Descent of the presenting part assessed with ultrasound

Torbjørn M. Eggebø, MD, PhD; Hulda Hjartardottir, MD, PhD

Fetal head descent can be expressed as fetal station and engagement. Station is traditionally based on clinical vaginal examination of the distal part of the fetal skull and related to the level of the ischial spines. Engagement is based on a transabdominal examination of the proximal part of the fetal head above the pelvic inlet. Clinical examinations are subjective, and objective measurements of descent are warranted. Ultrasound is a feasible diagnostic tool in labor, and fetal lie, station, position, presentation, and attitude can be examined. This review presents an overview of fetal descent examined with ultrasound.

Ultrasound was first introduced for examining fetal descent in 1977. The distance from the sacral tip to the fetal skull was measured with A-mode ultrasound, but more convenient transperineal methods have since been published. Of those, progression distance, angle of progression, and head-symphysis distance are examined in the sagittal plane, using the inferior part of the symphysis pubis as reference point. Head-perineum distance is measured in the frontal plane (transverse transperineal scan) as the shortest distance from perineum to the fetal skull, representing the remaining part of the birth canal for the fetus to pass. At high stations, the fetal head is directed downward, followed with a horizontal and then an upward direction when the fetus descends in the birth canal and deflexes the head. Head descent may be assessed transabdominally with ultrasound and measured as the suprapubic descent angle.

Many observational studies have shown that fetal descent assessed with ultrasound can predict labor outcome before induction of labor, as an admission test, and during the first and second stage of labor. Labor progress can also be examined longitudinally. The International Society of Ultrasound in Obstetrics and Gynecology recommends using ultrasound in women with prolonged or arrested first or second stage of labor, when malpositions or malpresentations are suspected, and before an operative vaginal delivery. One single ultrasound parameter cannot tell for sure whether an instrumental delivery is going to be successful. Information about station and position is a prerequisite, but head direction, presentation, and attitude also should be considered.

Key words: descent, engagement, head direction, labor outcome, station, ultrasound

Introduction

Fetal head descent can be expressed as fetal station and engagement. Examining station is based on the distal part of the fetal skull, and examining engagement is based on the proximal part. Friedman and Sachtleben[1–5] have published studies on the pattern of fetal head descent. Their important work was based on clinical digital estimation of the fetal head station in the pelvic cavity. The ischial spines and the leading fetal bony part were used as reference points, with a grading system from −5 to +5 cm. Fetal descent accelerated in nulliparous women when the cervix had reached 4 cm dilatation (Figure 1). The Friedman descent curve was implemented into partographs along with his dilatation curve and their use recommended worldwide.[6,7] A problem with using this grading system is that there is another system in use that divides the pelvic cavity into thirds from −3 to +3. Even though this system is less commonly used, caregivers may be confused unless the grading system used is clearly stated.[8] There has, recently, been reassessment of labor curves in contemporary obstetrical populations. The results of Zhang et al[9] showing both a slower fetal descent and cervical dilatation have led to the applicability of Friedman's labor curve being questioned. Similar results of slower and later descent were obtained in the study of Graseck et al,[8] who also updated the labor curves and stratified descent by parity and labor type.

Clinical vaginal methods for assessing descent

There are several problems connected with the clinical vaginal estimation of station. First, the ischial spines, used as the pelvic reference point, are not always easy to palpate, and many caregivers find it difficult to locate them. Second, 2 scoring systems have been in use. Third, 2 methods seem to be used for the reference point on the fetal head; the 1 most commonly used states that it is the leading bony point of the fetal head, which is gauged against the

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Received July 4, 2021; revised Aug. 15, 2021; accepted Aug. 19, 2021.

The authors report no conflict of interest.

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0002-9378

https://doi.org/10.1016/j.ajog.2021.08.030

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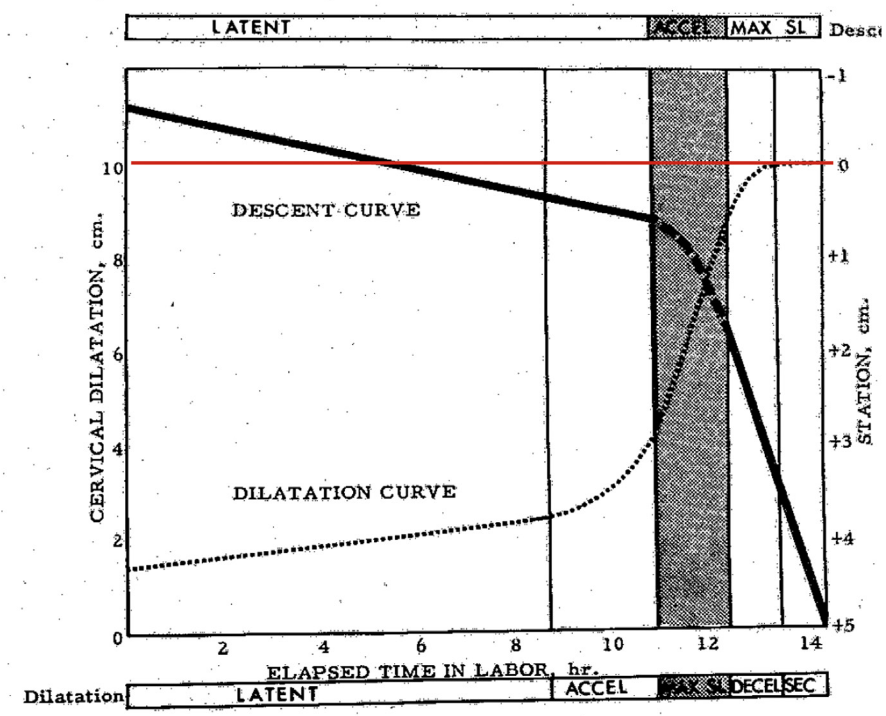
FIGURE 1
Pattern of descent by clinical assessment per the study of Friedman and Sachtleben[1]



Acceleration starts around 4 hours before delivery. The added *red line* shows the midpelvic level (station 0).

