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REVIEW ARTICLE

INTRAPARTUM SONOGRAPHY: AN OPPORTUNITY FOR OBJECTIVE ASSESSMENT OF LABOUR

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INTRODUCTION

Today, antenatal ultrasound is a necessary tool for screening and diagnosis in pregnancy. It is extensively used for fetal chromosomal risk assessment, fetal anatomy, biometry, placental localization and presentation in singleton and multiple pregnancies. It is essential for intrauterine invasive procedures and for the management of growth-restricted foetuses.

Ultrasound during labour (or intrapartum ultrasound) has been explored in the last decade, from simple uses such as determination of fetal presentation and identifying the fetal heart beat during labour to advanced topics like prediction of the mode of delivery, fetal head station and assessment of cervical dilatation.

Using intrapartum ultrasound, obstetrics has the opportunity to develop into an objectively guided skill. Assessment of fetal head descent no longer needs to rely on an imaginary line drawn between the ischial spines, and even cervical dilatation might possibly be measured accurately using simple two-dimensional (2D) ultrasound.

We here review published data on intrapartum ultrasound. These publications describe the current methodology and techniques in the assessment of fetal head descent and cervical dilatation in labour.

ASSESSMENT OF FETAL HEAD ENGAGEMENT, DESCENT AND ROTATION

Conventional methods have been used to assess fetal head engagement, head station and head (occiput) position.

Engagement of the fetal head

Engagement of the fetal head is said to have occurred when the largest diameter of the presentation has passed through the brim of the pelvis.[1] Palpation of the presenting

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fetal head in relationship to the maternal pelvis is attributed to Christian Leopold (1846–1911); his proposed external palpation included the fourth Leopold manoeuvre, which determines the relationship between the fetal head and the pelvic inlet.

Crichton introduced the concept of "fifths" of the fetal head palpable abdominally to quantify fetal head descent by abdominal palpation and vaginal examination[2]. It is based upon a basovertical diameter extending from the base of the skull to the most distant point of the vertex. This technique requires a full knowledge of – and palpatory access to – the landmarks on the fetal head and on the pelvis: the occiput and the sinciput for the fetal head, and the upper border of the pubic symphysis for the pelvis.

This technique and similar methods have become essential tools in the management of labour and in the conduct of operative vaginal deliveries[3]. However, Crichton highlighted that this method has common pitfalls in practice such as the incorrect alignment of the examiner's hands and arms during abdominal palpation; that the fingers must be held parallel to the surface of the abdomen; problems in quantifying the amount of pressure applied by the fingers; and, most importantly, the technique is not effective when the occiput is posterior. Moreover, it is known that in clinical practice it is impossible to palpate or ascertain precisely what is the largest diameter of the presenting fetal part[2].

Fetal head station

Fetal head station describes the level of the fetal head on its descent through the birth canal. The assessment of fetal head station is not easy. First, the assessment cannot be made abdominally, i.e. vaginal examinations are essential; second, identifying the landmarks on the fetal skull becomes inaccurate in the presence of a caput succedaneum and moulding; and, third, palpation of the pelvic landmarks is poorly reproducible[2].

Digital vaginal examinations are also used for assessing fetal head engagement[4]. The fetal head is considered engaged on digital vaginal examination when the presenting part has reached the level of the maternal ischial spines; this level is referred to as "station 0"[5].

Accuracy of head station palpation

Dupuis *et al.*, using a birth simulator, studied the reliability of digital vaginal examinations for 32 less experienced obstetricians (average experience of 2 years) and 25 experienced obstetricians (average experience of 9 years) in the assessment of fetal head engagement and station. In a birth canal simulator equipped with real-time sensor, a fetal head mannequin was placed in 11 possible fetal stations[6]. The operators determined the head position and station by digital examination. Residents and experienced obstetricians palpated incorrect head stations (in cm) in 50–88% and 36–80% for different stations, respectively. More importantly, "high" stations were palpated as "mid" or "low" in 22.4% and 16%, respectively[6]. Conversely, true "mid" and "low" stations were falsely palpated as "high" in 17.8% and 18.1%, respectively. The mean "group" error for residents was 30% and for obstetricians it was 34%[6].

Head (occiput) position

Head position describes the position of the fetal occiput with regard to the maternal pelvis: occiput anterior (OA), occiput posterior (OP) or any position in between. Accuracy of occiput palpation has been assessed using intrapartum ultrasound (see below).

Using ultrasound to assess the parameters before and during labour

Ultrasound has also been used to measure the parameters described above, either before labour with a view to predicting success of an attempted vaginal delivery or, in a more detailed fashion, to quantify birth progress. Transabdominal ultrasound in the context of intrapartum ultrasound was used to assess the fetal head position and rotation and the fetal spine, while transperineal or translabial ultrasound was used to measure fetal head station and head direction and their changes during contractions, the angle of progression (or angle of descent) of the fetal head, the fetal head–perineum distance, the head–symphysis distance and in the assessment of cervical dilatation. These aspects will be explained in-depth in the paper.

