-785.

86) Tutschek B, Braun T, Chantraine F, Henrich W. Computed tomography and ultrasound to determine fetal head station. Ultrasound Obstet Gynecol. 2017 Feb;49(2):279-280.

87) Maticot-Baptista D, Ramanah R, Collin A, Martin A, Maillet R, Riethmuller D. Ultrasound in the diagnosis of fetal head engagement. A preliminary French prospective study]. J Gynecol Obstet Biol Reprod (Paris). 2009 Oct;38(6):474-80

88) Popowski T, Porcher R, Fort J, Javoise S, Rozenberg P. Influence of ultrasound determination of fetal head position on mode of delivery: a pragmatic randomized trial. Ultrasound Obstet Gynecol. 2015;46(5):520-5

89) Ghi T, Youssef A. Does ultrasound determination of fetal occiput position improve labor outcome? BJOG. 2014 Sep;121(10):1312

90) Wong GY, Mok YM, Wong SF. Transabdominal ultrasound assessment of the fetal head and the accuracy of vacuum cup application. Int J Gynaecol Obstet. 2007;98(2):120-3

91) Jacobson LJ, Johnson CE. Brow and face presentations. Am J Obstet Gynecol. 1962;84(84):1881-6.

92) Cunningham GF LK, Bloom SL, Hauth JC, Rouse DJ, Spong CY. Labor and delivery. Williams Obstetrics 23rd Edition2010. p. 374-577

93) Akmal S, Paterson–Brown S. Malpositions and malpresentations of the foetal head. Obstetrics, Gynaecology & Reproductive Medicine. 2009;19(9):240-6

Figure legends:

Figure 1 Sagittal transabdominal scanning of a fetus in occiput-anterior (OA) position (image kindly provided by Dr. Aly Youssef).

Figure 2 Transverse transabdominal scanning of a fetus in occiput-posterior (OP) position (image kindly provided by Dr. Aly Youssef)

Figure 3: Classification of fetal occiput position based on a clock face: positions ≥02.30 and ≤03.30 hours should be recorded as left occiput transverse and positions ≥08.30 and ≤09.30 as right occiput transverse. Positions >03.30 and <08.30 should be recorded as occiput posterior and positions >09.30 and <02.30 as occiput anterior (, 82, 83).

Figure 4 Measurement of angle of progression. The figure illustrates where the transducer should be placed and how the angle is measured (image kindly provided by Drs. Aly Youssef, Erik Andreas Torkildsen and Torbjørn Moe Eggebø

Figure 5 Head direction is horizontal on the left image and up-wards on the right image. (Image kindly provided by Dr. Aly Youssef)

Figure 6 The transperineal ultrasound head station should be measured along the line indicating head direction. The angle of progression (AoP), the head-symphysis distance, and, as reference planes, the measurable infrapubic plane and the inferred ischial plane, are also shown (modified from 32)

Figure 7 Measurement of head-perineum distance. The figure illustrates where the tranducer should be placed and how the distance is measured (image kindly provided by Drs. Sigurlaug Benediktsdottir, Ingrid Frøysa and Johanne Kolvik Iversen)

Figure 8 Measurement of midline anlge. The figure illustrates were the trance user should be placed and how the angle is measured (Image kindly provided by Dr. Aly Youssef)