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ischial spines, but other caregivers have been taught that it is the biparietal diameter that is the reference point. Most caregivers are not aware of these 2 conflicting methods that may coexist within the same labor unit. This has recently been described in studies on both sides of the Atlantic.[10,11] A simulation study found that clinical transvaginal assessment of fetal head station was poorly reliable.[12] Another study investigating interobserver agreement in 508 women in term labor found that station could be estimated by both researchers in 88% of cases, agreement of station was found in 37% of cases, and disagreement by 1 cm in 47% of cases.[13] Researchers studying fetal head descent have for decades acknowledged the subjective nature of the method used and called for a more objective method than digital vaginal palpation.[1,9,14] During the last 20 years, several studies have been published describing various ultrasound methods that have been standardized and shown to be of use for this purpose.[15–19] An objective examination of fetal station is now possible, and several editorials have recommended to implement ultrasound as a diagnostic tool in labor care.[20–24]

Transperineal ultrasound methods to assess station

Lewin et al[25] from Paris were the first to examine fetal descent with ultrasound, and they published their work in 1977. The transducer was placed on the sacral tip, and they measured the distance from the sacrum to the fetal skull using A-mode ultrasound. Richey introduced the term transperineal sonography in 1995 and measured the distance from fetal skull to perineum in the sagittal plane.[26] In 1996, Voskresynsky[27] used ultrasound to examine biomechanics of labor. This work was presented as a thesis but unfortunately gained little attention because it was published in Russian. Transperineal scanning is demonstrated in Video.

Head progression distance

Dietz and Lanzarone[16] assessed engagement with translabial ultrasound. They used the new term translabial ultrasound instead of transperineal ultrasound introduced by Richey et al,[26] but translabial and transperineal ultrasound are 2 terms for the same ultrasound approach, and transperineal sonography is now recommended.[28] They used a line vertical to the central axis of the symphysis pubis placed at the inferior margin of the symphysis (infrapubic line) as reference and related the lowermost part of the fetal head to this line and called it the head progression distance (Figure 2).[16] A strong correlation with clinical assessments of engagement was found,[16] and the method could be used for antenatal prediction of operative deliveries.[29]

Head direction and intrapartum translabial ultrasound station

The first clinically useful method for intrapartum assessment of fetal descent was published in 2006 by Henrich et al.[18] They used a transperineal approach and examined the direction of the fetal head in relation to the symphysis pubis in 20 women before a vacuum extraction; 17 fetuses were in occiput anterior position and 3 were in occiput posterior position. At high stations, the fetal head is directed downward, followed with a horizontal and then an upward direction when the fetus descends in the birth canal and deflexes the head. They found the head up sign being a good prognostic factor for an easy operative vaginal delivery.[18]

This research group used a three-dimensional computer tomography reconstruction and found the level of the ischial spines corresponding to a line 3 cm below the infrapubic line.[30] They used this line as reference when measuring intrapartum translabial ultrasound station (Figure 3).[31] The fetal head position may affect the level of station where the head direction changes, because the pattern of descent is different between occiput anterior and occiput posterior positions.[32]

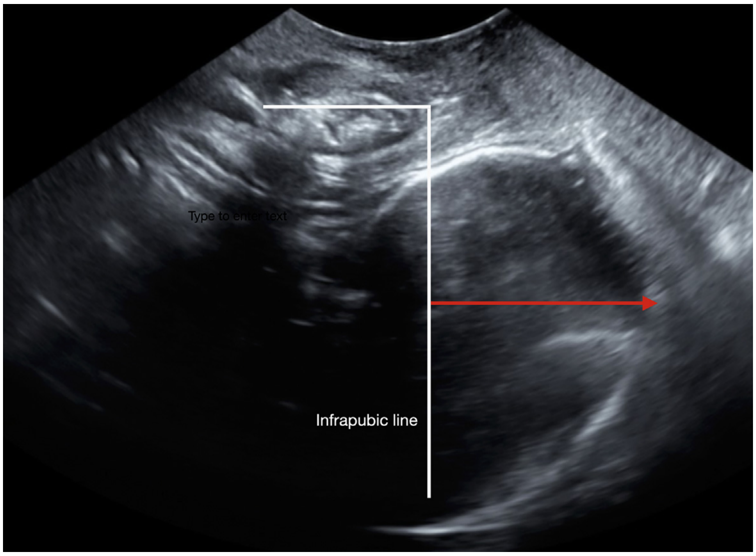
Angle of progression

Fetal descent can be measured with ultrasound as angle of progression (AoP), and this method was described by Barbera et al[15] in 2009. Fetal descent is measured transperineally as the angle between a line through the long axis of the symphysis pubis and a second line from the inferior end of the symphysis pubis tangentially to the contour of the fetal skull (Figure 4). In the original publication, the method was called angle of head descent. Labor is a dynamic process, and because the method can be used at all stations, labor progress can be examined; thus, the name has changed to AoP.