Pre-labour studies

Dietz *et al.*[7,8] used a uro-gynaecological approach (bladder neck mobility) to assess pelvic organ mobility in relation to vaginal birth[8] and also suggested using the pubic symphysis as a reference point in the birth canal[7]. They assessed fetal head engagement by translabial ultrasound in a prospective study of 139 nulliparous women[7]. The assessment consisted of abdominal palpation of the fetal head ($n = 139$), translabial ultrasound ($n = 139$) and vaginal examination ($n = 112$). The quantification of head engagement was performed using two methods. For method A, a line was drawn through the inferio-posterior symphyseal margin, parallel to the main transducer axis, as reference, identical to the vertical line used to measure bladder neck descent on Valsalva manoeuvre. The shortest distance between this line and the presenting part was measured in millimetres. For method B, the line of reference was a line perpendicular to the central axis of the symphysis pubis, placed through the caudal end of the symphysis; this line was later called the "infrapubic line". Head engagement was defined as the minimal distance between the presenting part and this line (Figure 1). The presenting part was defined as the most distal part of the hyperechogenic curvature signifying fetal skull and scalp. Diagnosis of fetal head engagement was obtained in all cases. Ultrasound for head engagement correlated

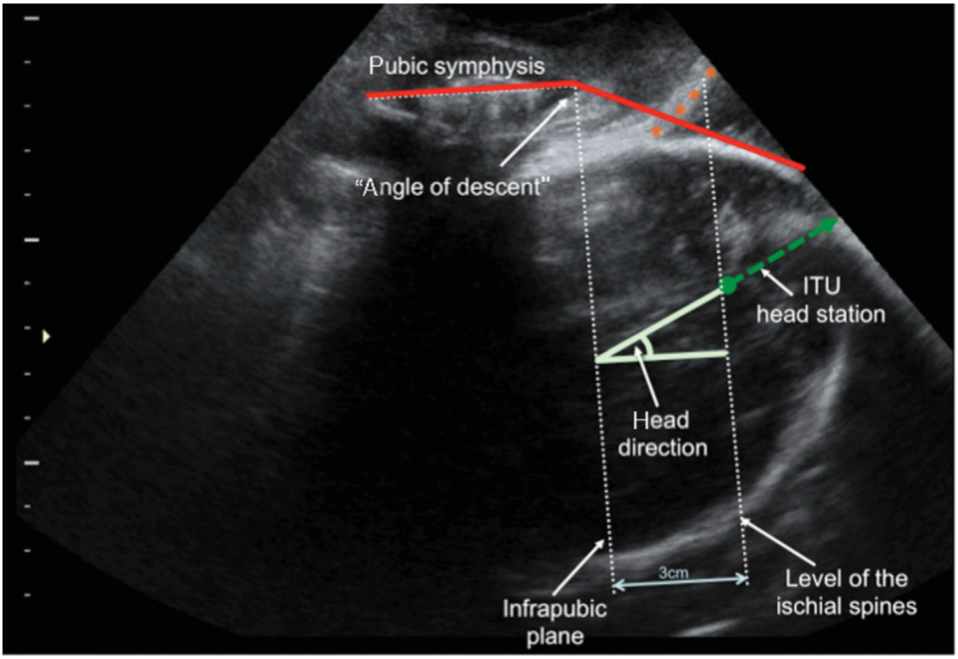

Figure 1 Possible objective parameters of ITU. All quantitative parameters require an exact median section of the pubic symphysis. A main landmark is the caudal end of the symphysis or rather a perpendicular line extending dorsally, the so-called infrapubic line. This infrapubic lines runs 3 cm cranial to a parallel plane that traverses the ischial spines, which in turn define mid-pelvis (station ± 0 cm). In addition, reference to the long axis of the symphysis enables angle measurements, for example that of the head direction (direction of the longest visible axis of the fetal head in the birth canal as seen in this insonation) as well as placing a tangent on the deepest bony part of the fetal head; together with the long axis of the pubic symphysis, this tangent defines the "angle of descent" or "angle of progression". Note that during a normal birth, often the scalp oedema (caput succedaneum) becomes visible (in the image indicated by asterisks) which must not be confused with the skull.

with abdominal palpation and Bishop scores. Translabial ultrasound assessment of fetal head engagement seemed feasible and the findings suggested that translabial ultrasound assessment of fetal head engagement could play a significant role in prediction of mode of delivery[7]. Ultrasound might potentially be used alone or in combination with other known predictors of mode of delivery such as maternal age[9], body mass index[10], cervical length[11] and fetal sex[12].