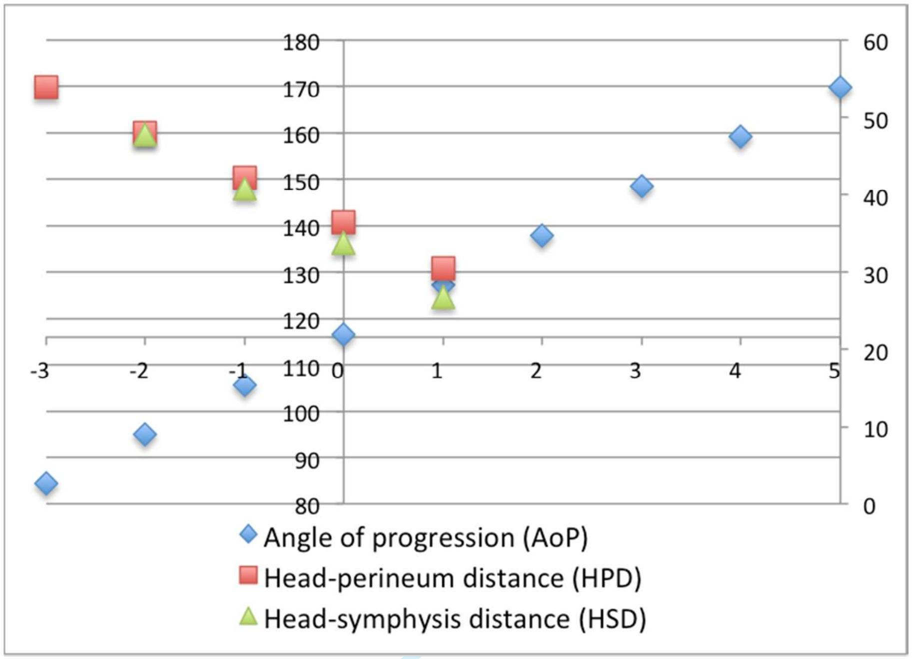
Figure 9 Measurement of progression distance. (image kindly provided by Dr. Aly Youssef)

Figure 10 Measurement of head-symphysis distance.. The figure illustrates were the transducer should be placed and how the distance is measured (image kindly provided by Aly Youssef)

Angle of descent (°)	ITU head station (in cm)
84	−3.0
90	−2.5
95	−2.0
100	−1.5
106	−1.0
111	−0.5
116	0.0
122	0.5
127	1.0
132	1.5
138	2.0
143	2.5
148	3.0
154	3.5
159	4.0
164	4.5
170	5.0

This table was calculated using the following formula, which was obtained by regression of head station over angle of descent: ITU head station (cm) = AoD (°) × 0.0937 − 10.911.

Tab. 1 Conversion between angle of progression (in degrees) and transperineal ultrasound head station (in centimeters) (from 41).



Tab. 2 Correlation of transperineal ultrasound head station, AoP/AoD, head-perineum distance and head-symphysis distance. X axis, transperineal ultrasound head station in cm +- level of the ischial spines; first Y axis, AoP/AOD in degrees; second Y axis, HPD and HSD in millimeters (data from 32)

Table 3. Indications for ultrasound examinations in active labor*

	Transabdominal scan	Transperineal scan	Recommendation Grade	Evidence level
Slow progress or arrest in 1. Stage (nulliparous women)	Head position		B	II-B
		Station (HPD or AoP)	B	II-B
Slow progress or arrest in 2. Stage (nulliparous women)	Head position		B	II-B
		Station (HPD or AoP)	B	II-B
Operative vaginal delivery and reassuring CTG (all women)	Head position		A	I-C
	Position of spine		C	III
		Station (HPD or AoP)	B	II-B
		Midline angle	B	II-B
		Head direction	C	III