Barbera et al[15] measured the same angle in a geometric model from computed tomographic images in nonpregnant women and found an angle of 99° to correlate with the level of the ischial spines but found that clinical digital assessment of station correlated poorly with computed station.[33] Arthuis et al[34] studied computed tomographic images and found that the ischial spines correlated to AoP of 110°. Bamberg et al[35] related AoP measurements to the ischial spines obtained with magnetic resonance imaging in pregnant women. An angle of 120° was found to correlate to ischial spines.[35,36] The 2 methods were compared and showed a mean difference of only 1.4°. Tutschek et al[37] compared AoP with clinical assessments and found station zero to correlate with AoP of 116°. AoP is found to be the most reproducible ultrasound method examining fetal descent.[38]

Many observational studies have shown that AoP can be used to predict labor outcome before induction of labor, as an admission test, and during the first and second stage of labor.[39—48] The International Society of Ultrasound in Obstetrics and Gynecology recommends to use ultrasound in women with prolonged or arrested first or second stage of labor, when malpositions or malpresentations are suspected, and before an operative vaginal delivery.[49] However, the

FIGURE 2
Progression distance



A line vertical to the central axis of the symphysis pubis placed at the inferior margin of the symphysis (infrapubic line) is used as reference. The distance from this line to the lowermost part of the fetal head is called the progression distance (*red arrow*).

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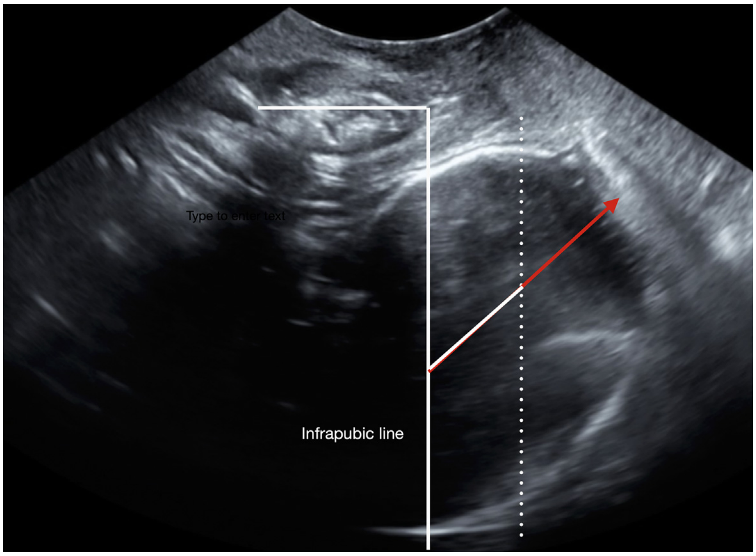
FIGURE 3
ITU in a fetus with head up sign



The midpelvic level (station 0) is 3 cm below the infrapubic line (*dotted line*). The intrapartum translabial ultrasound (ITU) station is the distance from the *dotted line* to the lowermost part of the skull following the head direction (*red arrow*).

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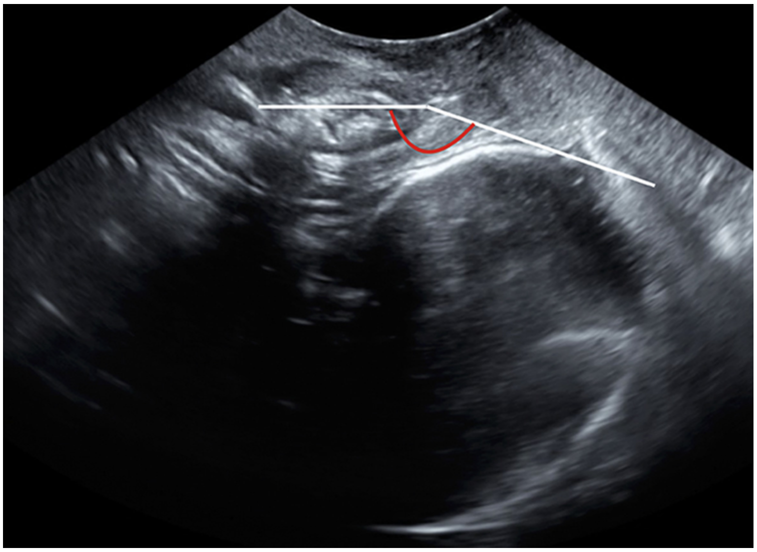
FIGURE 4
AOP



The AOP is measured as the angle between a line through the long axis of the symphysis pubis and a second line from the inferior end of the symphysis pubis tangentially to the contour of the fetal skull.

AOP, angle of progression.

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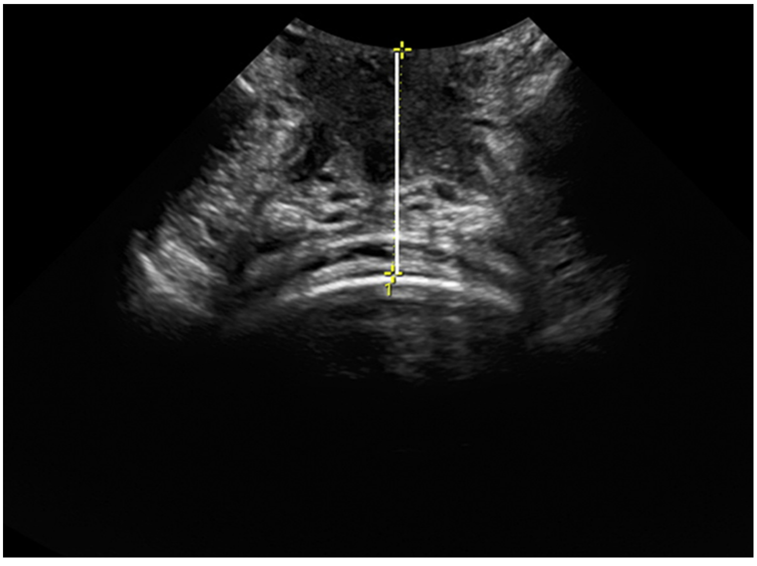
optimal cutoff level before an operative vaginal delivery is discussed, and angles varying from 120° to 145.5° are recommended in different studies.[15,50–53] In the original study, an angle >120°, measured during the second stage of labor, was associated with subsequent spontaneous vaginal delivery.[15] Kalache et al[50] examined 26 women with prolonged second stage of labor and fetuses in occiput anterior position and confirmed that a spontaneous delivery or an easy vacuum extraction occurred in 90% when the AoP was >120°. Bultez et al[53] examined 235 women and defined vacuum failure as duration of procedure >20 minutes or detachment of vacuum cup >3 times. The failure rate was below 5% if AoP was >145.5° in nulliparous women. Fetuses in all positions were included. It is a major limitation that inclusions and outcomes vary in the publications, and no studies have a randomized design.