Rane *et al.* studied the pre-induction cervical length, occipital position, posterior cervical angle and maternal characteristics for the prediction of induction to delivery interval, the likelihood of vaginal delivery and the likelihood of Caesarean section within 24 h of induction of labour[13]. Transvaginal ultrasound was performed for the measurement of cervical length and the posterior cervical angle and transabdominal ultrasound to determine the position of the fetal occiput[13]. The fetal position was described as anterior (OA) if the occiput was between 9.30 and 2.30 h, transverse (OT) if between 2.30 and 3.30 h, or 8.30 and 9.30 h, and posterior (OP) if between 3.30 and

8.30 h. It was concluded that these parameters are superior to the Bishop score for the prediction of the outcome of induction[13].

Eggebo *et al*. used a simple method in women with premature rupture of membranes (PROM) at term by applying a curved transducer transversely and firmly on the perineum to measure the shortest distance from the outer bony limit of the fetal skull to the skin surface of the perineum[14]. Thirty-six hours after PROM, 32% of women with a short head–perineum distance (<45 mm) and 43% of women with long distance (>45 mm) were still in labour. Women with a short head–perineum distance had fewer Caesarean section rate and shorter time in active labour[14].

Eggebo *et al*. also studied the fetal head–perineum distance before induction of labour for prediction of vaginal delivery in 275 women[15]. This distance was compared against maternal factors, Bishop score and ultrasound measurements of cervical length, cervical angle and occiput position. The mean distance fetal head–perineum was 47.5 mm. The fetal head–perineum distance could predict vaginal delivery in 62% (95% CI, 52–71%), similar to cervical length, cervical angle, Bishop score and BMI 61%, 63%, 61% and 60% respectively[15]. Caesarean delivery rate was 4% among 73 women with short distance (≤40 mm) and 16% among 202 women with long distance. The mean cervical length was 27.6 mm. Caesarean delivery rate was 8% among 112 women with a short cervix (≤25 mm) and 17% among women with long cervix. The predictive values were similar for this method and ultrasound measured cervical length and Bishop score[15].

Henrich *et al*.[16] and Barbera *et al*.[17] reported on female pelvic computed tomography (CT) datasets for the analysis of geometric dimensions relating to birth and investigated the level of the ischial spine with regard to the pubic bone. This information was then used to correlate US findings with birth progress.

MRI Magnetic resonance imaging was used in the context of establishing a relationship between the fetal head station and the angle of progression assessed by transperineal ultrasound in women before labour[18]. A significant correlation existed between the angle of progression and the distance between the presenting fetal part and the level of the maternal ischial spines. The group reported that station zero would correspond to an angle of progression[18] at 120°. Bamberg *et al*. were also the first to use open MRI to analyse the progress of fetal head in the second stage of labour[19], clearly as a research application.

Levy *et al*. proposed to measure the angle of progression a week prior to labour for prediction of mode of delivery[20]. In a study of 100 nulliparous and 71 parous women, they found that nulliparous women who later required Caesarean delivery had a narrower pre-labour angle of descent than those delivering vaginally[20].

Intrapartum sonography

Interest in intrapartum ultrasound seems to have arisen independently and from various researchers. Lewin *et al*. back in 1977 published about the echographic measurement of the height of presentation by using a sacral approach[21]. Recently, a book in Russian published in 1996 came to our attention that seems to describe the use of ultrasound to assess birth progress[22] (personal communication, S. Voskresinsky).

Head position, spine position

Several studies have assessed the accuracy of digital vaginal examination for the determination of fetal head position in comparison to ultrasound.

Akmal *et al.*[23] investigated the accuracy of fetal head position by digital vaginal examination in 496 women in labour. They reported that digital vaginal examination failed to define the fetal head position in 33.5% of cases[23]. And, in the 72.5% of cases where the position was determined, the agreement with ultrasound was achieved only in 49.4% of cases. Correct identification of fetal head position increased with the increase of cervical dilatation from 20.5% at 3–4 cm to 44.2% at 8–10 cm[23]. This emphasizes the fact that digital vaginal examinations fail to identify the correct fetal head position in the majority of cases[23].

Similarly, Sherer *et al.* studied intrapartum fetal head position in the first stage of labour by comparing digital vaginal examination with transabdominal ultrasound. The group reported that in only 24% of patients, digital vaginal examinations were consistent with ultrasound assessments (95% confidence interval, 16–33). Also, cervical effacement and ischial spine station significantly affected the accuracy of digital vaginal examinations. The accuracy of digital vaginal examinations was increased to 47% (95% confidence interval, 37–57) when fetal head position assessed by digital vaginal examination was considered correct if reported within $\pm 45^\circ$ of the ultrasound assessment[24].