*Repeated measurements are recommended in women with slow progress

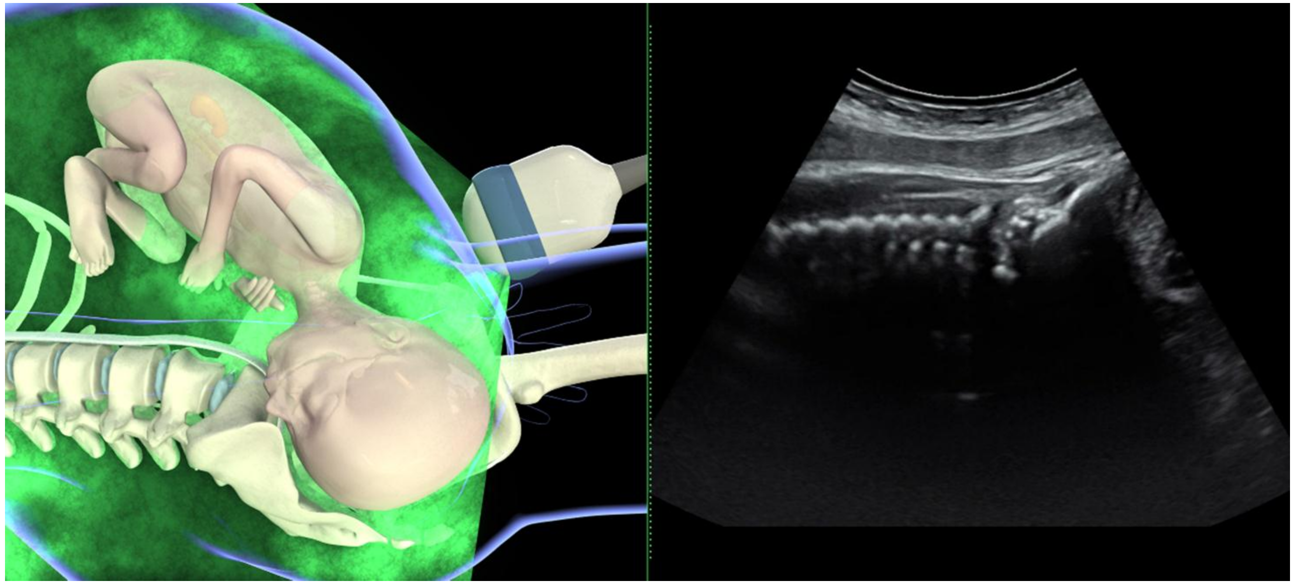


Figure 1 Sagittal transabdominal scanning of a fetus in occiput-anterior (OA) position (image kindly provided by Dr. Aly Youssef).

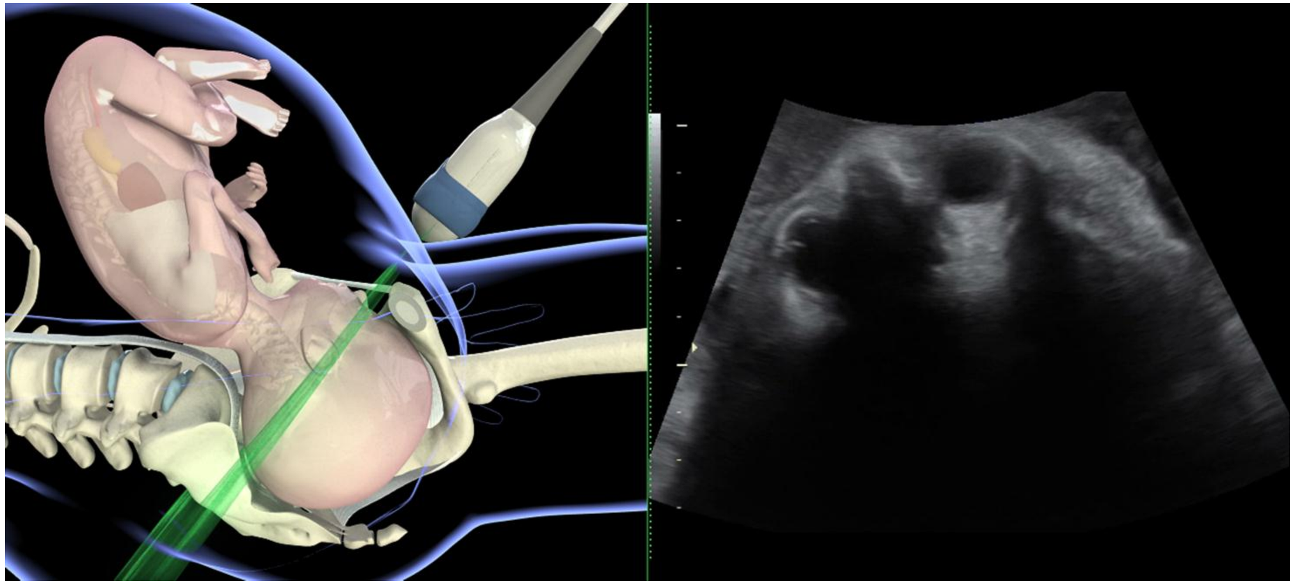


Figure 2 Transverse transabdominal scanning of a fetus in occiput-posterior (OP) position (image kindly provided by Dr. Aly Youssef)