FIGURE 5
HPD



HPD is measured in the frontal plane (transverse in perineum) as the shortest distance from the transducer to the fetal skull. The transducer should be placed between the labia and the soft tissue should be compressed.

HPD, head-perineum distance.

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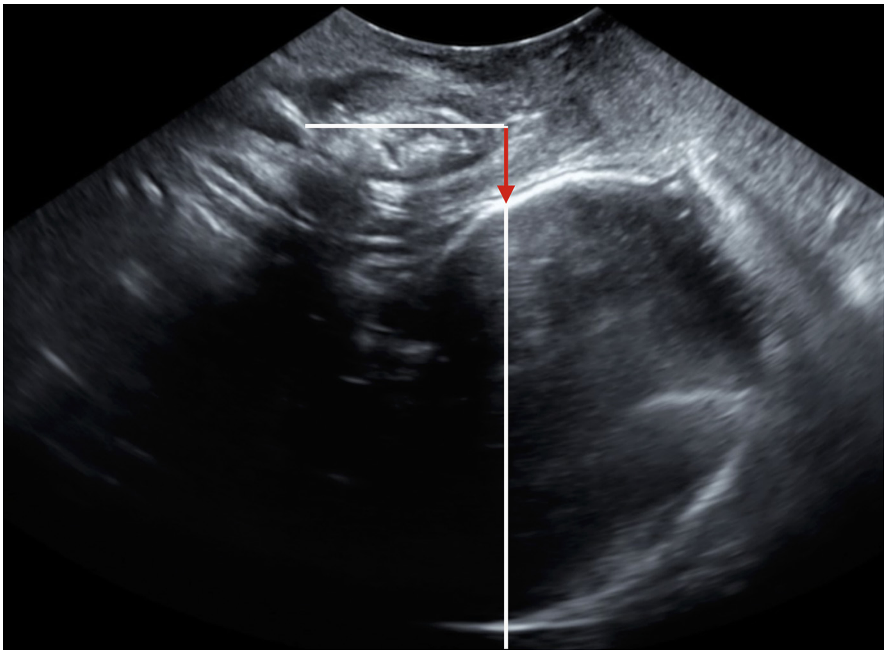
The predictive value of AoP may differ among fetuses in occiput anterior and occiput posterior positions.[32] In occiput posterior positions, the fetal head descends deeper in the birth canal before the third cardinal movement (flexion) starts compared with the third movement (extension) in occiput anterior positions.[54] Even when maximally flexed, the fetus in occiput posterior position cannot follow the curve of the birth canal as optimally as the fetus in occiput anterior position.[32,54] One single ultrasound parameter cannot tell for sure whether the instrumental delivery is going to be successful. Information about station and position is a prerequisite, but also head direction, presentation, and attitude should be considered.

Only 1 study has examined fetal descent with ultrasound in breech-presenting fetuses. The breech progression angle is measured in the same way as AoP. An angle between the long axis of the symphysis pubis and a line from the inferior part of the symphysis tangentially to the lowest part of the fetus can be measured, and the measurement was found to be feasible and highly reproducible.[55]

Head-perineum distance

Head-perineum distance (HPD) is a simple method measuring the remaining part of the birth canal for the fetus to pass. The ultrasound probe should be

FIGURE 6
HSD



HSD is the distance from the inferior part of the symphysis pubis to the fetal skull along the infrapubic line (*red arrow*).

HSD, head-symphysis distance.

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placed transversely between labia majora (in the fourchette), and the soft tissue should be compressed against the pubic bone and the transducer angled until the skull contour is as clear as possible, indicating that the ultrasound beam is perpendicular to the fetal skull. The shortest distance from the transducer to the fetal skull in the frontal plane should be measured (Figure 5).[45,49] The method was first published in 2006 by Eggebø et al,[17] who studied a population of women with prelabor rupture of membranes. The predictive value of time to delivery and delivery mode has later been investigated in observational studies before induction of labor, as an admission test, and in women with prolonged first and second stage of labor.[40,41,45–47,56] HPD of 60 mm corresponds to head station at the pelvic inlet, 36 mm corresponds to midcavity, and 20 mm corresponds to the pelvic outlet.[37,57] HPD ≤40 mm has been reported as cutoff level for high chance for a vaginal delivery in nulliparous women with a prolonged first stage of labor, and HPD ≤35 mm for a successful vacuum extraction.[45–47] HPD is simple to perform for examiners with little ultrasound experience because only one distance is measured, and good repeatability has been reported.[17,58] A French study from 2009 found an unengaged head corresponding to 68 mm, high-cavity station corresponding to 49 mm, and midcavity station corresponding to 38 mm.[59] Kasbaoui et al[60] used a similar method but called it perineum to skull distance and found a distance of ≥40 mm to be associated with a difficult extraction. The transducer was placed on the perineal body and the examiners did not compress the soft tissue in this study, which can explain why they found that a longer distance was compatible with an easy extraction compared with the findings of Kahrs et al.[46]