Sherer *et al.* also assessed fetal head position in the second stage of labour by comparing digital vaginal examinations with transabdominal suprapubic ultrasound. They reported an error of digital vaginal examinations in 65% of patients (95% confidence interval, 56–74). The error was reduced to 39% (95% confidence interval, 30–49) when digital vaginal examination was considered correct if reported within $\pm 45^\circ$ of the ultrasound assessment. Using ultrasound assessment as the gold standard, it was concluded that an overall rate of error occurred in 76% in digital vaginal examination during the first stage of labour and 65% in digital vaginal examinations in the second stage of labour[25].

In a longitudinal study of 148 labouring women in the first and second stages, digital palpation and the feasibility of assessing fetal head position by transabdominal ultrasound were measured[26]. Fetal head position could not be determined by digital palpation in 60.7% (122/201) of examinations in the first stage and 30.8% (41/133) in the second stage of labour; palpation of the position was correct in only 31.3% in the first and 65.7% in the second stage[26]. Occiput posterior positions were more difficult to palpate compared with occiput anterior positions. Ultrasound proved to be feasible and more successful and accurate in determining fetal position compared with vaginal palpation[26].

Head position in the second stage of labour is traditionally examined using vaginal palpation, but it is known that this is inaccurate. Diagnosis of head position, OA, OP or any other position, by vaginal palpation can be challenging[27]; however, head position can be diagnosed using ultrasound[28]. The comparison between digital vaginal and transabdominal ultrasound assessment of fetal head engagement supports the concept that vaginal palpation findings may be misleading while intrapartum ultrasound might be more precise, in part because caput succedaneum or moulding can be seen that may make palpation more difficult[27–29].

Dupuis *et al*. compared digital vaginal examination and transabdominal ultrasound examination for the assessment of fetal head position in 110 women in the second stage of labour. Transabdominal ultrasound for fetal head position was done immediately after a clinician had performed digital vaginal examination[30]. Fetal head position was found to be identical in 70% (80% when allowing a difference of 45°). Occiput posterior and transverse head positions were associated with a 50% rate of clinical error[30]. Caput succedaneum diminished the accuracy of clinical examination[30].

Intrapartum ultrasound was also researched in the assessment of the fetal spine position in combination with head position. Akmal *et al*.[31] and Blasi *et al*.[32] assessed the fetal head position and fetal spine position in first and second stages of labour in 918 and 100 pregnancies, respectively. Both studies conclude that occiput posterior position at delivery in the second stage of labour results from failure of rotation during the first stage of labour rather than a malrotation from the occipito-anterior position. It was also found that all cases that were occiput posterior position in the second stage of labour had the fetal spine in posterior position.[31,32]

Head station, direction and dynamics

Researchers have studied the degree and the mechanisms of descent of fetal head using intrapartum sonography. This can be done by analysis of the fetal head station with relation to sonographically accessible landmarks of the maternal pelvis.

Henrich *et al*.[33] were the first to report in the peer-reviewed English literature the use of intrapartum translabial ultrasound (ITU) in the second stage of labour. They correlated the inferior pubic margin with the ischial spines, at the same time using the long axis of the pubic symphysis as a reference for the long axis of the head. In a median sonographic section of the pelvis, with a curved transducer placed on the labia, a perpendicular line through the inferior margin of the symphysis (termed the infrapubic line) was used to define head station with regard to the ischial spines (Figure 1). The distance between the infrapubic line and the ischial spines in the axis of the birth canal had been determined to be 3 cm in a CT reconstruction of a female pelvis, enabling the correlation of ultrasound head station with the conventional clinical reference system, i.e. the level of the ischial spines[33]. They then measured head station, head direction and dynamic changes during a contraction and pushing in