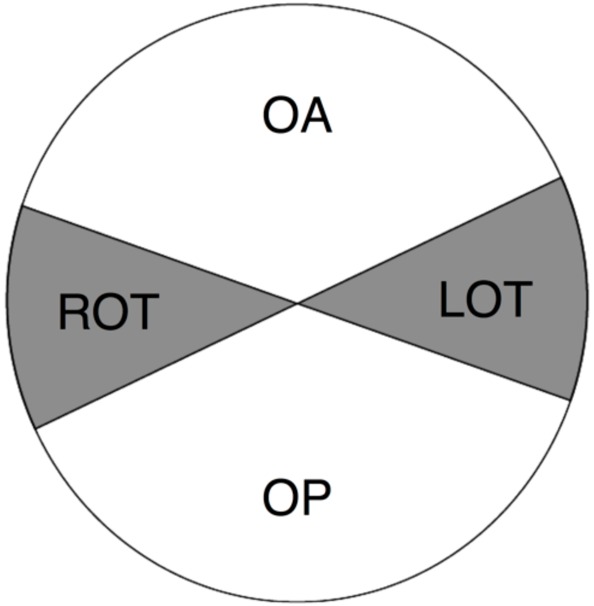


Figure 3: Classification of fetal occiput position based on a clock face: positions ≥02.30 and ≤03.30 hours should be recorded as left occiput transverse and positions ≥08.30 and ≤09.30 as right occiput transverse. Positions >03.30 and <08.30 should be recorded as occiput posterior and positions >09.30 and <02.30 as occiput anterior (, 82, 83).

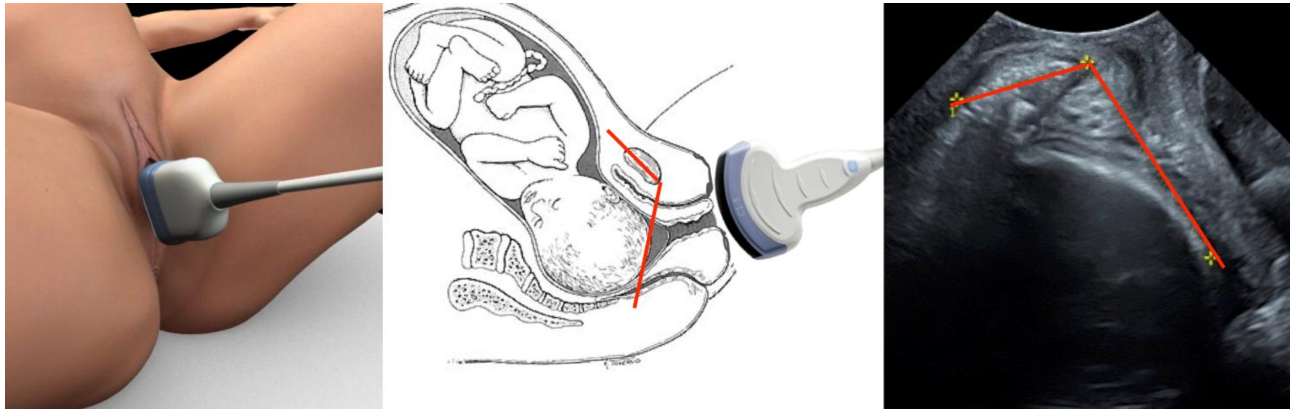


Figure 4 Measurement of angle of progression. The figure illustrates where the transducer should be placed and how the angle is measured (image kindly provided by Drs. Aly Youssef, Erik Andreas Torkildsen and Torbjørn Moe Eggebø