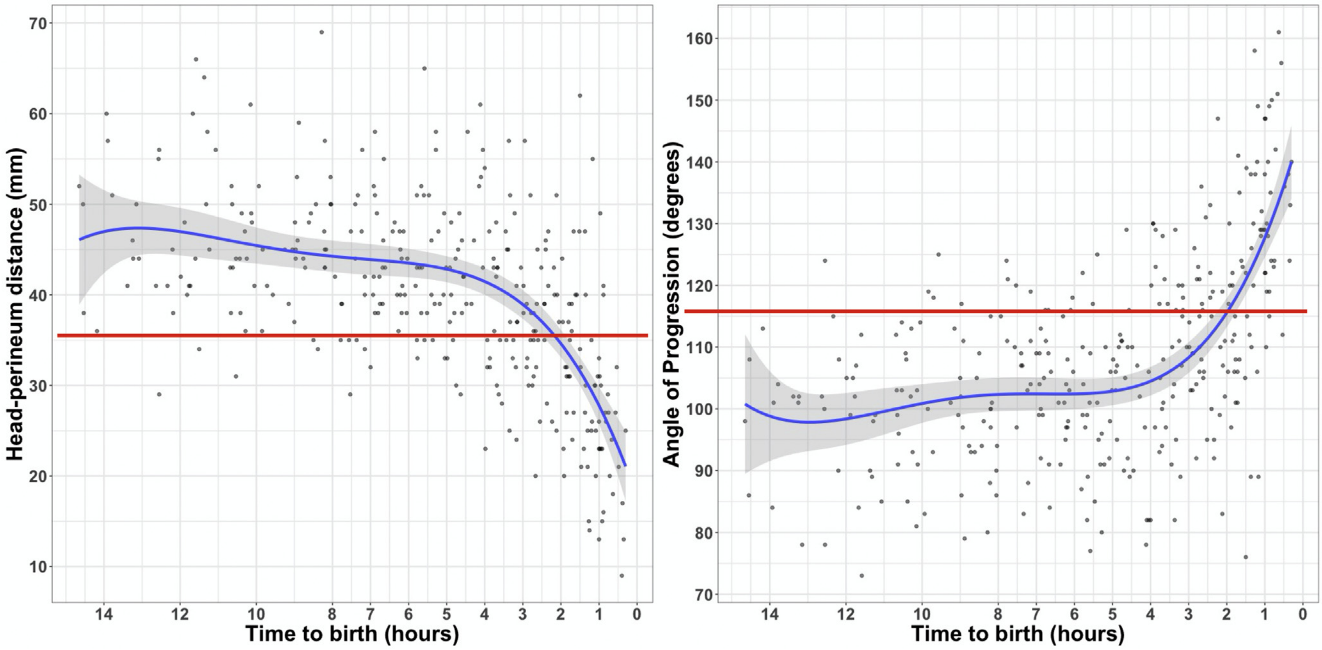
Head-symphysis distance

The distance between the symphysis pubis and the fetal head is a clinical marker for labor arrest, and Youssef et al[19] suggested to measure this distance with ultrasound, the head-symphysis distance (HSD) as shown in Figure 6. This examination is done in the sagittal transperineal plane and the distance from the symphysis pubis to the fetal head is measured along the infrapubic line. The original study found a good correlation with AoP.[19] The method cannot be used if the lowermost part of the fetal head is above the infrapubic line. In a study from Hong Kong with serial measurements of HSD, AoP, and HPD during early active phase of labor, a slower progression was found using all 3 ultrasound measurements in women ending with a cesarean delivery because of nonprogressive labor.[61] Another study showed that HSD used in the second stage could predict operative delivery,[62] and 2 more studies showed that HSD measured in the second stage could predict the likelihood of a spontaneous vaginal delivery.[40,63] A good correlation between the HSD, AoP, and HPD has been shown, and the level of the ischial spines corresponds to AoP 116°, HPD 36 mm, and HSD 34 mm.[37]

Clinical methods to assess descent transabdominally

Less attention has been paid to the part of the fetal head above the pelvic inlet. Engagement occurs when the widest part of the fetal head has descended below the pelvic inlet and is a prerequisite for an operative vaginal delivery.[64,65] The part of the fetal head above the pelvic inlet reflects the true descent of the largest diameter of the skull. The skull bones overlap during the passage through the birth canal and the fetal head becomes molded.[66] Because of molding, the leading bony part of the skull may be

FIGURE 7
Labor curves



Labor curves showing the fetal head station measured with ultrasound as the head-perineum distance measured in millimeters (left image) and angle of progression measured in degrees (right image) in nulliparous women with spontaneous onset of labor. The birth is at 0 hours and time from birth was calculated backward. The 95% confidence intervals are shaded. The added *red lines* show the midpelvic level (station 0).[75]

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below the ischial spines whereas the largest diameter of the fetal skull still remains above the pelvic inlet. An attempt of operative vaginal delivery in such a situation will be associated with risks. Thus, the transperineal assessments of fetal descent should be supplemented with a transabdominal examination.

The fifths method is used for clinical palpation of the fetal head above the pelvic inlet, and engagement occurs when only two-fifths of the head or less is palpable above the brim.[67] The fifths method is inexact and poorly reproducible,[68] but it is still used as the only method to assess descent in the World Health Organization partograph from 2020.[7]

