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Original Research Article

An ultrasound study of foetal head-perineum distance in term pregnant women to estimate successful vaginal delivery

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ABSTRACT

Background: The aim of the study is to find the role of foetal head-perineum distance in term primiparous pregnant women being induced, in estimating successful vaginal delivery using transperineal ultrasound. And further to compare fetal head-perineum distance with cervical length and Bishop score. Cervical length and Bishop score were already established as good predictors of vaginal delivery.
Methods: An ultrasound machine with transabdominal and transvaginal probe was used in the study. In this study spanning from December 2023 to October 2024; 63 primiparous term pregnant women were recruited from Vijaya hospital, Chennai after getting approval from the Institutional Ethical Committee. 63 primiparous patients who underwent induction of labour for various reasons were selected for the study and examined. Patients undergoing elective induction of labour at term gestation were assessed for the fetal head-perineum distance (FHPD) by transperineal ultrasound and cervical length by transvaginal ultrasonography. Bishop score was assessed digitally. After induction of labour, patient undergoing vaginal delivery and caesarean sections were noted down.
Results: Forty-two patients delivered vaginally. Twenty-one patients delivered by LSCS. Fetal head-perineum distance cut-off in my study was 5.5 cm. Cervical length cut-off was 3cm. Patients having favorable bishop score of 5 and above delivered vaginally.
Conclusions: Trans perineal fetal-head perineum distance measured by ultrasound can be used as an important tool to predict vaginal delivery before induction of labour.

Keywords: estimating mode of delivery, Fetal head-perineum distance, Transperineal ultrasound

INTRODUCTION

Every expectant mother wishes for an uneventful pregnancy and a normal vaginal delivery with the well-being of both mother and baby. Traditionally, the likelihood of a successful induction has been assessed using the Bishop score. However, this score is subjective.[1] Emergency caesareans performed during advanced labor, carry additional risks, including significant blood loss, uterine tears, bladder injuries, and broad ligament hematomas.[2] Ultrasound provides a more accurate assessment of factors like cervical length, dilatation, position, consistency, and fetal head station [3]. Moreover, advanced ultrasound parameters, such as the fetal head's position relative to the pelvis, spine alignment, angle of progression, head-to-symphysis distance, and head-to-perineum distance, have been explored extensively.[4,5]

The distance of the presenting part from the pelvic outlet is a key factor in determining labor success. While traditionally this is assessed by the head distance either above or below the ischial spine digitally. This method often lacks accuracy and reproducibility.[6]

More objective methods, like transperineal ultrasound to measure fetal head-perineum distance and transvaginal

sonography for cervical length, are also available. The supravaginal portion of the cervix, which makes up about 50% of its length, is difficult to assess digitally. This study aims to examine the fetal head-perineum distance, cervical length, and Bishop's score before induction to estimate the cut off for vaginal delivery.

METHODS

Study design and setting

This was a prospective, clinical observational study conducted at Vijaya Hospital, Chennai. The study included term primiparous pregnant women who were posted for induction of labour. The study was carried out over a period from December 2023 to October 2024.

Study procedure

After getting approval from the Institutional Ethical Committee, 63 primiparous patients who underwent induction of labour for various reasons were selected for the study and examined. Patients undergoing elective induction of labour at term gestation are assessed for the fetal head- perineum distance (FHPD) by transperineal ultrasound and cervical length by transvaginal ultrasonography. On the day of induction of labour or the day before, the transabdominal probe is placed in the perineum. The shortest distance from the outer bony limit of fetal skull to skin surface of the perineum in a transverse view was measured in millimeters to represent FHPD. The probe is placed in the vagina approximately 3 cm proximal to the cervix and the distance between the internal os and external os is measured as the pre-induction Cervical length. Three measurements were obtained and the shortest, technically best measurement in the absence of uterine contractions was recorded. Clinical Cervical assessment by Modified Bishop's score is done. The patients undergo induction of labour with Dinoprostone Gel [PGE_2] based on their modified Bishop's Score.

Inclusion criteria

The study population included term primiparous patients between 37 and 40 weeks, over a period of 10 months. Pregnant women with live singleton pregnancy with cephalic presentation, who were not in labour in the age group between 18 and 40 years were included. Women with pre-labour rupture of membranes were also included. All Primigravida undergoing induction of labour were included.

Exclusion criteria

Patients in Labour, patients with previous caesarean section, multiple pregnancy (Twins) and bony abnormalities of pelvis were excluded from the study.