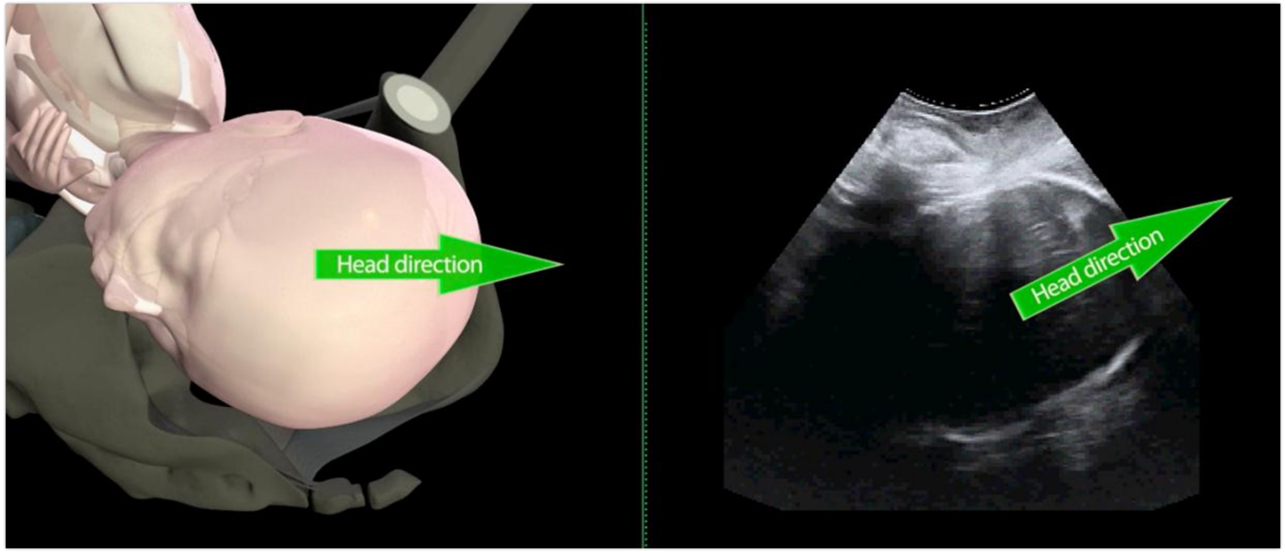


Figure 5 Head direction is horizontal on the left image and upwards on the right image. (Image kindly provided by Dr. Aly Youssef)

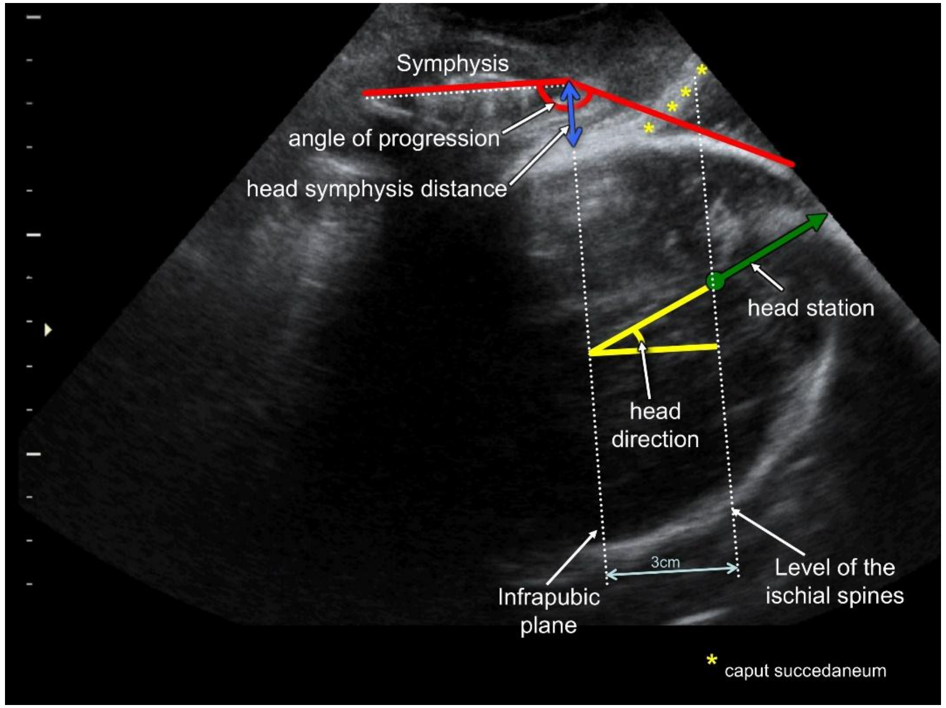


Figure 6 The transperineal ultrasound head station should be measured along the line indicating head direction. The angle of progression (AoP), the head-symphysis distance, and, as reference planes, the measurable infrapubic plane and the inferred ischial plane, are also shown (modified from 32)