Ultrasound methods to assess descent transabdominally

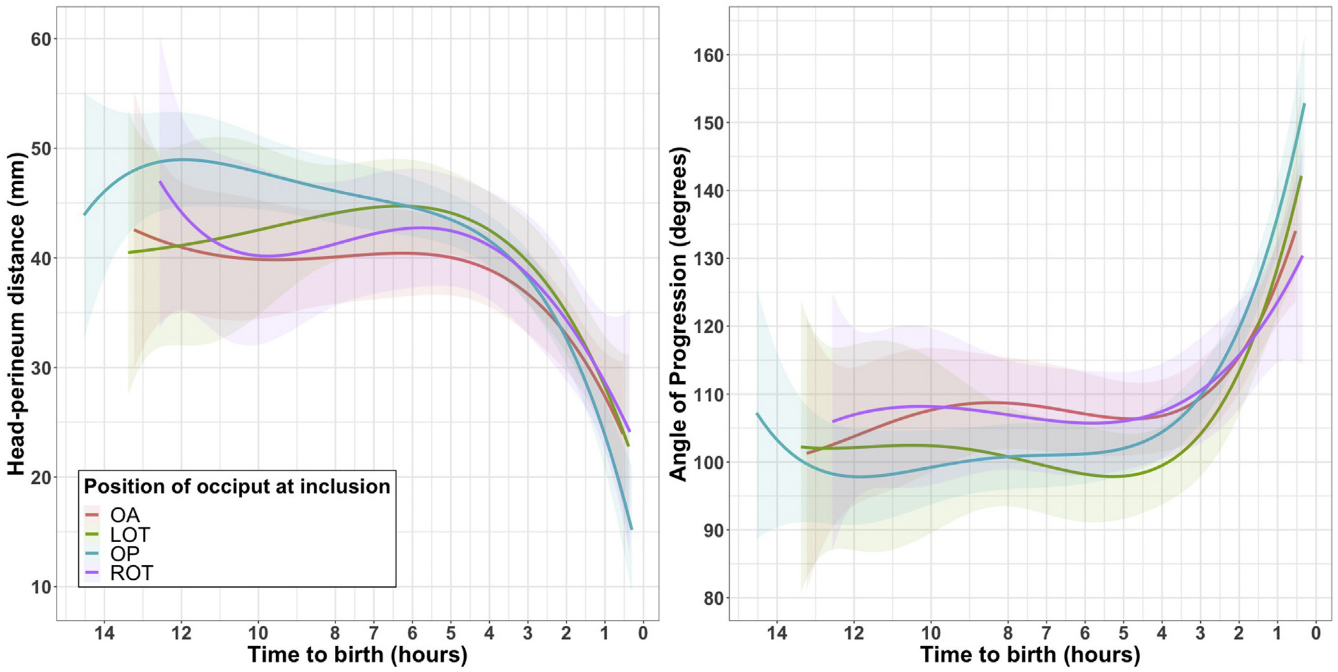
In 2003, Sherer and Abulafia[69] used transabdominal ultrasound to examine fetal engagement. They determined the pelvic inlet with the transducer placed transversely immediately above the symphysis pubis and directed toward the promontory. Unfortunately, they could not see the promontory with ultrasound during labor, and the transducer was angled toward a marked position between L5 and S1 vertebrae. Fetal head was considered not engaged if the biparietal diameter was above the described pelvic inlet. A high degree of agreement between ultrasound findings and clinical examinations was found. The method is quite complicated and has not gained much attention. Recently, it has been shown that the obstetrical conjugate can be measured at an antepartum consultation around pregnancy week 36, but the purpose of this ultrasound measurement is not to assess the head station but the pelvic size in relation to the risk of dystocia.[70] The measurement of the pubic arch angle is a method assessing the shape of the pelvis.[71,72]

It is possible to examine the fifths above the pelvic inlet with transabdominal ultrasound, but the lowermost part of the fetal skull is difficult to visualize transabdominally.[73] Kamel et al[74] have suggested to measure fetal descent with transabdominal ultrasound as the angle between a longitudinal line through the symphysis pubis and a line from the upper part of the symphysis pubis extending tangentially to the fetal skull (the suprapubic descent angle). The method is a mirror of AoP, but the superior edge of the symphysis pubis is used as reference instead of the inferior part. A strong correlation was found between the suprapubic descent angle and AoP.[74]

Ultrasound descent patterns

Hjartardottir et al[75] published descent patterns in nulliparous women with

FIGURE 8
Labor curves



Labor curves showing patterns of fetal head station measured with ultrasound as the head-perineum distance measured in millimeters (left image) and angle of progression measured in degrees (right image) in nulliparous women with spontaneous onset of labor at term and also delivering spontaneously, stratified by the fetal occiput position at inclusion.
The birth is at 0 hours and time from birth was calculated backward. The 95% confidence intervals are shaded.[75]

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spontaneous start of labor using AoP and HPD to assess fetal head station. The ultrasound descent patterns were similar in shape to the clinical curves from Friedman but with some differences (Figure 7). The ultrasound-assessed station was slightly higher and above the midpelvis at the start of the active phase. In Friedman's study, the fetal head was on average considered to be below the ischial spines when the active phase of labor was reached.[1] Hamilton et al[14] found a linear association between clinical assessments of cervical dilatation and fetal descent; however, the ultrasound study showed a nonlinear association and a rapid descent starting when the cervix was 7 to 8 cm dilated, ending with delivery on average 4 hours later. The acceleration of descent started slightly later than in Friedman's curves. In initial occiput posterior positions, the fetal head was higher throughout the early part of the active phase of labor (Figure 8). However, the rapid descent pattern in women delivering spontaneously was similar to the pattern in occiput anterior positions. The descent was only slightly slower in women with epidural analgesia (Figure 9). Fetal descent was slower in labors ending with an operative vaginal delivery than spontaneous delivery, and in labors ending with cesarean delivery owing to arrested labor, the fetal head did not descend (Figure 10). The importance of observing the descent patterns increases at the end of the first stage and especially during the second stage, when the pattern of cervical dilatation can no longer be used as a guide to progress. Ultrasound descent may be incorporated into a sonopartogram, an idea which has already been published.[76]