Induction was done with PGE_2 - DINOPROSTONE Gel 0.5 mg intracervical application. The favorability of cervix was assessed after 1.5 mg of PGE_2 gel (3 doses) and the patient is taken up for Caesarean Section as failed induction if the cervix was still unfavorable. If Bishop's Score had improved oxytocin augmentation was started after amniotomy.

Outcome of induction was considered as successful when it resulted in a vaginal delivery. Vacuum and forceps delivery were also included. Outcome was unsuccessful when it resulted in caesarean delivery (for reasons like failed induction and non-progress of labour).

Statistical analysis

Statistical analysis was done and p value <0.05 was considered significant.

Intrapartum ultrasound assessment

The idea of a non-invasive ultrasound-based approach to labor monitoring, termed the sonopartogram, was first introduced in 2014, providing a comprehensive tool for labor assessment.

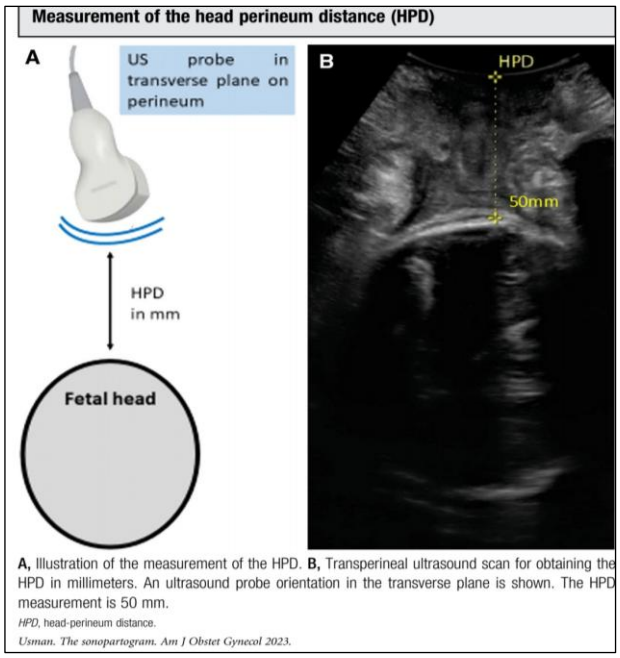

Figure 1: Measurement of head-perineum distance.
Source: Expert Review-The sonopartogram-Am J Obstet Gynecol[25]

Methods of intrapartum ultrasound

This section outlines frequently described intrapartum ultrasound methods used to evaluate labor progress.

Cervical dilatation

The use of trans perineal ultrasound to measure cervical dilatation during labor was first introduced by Hassan et al.[7] In the early stages of active labor, especially prior to

membrane rupture, cervical dilatation can be visualized and measured along the anteroposterior plane. This is achieved by placing the ultrasound transducer in the transverse position at the vaginal introitus and gently angling it to obtain the best view.

Fetal head descent (station)

Various transperineal ultrasound techniques have been proposed to evaluate fetal head descent or station. Due to the challenge of identifying the ischial spines on ultrasound, direct measurement of fetal head descent is not possible.

Fetal Head-Perineum Distance (FHPD)

One simple technique for evaluating fetal head descent with intrapartum ultrasound involves placing the transducer transversely just above the posterior fourchette. The shortest distance from the edge of the transducer to the fetal skull is measured in millimetres, representing the perineum-skull distance (FHPD).[8]

Angle of Progression (AoP)

The AoP is measured by positioning the ultrasound probe transperineally in the sagittal plane. This angle is calculated between a line through the long axis of pubic symphysis and a tangent to the fetal skull. Measurements can be performed manually or automatically, depending on the USG machine used. A larger AoP indicates greater fetal head descent into the maternal pelvis during labor. The AoP has been shown to be an accurate and reproducible method for assessing head descent.[24]

Research has linked both HPD and AoP to labor outcomes. For instance, a study by Eggebø and colleagues examined the sonographic prediction of vaginal delivery during prolonged labor in 150 women.[9] Results showed that when HPD was <40 mm or AoP >110°, most women experienced spontaneous vaginal deliveries. Conversely, when HPD exceeded 40 mm or AoP was <110°, approximately half of the women still achieved vaginal delivery.

Fetal head position (rotation)

Assessing fetal head position is critical for evaluating labor progress, as malposition can contribute to dystocia. Digital vaginal examination has notable limitations in this regard. A study by Akmal et al found that clinicians misdiagnosed the occipito-posterior (OP) position in nearly 50% of cases.[10] Transabdominal ultrasound offers superior accuracy and a higher success rate than digital vaginal examination for determining head position.[11]

The larger diamond shape is bordered by 4 suture lines-indicates anterior fontanelle. The 3 suture lines represents the posterior fontanelle. The fetal head position is determined by the location of the posterior fontanelle.