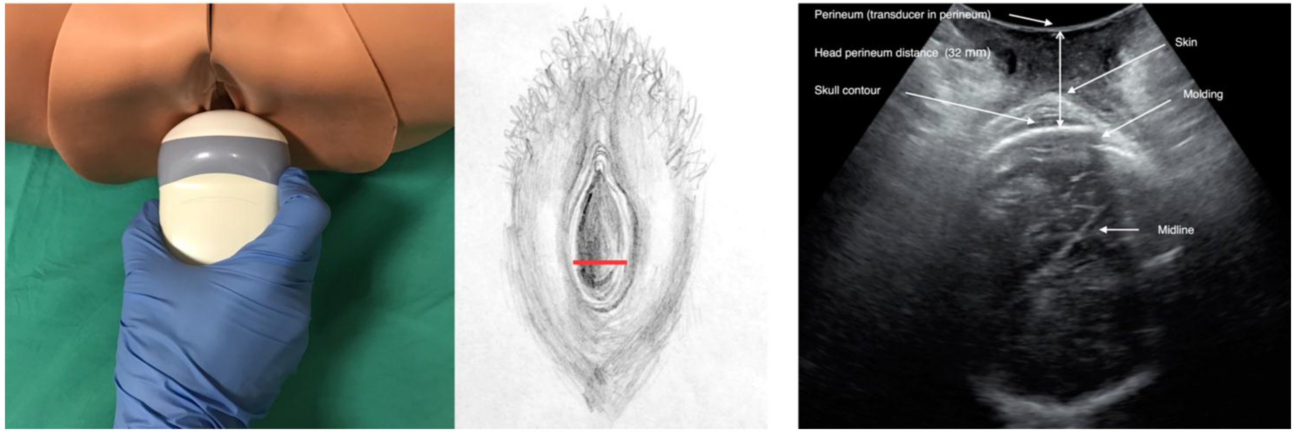


Figure 7 Measurement of head-perineum distance. The figure illustrates where the tranducer should be placed and how the distance is measured (image kindly provided by Drs. Sigurlaug Benediktsdottir, Ingrid Frøysa and Johanne Kolvik Iversen)