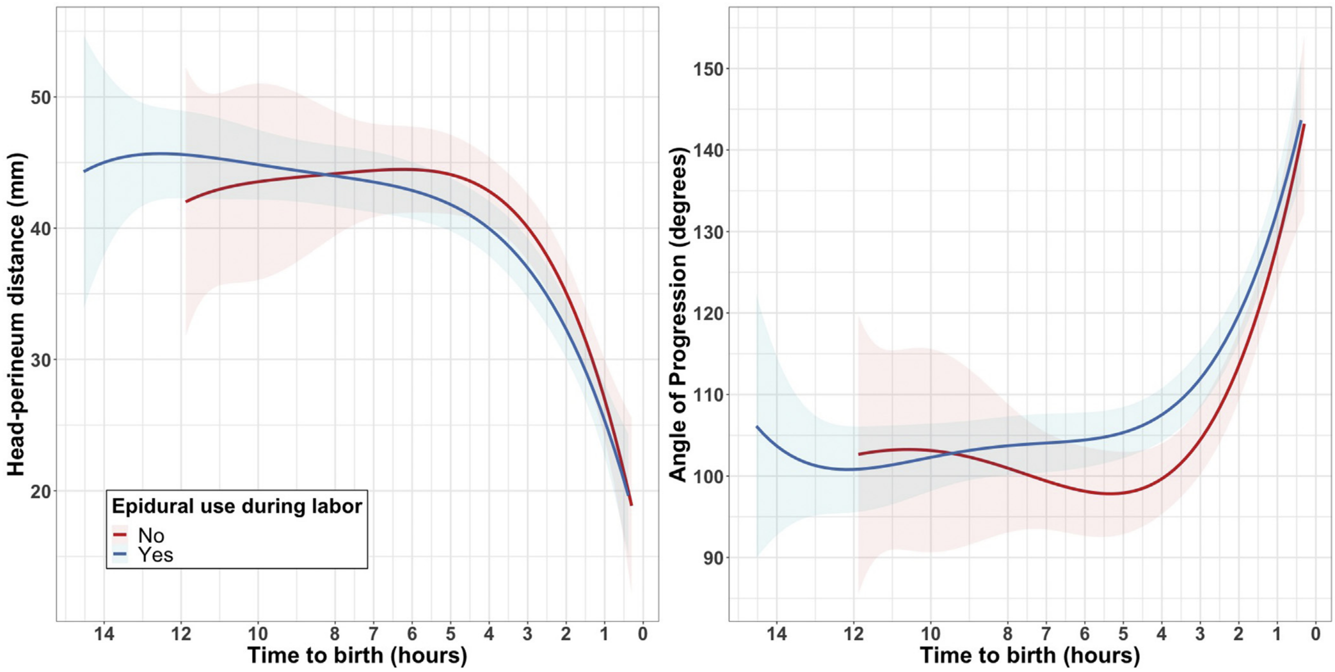
Dynamic ultrasound assessments of descent

Usually, the ultrasound examinations are done between contractions, but labor is a dynamic process, and changes in descent can be examined (Figure 11).[18] Minimal or no fetal head descent during active pushing has been found to be associated with longer duration of operative vaginal delivery and higher frequency of cesarean deliveries.[77] Insufficient pushing technique may even lead to upward movement of the fetal head caused by coactivation of the levator ani muscle, and ultrasound can be used in guiding women during bearing down efforts.[78–80]

Adding rotational information to descent

An ultrasound examination should not only include assessment of fetal station, because rotational movements are

FIGURE 9
Labor curves



Labor curves showing the patterns of the fetal head station measured with ultrasound as the head-perineum distance measured in millimeters (left image) and angle of progression measured in degrees (right image) in nulliparous women with spontaneous onset of labor at term and also delivering spontaneously, stratified by the use of epidural analgesia. The birth is at 0 hours and time from birth was calculated backward. The 95% confidence intervals are shaded.[75]

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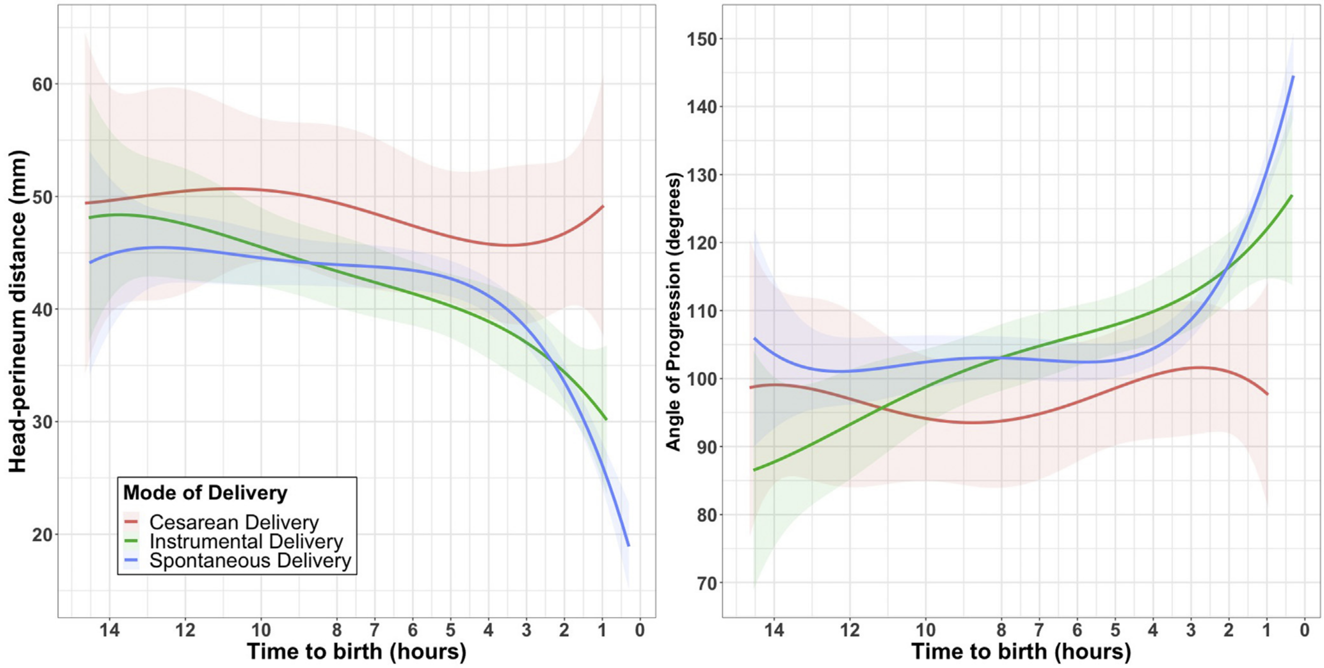
necessary for the fetus to descend. These rotational movements of the fetal head and shoulders are often called the cardinal movements. In the modern Anglo-American tradition, it is common to cite 7 cardinal movements.[81] Engagement is called the first movement, and descent is the gradual passage of the fetus through the birth canal and is called the second movement. The next 4 movements are flexion, internal rotation, extension, and rotation, and expulsion of the fetus is called the seventh movement. In German and older English literature, only the 4 actual rotational movements are called cardinal movements (change in attitude and position).[82–84] Fetal position and attitude can be examined with ultrasound.[85–91] Lack of descent is often caused by malpositions and malpresentation and not only insufficient contractions.[89,92–95] Asynclitism is associated with slow labor progress and arrested labors.[96] Anterior asynclitism is physiological during the early stages of labor but a malpresentation at low stations.[97] Posterior asynclitism is incompatible with a vaginal delivery.[98] A combination of maternal and fetal variables should be used in predictive models.[99,100]