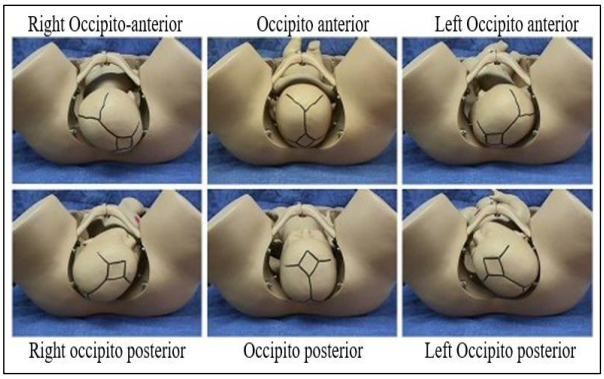

Figure 2: Representation of the fetal head position from palpation of the fontanelles.

In the context of the sonopartogram, fetal head rotation is assessed based on the location of the posterior fontanelle, using a 12-hour clock-face analogy to categorize positions into 30° segments.[12,10] This method has shown good interobserver and intra-observer reliability.

Additionally, transabdominal ultrasound can provide insights into the fetal spine position by imaging the transverse plane at the level of the four-chamber view of the heart. This additional perspective enhances understanding of fetal orientation.

The Royal College of Obstetricians and Gynaecologists (RCOG) 2020 guideline Number 26 for assisted vaginal birth recommend using intrapartum ultrasound to assess fetal head position prior to assisted vaginal birth when clinical uncertainty exists following clinical examination.[13] However, there is insufficient evidence to recommend routine use of abdominal and perineal ultrasound for assessment of the station, flexion and descent of fetal head in the second stage of labour.[13]

Modified Bishop's score and transvaginal cervical length

In 1955, Bishop devised a cervical scoring system for multiparous patients with planned elective induction of labor in which 0 to 3 points are given for each of five factors.[14]

Modified Bishop's Score (CALDER 1974)

The scoring was done using cervical dilatation, cervical length, station of head, consistency of cervix and position of cervix.[15]

RESULTS

Age distribution of the study population

The majority of patients belonged to the 26-30 years age group (n=44). Approximately 10 patients were in the 19-25 years age group (Figure 3).

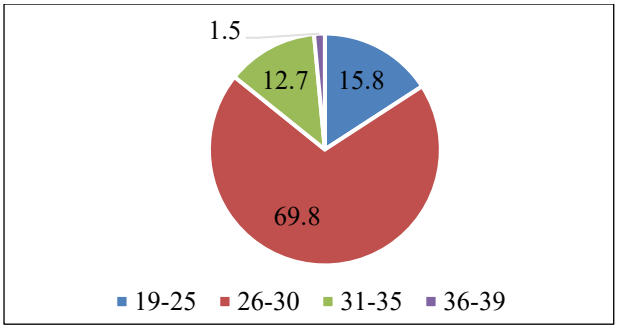

Figure 3: Age distribution.

Gestational age distribution

FHPD was studied among patients across varying gestational ages at delivery. Most patients (n=37) delivered between 39-40 weeks of gestation. Fourteen patients delivered between 37-37^{+6} weeks, while 12 patients delivered between 38-38^{+6} weeks of gestation.

36 patients had normal body mass index. 21 patients were overweight. 6 patients were obesity class 1. Of the 6 patients, 4 had vaginal delivery, 2 had caesarean sections (Figure 4).

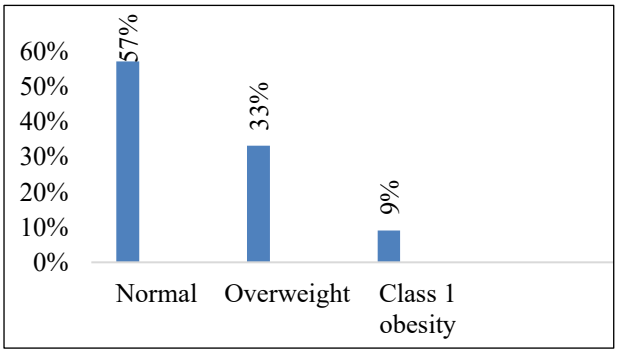

Figure 4: Bar diagram for BMI distribution.