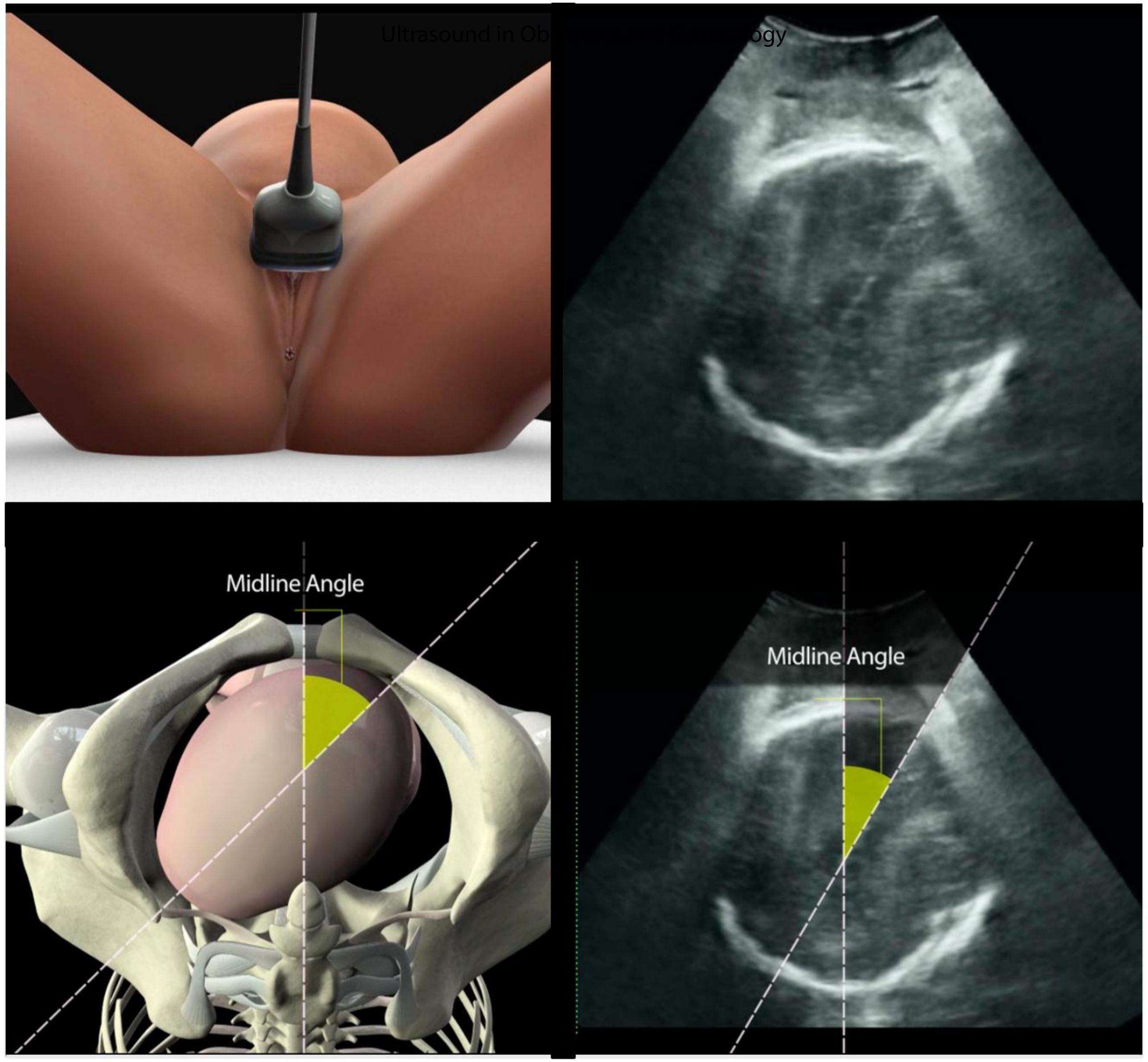


Figure 8 Measurement of midline anlge. The figure illustrates were the trance user should be placed and how the angle is measured (Image kindly provided by Dr. Aly Youssef)