Comments

During the last 20 years, methods where ultrasound is used to assess fetal descent have been standardized and tested. Because ultrasound equipment is becoming increasingly portable, the methods may be used during labor and offer ease of use, objectivity, and less invasiveness than the conventional, subjective clinical methods. In addition, the assessments and progress can be documented in hospital records, which is especially important when operative assistance is needed. Many observational studies have shown that ultrasound can predict delivery mode and duration of remaining time in labor. Ultrasound labor patterns in nulliparous women with spontaneous labor onset have been published.[75] Because of the differences in labor patterns and outcomes among various groups of laboring women, Robson[101] has suggested to differentiate women into 10 groups, of which only the first group has been studied longitudinally with ultrasound.[8] New longitudinal ultrasound studies in other groups, such as parous women, induced labors, women with a previous cesarean delivery, and twin deliveries are needed. One study has examined fetal station in breech presentations with ultrasound.[55] Fetal descent during the latent phase should also be investigated.

No randomized ultrasound studies have investigated fetal descent. Several randomized ultrasound studies have investigated fetal position,[102–105] and it has been shown that ultrasound is more precise than clinical examinations.[102]

FIGURE 10
Labor curves



Labor curves showing the fetal head station measured with ultrasound as the head-perineum distance measured in millimeters (left image) and angle of progression measured in degrees (right image) over time in nulliparous women with spontaneous onset of labor, stratified by mode of delivery. The birth is at 0 hours and time from birth was calculated backward. The 95% confidence intervals are shaded.[75]

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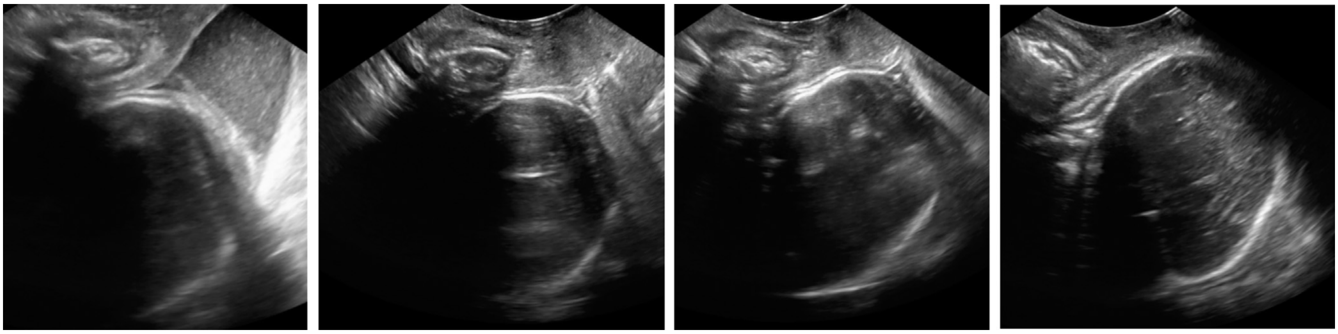
However, maternal or fetal outcomes were not improved in any of the studies. Adverse outcomes are rare, and very large randomized studies will be needed. This will be challenging to do, because it is not easy to include women in active labor into randomized studies.[104] More studies should focus on maternal satisfaction. Transperineal ultrasound is well accepted by women and preferred to clinical vaginal examinations.[106,107] A randomized controlled trial found significantly lower anxiety and pain score when examined with transperineal ultrasound than with clinical examinations during the latent phase.[108] Ultrasound should not replace clinical examinations, but

FIGURE 11
Longitudinal assessment of labor progress



In the left image, the membranes are not ruptured, and the amniotic fluid may be observed in front of the head. In the next 3 images, labor progress may be observed as the fetal head moves under the symphysis pubis.

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the number of vaginal examinations can be reduced.

Conclusion

We conclude that ultrasound examinations of fetal descent add knowledge and certainty in the assessment of the laboring woman and her fetus. This knowledge is further enhanced when combined with information about fetal position and presentation. However, knowledge is not enough; the clinicians also need to understand how to use the knowledge achieved by ultrasound, and this should be the focus of continuing research.[109,110] ■

ACKNOWLEDGMENT

The authors would like to thank Johanne Kolvik Iversen for the ultrasound acquisitions.

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