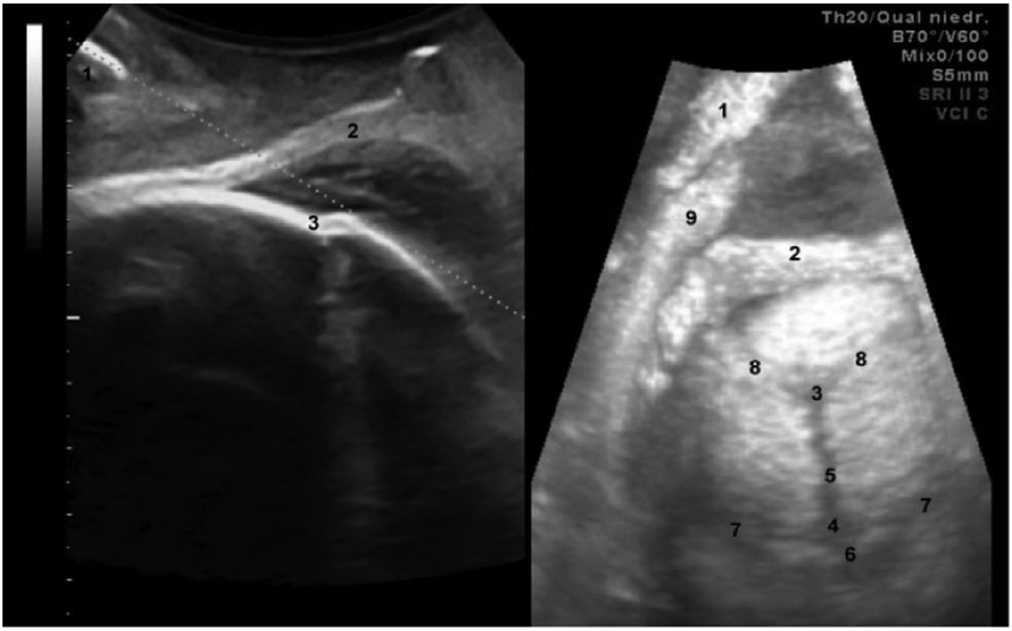

Figure 2 Sagittal view of the maternal pelvic outlet in the second stage of labour on translabial 2D and 3D ultrasound. The 2D image (left) demonstrates the symphysis (1), the caput succedaneum with hyperechogenic skin and hypoechogenic subcutaneous edema (2) and the fetal head with moulding of the bones (3) at the posterior fontanelle. The tangent on the inferior margin of the pubic symphysis and the fetal skull can be seen as a dotted line from the symphysis to the vertex of the head. The 3D image (right) shows the fetal head after completed internal rotation: the leading triangular posterior fontanelle (3), the quadrangular anterior fontanelle (4), and the sagittal (5), metopic (6), coronary (7) and lambdoid (8) sutures, the fetal skin (2), the birth canal (9) and parts of the pubic arch (1) are visible (with permission from Fuchs *et al.*[34]).

20 women immediately before clinically indicated operative vaginal deliveries[33] and correlated ITU head station, the head direction (the visible longest axis of the fetal head) with regard to the pubic axis and their changes during a naturally occurring contraction augmented by pushing with the success and ease of vacuum delivery. They concluded that ITU provided objective information on the dynamics of the second stage of labour, head station and head direction and that ITU may be used to assess the prognosis for operative vaginal delivery[33].

Fucks *et al*. in 2008, using 3D ultrasound, reported that fetal head rotation could be obtained by ITU with visualization of the fetal fontanels and skull sutures. In a case report, they showed that even in the presence of a marked caput, ITU could correctly identify the fetal head rotation[34] as shown in Figure 2.

Barbera *et al.*[17] published a geometric model from CT images in non-pregnant women to determine the "angle of descent" (tangent from the inferior margin of the pubic symphysis and the fetal head; Figure 3) that corresponds with a conventional station 0 cm. In a geometric model from CT images, mean angles for different station were assigned, for example (station −2 corresponds to a mean angle of 85°, station

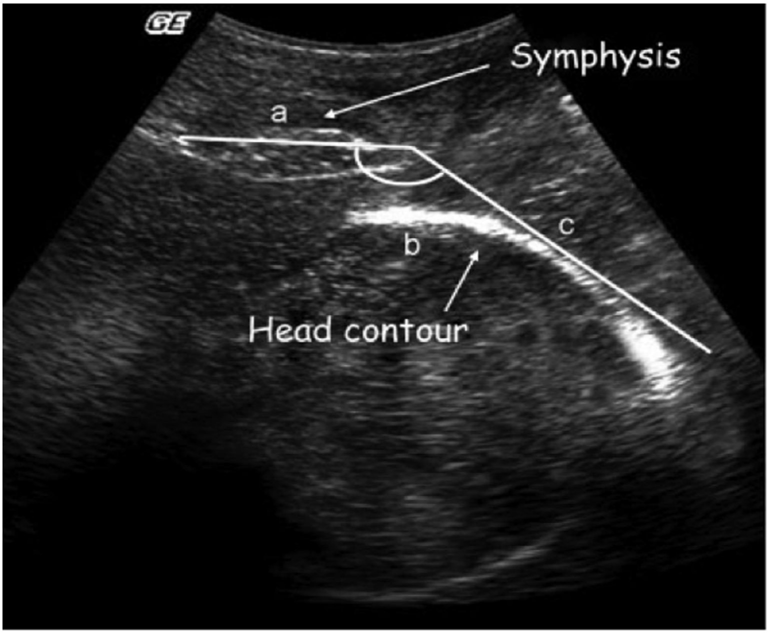

Figure 3 Angle of descent. (a) Midline through the pubic symphysis bone, (b) fetal skull contour and (c) is a tangent line to the fetal skull from the pubic symphysis midline to form the angle of descent (with permission from Barbera *et al.*[17]).