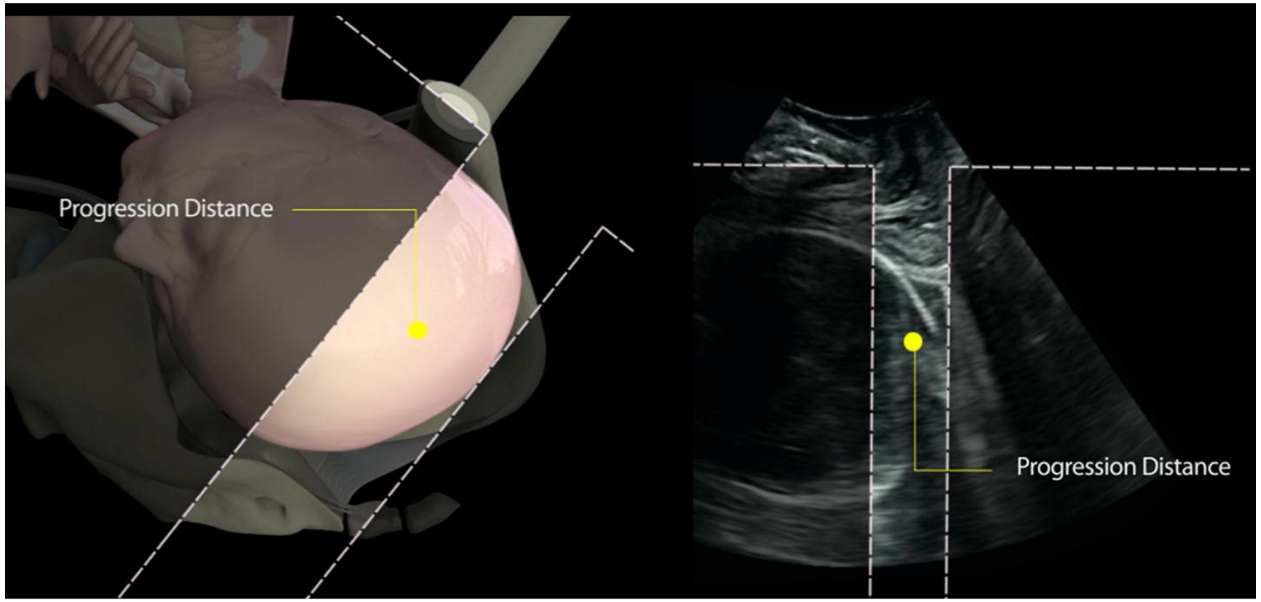


Figure 9 Measurement of progression distance. (image kindly provided by Dr. Aly Youssef)

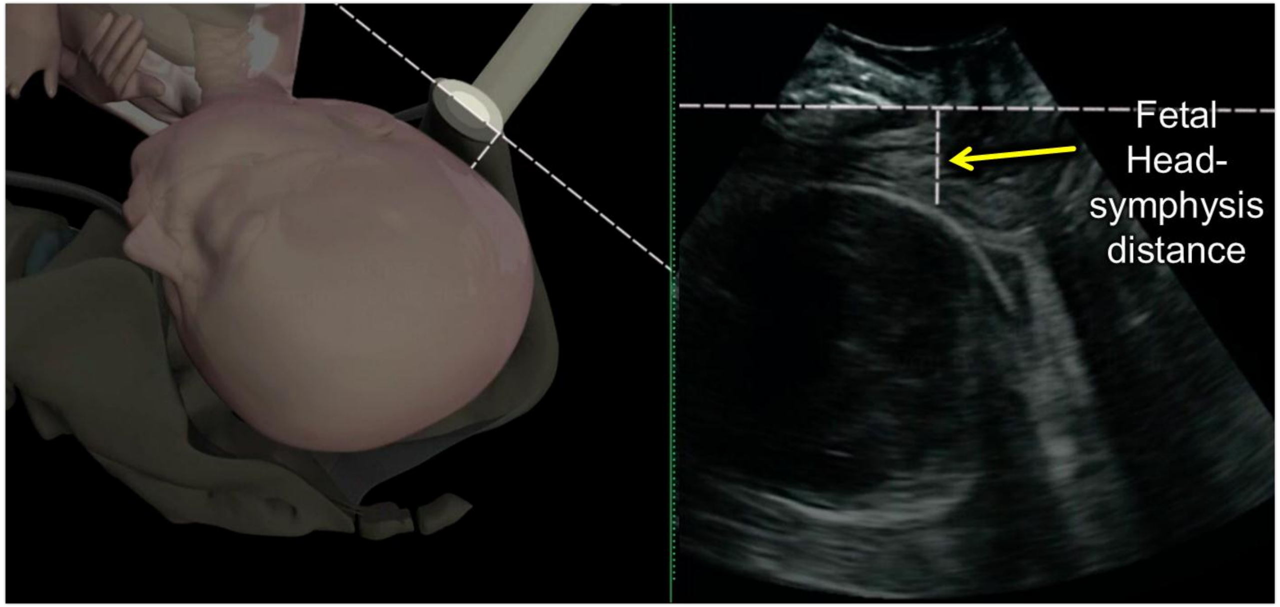


Figure 10 Measurement of head-symphysis distance.. The figure illustrates were the transducer should be placed and how the distance is measured (image kindly provided by Aly Youssef)

Appendix

Classification of evidence levels

1++	High-quality meta-analyses, systematic reviews of randomised controlled trials or randomised controlled trials with a very low risk of bias
1+	Well-conducted meta-analyses, systematic reviews of randomised controlled trials or randomised controlled trials with a low risk of bias
1–	Meta-analyses, systematic reviews of randomised controlled trials or randomised controlled trials with a high risk of bias
2++	High-quality systematic reviews of case–control or cohort studies or high-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal
2+	Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal
2-	Case–control or cohort studies with a high risk of confounding, bias or chance and a significant risk that the relationship is not causal
3	Non-analytical studies, e.g. case reports, case series
4	Expert opinion