In a study, obesity conferred a two- to threefold increased risk of delivery by emergency caesarean section for both primigravida and multigravida women. The study concluded that increasing maternal BMI exerts a progressive adverse effect on vaginal delivery rates for both primigravida and multigravida women. Obese primigravida should be counseled antenatally about the 30% risk of emergency caesarean section.[16]

In our study, of the 6 obese women, 4 delivered vaginally. This was because they had favorable FHPD and Bishop score.

Indication for induction

The distribution of the indication for Induction of labour in the study group.

25 patients were induced after completing 40 weeks, following hospital protocol to prevent post-datism risks. 14 were induced for co-morbidities such as gestational hypertension or abnormal Doppler findings. 12 were induced for pre-labour rupture of membranes, and 12 as they neared the expected date.

Table 1: Modified Bishop score of patients.

Bishop score	Number	Percent
3	7	11.11
4	21	33.33
5	20	31.75
6	13	20.63
7	2	3.17
Total	63	100

Table 1 shows the distribution of Modified Bishop's score in the study group. BISHOP score ranged between 3 and 7. 15 patients had favourable bishop score of 6 and 7. 21 patients had a pre-induction Modified Bishop's score of 4.

Mode of delivery of the study group

The distribution of mode of delivery in the study group. 40 patients had normal vaginal delivery, 2 patients had forceps delivery and 21 patients underwent LSCS. Forceps delivery was included in vaginal delivery (Table 2).

Table 2: Outcome as per cervical length.

Non-reactive	Mean	SD	Median	P value
LSCS (21)	3.04	0.21	3.1	<0.0001*
Vaginal (42)	2.50	0.22	2.5	

*statistically significant

Table 3: Outcome as per FHPD.

Non-reactive	Mean	SD	Median	P value
LSCS (21)	5.77	0.20	5.81	<0.0001*
Vaginal (42)	5.06	0.41	5.16	

*statistically significant

Table 4: FHPD and mode of delivery.

	Outcome			
FHP	**LSCS**	**Vaginal**	**Total**	**P value**
4 to 5	0	18	18	<0.001*
	0	42.86	28.57	
5.01 to 6	17	23	40	
	80.95	54.76	63.49	
>6	4	1	5	
	19.05	2.38	7.94	
Total	21	42	63	
	100	100	100	

*statistically significant

When the cervical length was on an average 2.5 cm on TVS it resulted in vaginal delivery. Cervical length of 3.04 cm was mean for caesarean (Table 2).

Average FHPD for vaginal delivery 5.06 cm. Average FHPD for LSCS 5.77 cm (Table 3).

All patients with FHPD <5 cm delivered vaginally, while those with >6 cm had a higher likelihood of caesarean delivery (Table 4). ROC analysis identified FHPD <5.5 cm as the optimal cut-off, offering maximum sensitivity and specificity for predicting vaginal delivery (Table 5).

Table 5: Diagnostic accuracy of predictive factors in determining successful vaginal delivery.

Statistics	FHPD	Cervical length	Bishop score
Cut-off	5.5cm	3cm	3
Sensitivity (%)	95.24	66.67	33.33
Specificity (%)	90.48	100.00	100.00
Positive predictive value (%)	83.33	100.00	100.00
Negative predictive value (%)	97.44	85.71	75.00
Accuracy (%)	92.06	88.89	77.78
Area under curve	0.044	0.043	0.921

DISCUSSION

In contemporary obstetrics, induction labour has become a standard practice, especially for high-risk pregnancies, as prompt delivery often offers significant benefits. Approximately 5-15% of pregnancies involve routine induction of labour for various maternal or fetal reasons [17]. Failure of induction often arises from inappropriate case selection. Attempting vaginal delivery in unrecognised cephalopelvic disproportion (CPD) may lead to complications such as failure of cervical dilatation and arrest of descent, necessitating emergency caesarean sections.

The frequency of caesarean sections has increased over time, with failure of descent ranking as the second most common reason for this procedure. Ultrasound imaging before the onset of labour has emerged as a valuable tool for aiding obstetricians in developing effective delivery plans. One such parameter, the fetal head-perineum distance (FHPD), measured through trans-perineal ultrasound, has shown promise in predicting the likelihood of successful labour induction. This technique is minimally time-consuming, involves a quick learning curve, and is relatively simple to master.

Fetal Head–Perineum Distance (FHPD) and its predictive value for vaginal delivery

FHPD cut-off values reported by different studies that have demonstrated predictive success for vaginal birth under diverse labor conditions.