0 corresponds to 99° and station +2 corresponds to 113° angle). They also reported very poor correlation between the digital vaginal examinations and the transperineal ultrasound assessments.[17] An agreement of 89% and 100% was only observed with ±2-cm variation, denoting that every time clinical assessment of station at zero (0), the real station may vary between −2 and +2 cm.[17]

Barbera *et al.*[35] used transperineal ultrasound in an intrapartum study of fetal head descent, measuring the angle of descent in 75 labouring women. The head descent was quantified by measuring the angle between the long axis of the pubic symphysis and a line extending from its most inferior portion tangentially to the fetal skull. There was a significant linear correlation between the angle of descent measured by transperineal ultrasound and the clinical station assessed by digital vaginal examination. An angle of descent of at least 120° measured during the second stage of labour was always associated with subsequent spontaneous vaginal delivery[35]. The authors concluded that the angle of descent measured by transperineal ultrasound is an objective, reproducible and non-invasive technique that uses precise landmarks to assess fetal head descent[35].

Ghi *et al.*[36] investigated ITU head station and head rotation in the second stage of labour and concluded that translabial sonography increases the accuracy of diagnosing fetal head station. A total of 60 women in the second stage of labour underwent translabial ultrasound assessments, and the findings were compared with clinical examination. When the fetal head direction was directed downwards, the palpated head station was $\leq$ +1 cm (77.2% of cases). When the fetal head direction was horizontal, the fetal head station palpated clinically at station $\leq$ +2 cm (89.9% of cases) and when the fetal head direction was upwards, clinically the station was $\geq$ +3 cm (88.5%). Failure to visualize the cerebral midline or a rotation $\geq 45^{\circ}$ was associated with a station of +2 cm or less (95.1%). On the other hand, a rotation of $\leq 45^{\circ}$ was associated with a station of +3 cm or more (69.2% of cases)[36].

Kalache *et al*. compared the angle of progression by transperineal ultrasound in women with failure to progress in the second stage. Forty-one women were classified in three groups, Caesarean section for failure to progress, vacuum extraction for failure to progress and spontaneous delivery following prolonged second stage of labour. The angle of progression was measured offline just before digital examination and subsequent delivery[37]. When the angle of progression was 120°, the possibility of either an easy and successful vacuum extraction or spontaneous vaginal delivery was 90%. The group concluded that the measurement of the angle of progression is a simple ultrasound technique which relies on two easily depicted ultrasound markers (maternal pubic symphysis and fetal skull leading edge)[37].

Molina *et al*. studied the repeatability of 3D ultrasound measurements of head direction, angle of the midline, progression distance and angle of progression in the second stage of labour. They found that the angle of progression showed a high intraclass correlation coefficient (ICC) for the same observer[38] (0.94; 95% CI, 0.90–0.97) and for two different operators (0.84; 95% CI, 0.73–0.91). Also, the angle of progression showed smaller limits of agreement for intraobserver and interobserver variability[38].

Tutschek *et al.*[39] studied ITU of head station, head direction and angle of descent and the dynamic changes of these parameters during normal and obstructed labour, measured reproducibility and described patterns of changes in these parameters depending on head station. Distinctive patterns of dynamic changes depending on the head station were apparent. Above station ±0, the head moved parallel during a contraction or even downwards, but between stations ±0 and +2 a marked upward change in the head direction occurred[39]. Time to delivery as well as successful delivery correlated with head station. Successful operative or spontaneous vaginal delivery occurred in 97% for an ITU head station greater than +2, in 94% when the head direction was $>22^{\circ}$ and in 94% when the angle of descent was greater than 135°. Vaginal palpation for head station correlated weakly with ITU with a wide scatter around the objectively determined ITU head station. It was concluded that ITU is a simple technique that improves the understanding of normal and abnormal labour and enables an objective measurement of birth progress[39].

Youssef *et al.*[40] have very recently proposed yet another ultrasound marker that can be obtained by translabial insonation, the so-called head–symphysis distance "HSD" to assess the fetal head descent in labour. The HSD was measured as the distance between the lower edge pubic symphysis and the nearest point of the fetal skull along the infrapubic line[40].

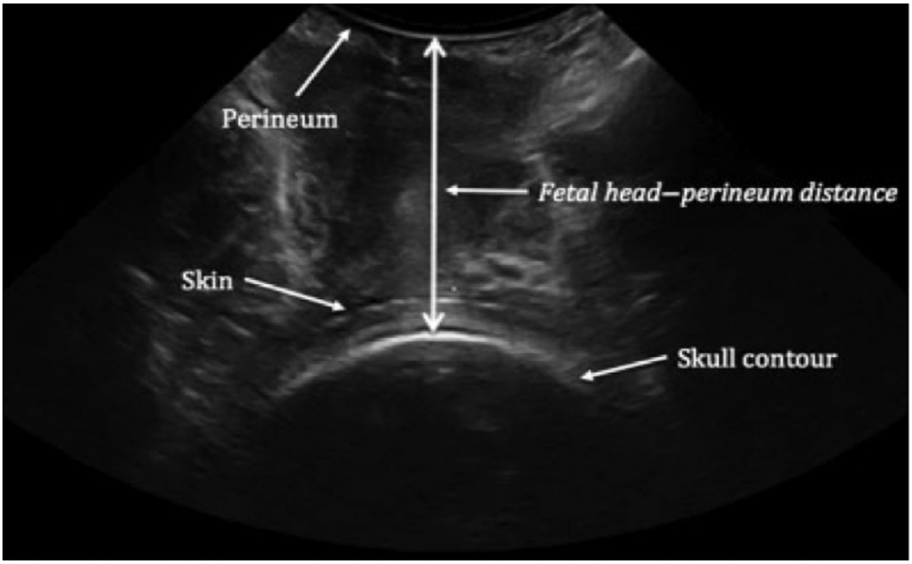

Figure 4 Ultrasound image showing how the fetal head–perineum distance (60 mm) can be measured as the shortest distance between the outer bony limit of the fetal skull and the perineum in a transverse view (with permission from Torkildsen *et al.*[41]).

Torkildsen *et al.*[41], in a study of 110 primiparous women with the prolonged first stage of labour, investigated the fetal head–perineum distance (shortest distance from the fetal head to perineum as shown in Figure 4) and angle of progression measured by 2D and 3D transperineal ultrasound for the prediction of mode of delivery. The transducer was applied transperineally in transverse view for the assessment of the fetal head–perineum distance and in a sagittal view for the assessment of the angle of progression. Receiver-operating characteristics (ROC) showed that areas under curves for prediction of vaginal delivery were 81% (95% CI, 71–91%) and 76% (95% CI, 66–87%) for the fetal head–perineum distance and the angle of progression when measured by 2D ultrasound and 66% (95% CI, 54–79%) for the digital assessment of fetal station. Fifty per cent of women had the fetal head–perineum distance at ≤40 mm, 93% (95% CI, 83–97%) of them delivered vaginally; and 18% (95% CI, 5–48%) delivered vaginally when the distance was >50 mm[41]. In 48% of women, the angle of progression was ≥110°, 87% (95% CI, 75–93%) of them delivered vaginally while 38% (95% CI, 21–57%) delivered vaginally when the angle of progression was <100°. It was concluded that the fetal–head perineum distance and the angle of progression measured by 2D can predict labour outcome; however, only one obstetrician performed the ultrasound measurements, thus repeatability and reproducibility studies would be of interest.[41]

Ghi *at al.*[42] researched the progress of the fetal head in the birthing canal during labour by 3D ultrasound. Volume acquisitions were carried out using an infrapubic or translabial approach by placing the transducer below the symphysis on the labia majora[42]. The fetal skull and maternal pubic bone were visualized in the screen before the acquisition. The head direction (angle between the infrapubic line and the longitudinal axis of the fetal head), the angle of progression as described before and the head progression (distance between the infrapubic line and the lowest part of the fetal skull) were analysed. It was found that for all the three parameters, the interobserver variation was significantly higher than the intraobserver variation, and it was easy to reproduce the parameters except of the midline angle. The angle of progression had the highest reproducibility among the other parameters[42].

ASSESSMENT OF CERVICAL DILATATION

Digital examination is traditionally seen as the "gold standard" to evaluate fetal head descent, cervical ripening and dilatation and fetal head position before and during labour[43]. Now, this view is being challenged for most of the parameters, as described above.

Cervical dilatation is considered an essential indicator of the progress of labour[44]. However, the assessment of cervical dilatation by digital vaginal examination can be inaccurate, inconsistent and insensitive[6,38,45].

Zilianti *et al.*[46] has described the use of transperineal ultrasound for the assessment of the effacement of the cervix at the beginning of labour. They concluded that transperineal ultrasound could image the changes in the dilatation of external os starting with funnelling, then fusing of both orifices to the completion of the process of effacement[46].

Electromechanical devices have been tried to assess cervical dilatation during labour; however, the evaluation of cervical assessment showed limited precision[47].

Ultrasound assessment of cervical dilatation in labour has been largely unsuccessful in its application to clinical practice. Zimerman *et al.*[48] used intrapartum 3D ultrasound to assess the accuracy and reproducibility of intrapartum translabial cervical dilatation during labour. Twenty-four patients were included during the latent phase of labour and 28 patients during the active phase of labour[48]. Intrapartum translabial 3D cervical dilatation assessment was accurate and reproducible and correlated with digital vaginal examination. Although the authors stated that 3D translabial ultrasound assessment of cervical dilatation is not a candidate to replace digital vaginal examination in the management of routine low-risk labour, this technology could play an adjuvant role in the management of cases such as premature rupture of membranes, dysfunctional labour and cases where patients' preferences or other aspects preclude repeated pelvic examinations[48].