Key studies and findings

Torkildsen et al conducted at Stavanger University Hospital in Norway with 110 patients undergoing labor induction, this study identified an FHPD cut-off of <4 cm. Sensitivity, specificity, and negative predictive value for predicting vaginal delivery were 62%, 85%, and 43%, respectively.[18]

Ali et al reported a cut-off value of <4.8 cm, with sensitivity, specificity, and negative predictive value of 84.7%, 84%, and 61.8%, aligning closely with findings from our study.[19]

Eggebø and Hassan et al focused-on singleton primigravidae experiencing prolonged first-stage labor, this study demonstrated that an FHPD cut-off of ≤4 cm could predict successful vaginal delivery. Sensitivity and specificity for transperineal distance in their research were 69% and 72%, respectively.[9]

Ali et al we found that FHPD assessed transperineally outperformed traditional parameters such as cervical length and Bishop's score. It showed a sensitivity of 97%, specificity of 88.1%, and an overall accuracy of 93.6%.[22]

FHPD and instrumental vaginal delivery

FHPD has also been utilized as a predictive tool for difficult extractions during instrumental vaginal deliveries:

Indonesian study established an FHPD cut-off of ≤4.35 cm, reporting sensitivity and specificity of 98% and 80%, respectively, with 89% of subjects achieving successful vaginal delivery (AUC 0.825).[20]

Strasbourg University, France found that FHPD values exceeding 40 mm correlated with a higher likelihood of difficult extractions, even after adjusting for factors like multiparity, fetal head position, and fetal weight.[21]

Clinical implications

A recent review emphasized that challenges during instrumental vaginal extractions could be mitigated by adopting ultrasound imaging. This approach provides an objective assessment of fetal-pelvic relationships, including fetal weight, head station, and position, offering better preparation before attempting vaginal delivery.[23]

In most referenced studies, the fetal head-perineum distance (FHPD) was found to be less than 4-4.35 cm. This

is likely because these studies were conducted on women already in labor, including those experiencing a prolonged first stage, active labor, or undergoing instrumental vaginal delivery during the second stage.[18,9,20,21] However, two studies had a participant pool similar to ours, with FHPD measured before the induction of labor. Since these women had not yet started the labor process, they typically presented with a higher fetal head station. That study reported an FHPD cut-off of 4.8 cm and 5.5 cm, which aligns closely with our cut-off of 5.5 cm.

While transperineal ultrasound offers a more objective assessment of the head-to-perineum distance, it cannot entirely replace vaginal examinations during labor. Digital examination remains crucial for pelvic assessment for vaginal delivery, detecting cephalopelvic disproportion, and assessing the effacement and stretch ability of the cervix. Ultrasound is effective in determining cervical dilatation during the latent phase of labor (less than 4 cm). However, beyond 4 cm, during the active phase, cervical dilatation is best assessed through periodic vaginal examinations, which are critical for monitoring the progress of labor and identifying abnormalities like protracted active phases or secondary arrests in cervical dilatation.

That said, vaginal examinations can be uncomfortable for many women and potentially increase the risk of ascending infections. Incorporating intrapartum ultrasound can reduce the frequency of per vaginal examinations while providing valuable insights into fetal head position relative to the maternal pelvis, particularly distinguishing between occipito-anterior and occipito-posterior positions. Ultrasound acts as a complementary tool, enabling obstetricians to verify and enhance the findings from vaginal examinations.

Study observations

In this study, trans perineal ultrasound was performed efficiently and without discomfort to the participants. The findings align with other studies, where trans perineal ultrasound was similarly well-tolerated and easy to administer.

This study has few limitations. Sample size is small. Recent research has explored additional ultrasound parameters, such as the angle of head progression, head-to-internal os distance, fetal head position, fetal head perimeter, pubic arch angle, and posterior cervical angle. These parameters, either individually or in combination, may influence labor outcomes. Adjusting for these variables is essential before concluding that FHPD alone is a definitive predictor of labor success. Further studies are necessary to determine whether incorporating these parameters enhances the predictive power of intrapartum sonography.

CONCLUSION

Trans perineal ultrasound measurement of FHPD is a simple, reliable, non-invasive, and comfortable method for predicting the mode of delivery in women before labor induction. It serves as a valuable adjunct in assessing fetal head descent during labor, complementing traditional methods.

Though FHPD is a good predictor of vaginal delivery, we need to rely on clinical methods as well. Moreover, we need extensive research in the field of intrapartum ultrasound to claim it as an alternative to clinical digital examination.

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