Hassan *et al.*[49] recently, in a study to assess the progress of labour sonographically, found that cervical dilatation could also be assessed and measured using 2D transperineal ultrasound. The transducer was placed transperineally at the level of the posterior fourchette in a sagittal position; fine lateral movements were performed in order to obtain views of the maternal pubic symphysis and fetal skull landmarks[49].

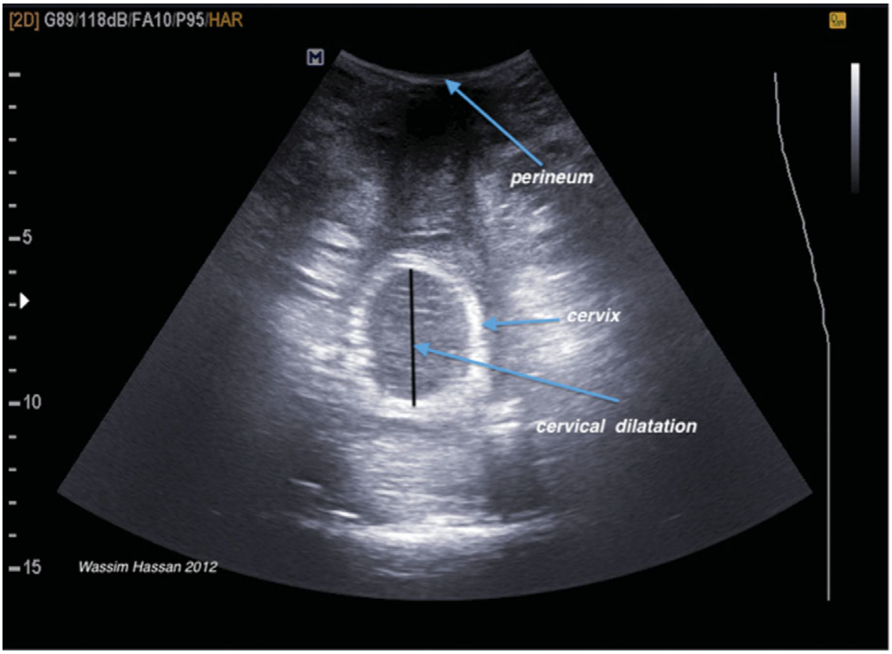

Figure 5 Cervical dilatation assessed by 2D transperineal ultrasound during labour. The cervical dilatation is clearly visible at the centre with vaginal wall hyperechogenic laterally to the cervix. At the top of the picture is the perineum where the transperineal probe is placed.

The anterior part of the cervix was identified on top of the upper part of the fetal skull in a sagittal view. The transducer was then rotated by 90°, keeping the anterior part of the cervix or the fetal skull in sight[49]. Angling and dipping movements of the transducer were then performed to obtain optimal views of the cervix[49]. The circular aspect of the cervix could be obtained (Figure 5). The ultrasound measurement of the cervical dilatation was obtained in the anterio-posterior plane with the cursors placed on the inner part of the cervical tissue anteriorly and the inner part of the cervical tissue posteriorly (inner-to-inner)[49]. An ultrasound cervical dilatation score was developed to assess the quality of cervical visualization. A scale from 0 to 3 was introduced, with 3 when the cervical dilatation was visible in more than 75% of the cervical circumference and 0 when the cervical dilatation was visible in less than 25% of the cervical circumference[49].

Cervical measurements were obtained by transperineal 2D ultrasound and compared with conventional digital vaginal examinations. There was a strong positive correlation between digital and ultrasound measurements ($r = 0.91$, $n = 16$, $p < 0.01$). The ICC between the two methods showed a high association with ICC 0.90 (95%CI, 0.75–0.97)[49].

Hassan *et al.* also proposed the hypothesis of using a "sonopartogram" that incorporates head station and cervical dilatation, both obtained objectively and longitudinally used intrapartum ultrasound. This concept has the potential to allow the progress of labour to be tracked entirely with ultrasound, potentially dispensing with the variability and discomfort of conventional examination[49].

CONCLUSION

In the last decade, the application of intrapartum sonography has significantly increased. Ultrasound machines are available onsite in most of the delivery units around the developed world. However, their proper use requires training strategies for the health care providers looking after women in labour. Some of the intrapartum ultrasound techniques described above can be achieved with equipment already available in most of the delivery units. Sonographic analysis of labour may be a simple way of monitoring the "mechanical" parameters of labour such as head descent, head position and cervical dilatation by simple 2D ultrasound. Cross-sectional (2D B-mode) ultrasound is the most obvious technology to objectively obtain these parameters.

We hypothesize that this decade will witness the application of intrapartum ultrasound as an adjunct to routine obstetric care in most modern delivery units.

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