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Assessment of the angle of progression and head-perineum distance in the prediction of type of delivery and duration of second stage of labor using intrapartum transperineal ultrasonography

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Abstract
Background: Each pregnancy's straightforward goal is to deliver a healthy baby to a healthy mother. Prolonged second stages of labour have been linked to poor mother and neonatal outcomes. The gold standard for diagnosing head descent clinically is still a digital transvaginal examination. Head station is based on the relationship between the ischial spine and the leading edge of the foetal head in the maternal pelvis. The intrapartum transperineal ultrasonography is a safe method for determining the position of the foetal head and for anticipating the course of the delivery. It is very useful in analyzing phenomena connected to the transit of the foetus through the birth canal.
Aims: This study's objective is to assess the effectiveness of intrapartum transperineal ultrasound in predicting the kind of birth and length of the second stage of labour by assessing parameters for the Angel of Progression and Head Perineum Distance.
Patients and Methods: Cross-sectional prospective research is the study's design. At Tanta University Hospitals' Department of Obstetrics inpatient ward, 65 primigravida women participated in the study. commenced in August 2021 and concluded in August 2022.
Results: According to our findings, there was a positive highly statistically significant correlation between AOP and vaginal delivery patients compared to CS delivery patients, while there was a negative highly statistically significant correlation between HPD and vaginal delivery patients compared to CS delivery patients. A positive highly statistically significant association was found between the length of the second stage and the HPD, while a negative highly statistically significant correlation was found between the length of the second stage and the angle of progression.
Conclusion: Intrapartum ultrasound has been used to measure a number of characteristics, including the angle of progression (AOP) and head-perineum distance (HPD). The manner of delivery and length of pushing can be predicted with the help of an ultrasound conducted at the start of the active second stage of labour.

Keywords: Progression and head-perineum distance, transperineal ultrasonography, delivery and duration

Introduction

Each pregnancy's straightforward goal is to deliver a healthy baby to a healthy mother. Prolonged second stages of labour have been linked to poor mother and neonatal outcomes. The safe and efficient treatment of this period is necessary to prevent such unfavourable results (Khalil *et al*., 2012) [15].

The period from complete cervical dilation to delivery is known as the second stage of labour.
When it lasts more than two to three hours for nulliparous women and one to two hours for multiparous women, it is considered prolonged. Failure of head descent is a significant sign that a surgical delivery is needed; therefore, a careful assessment of this process is essential to choosing the best delivery method (Gilboa *et al*., 2013) [10].

The gold standard for diagnosing head descent clinically is still a digital transvaginal examination. Head station is based on the relationship between the ischial spine and the leading edge of the foetal head in the maternal pelvis. T Unfortunately, the latter approach has shown to be unreliable and difficult to replicate. With prolonged labour, errors in assessment are further established, particularly when foetal head moulding and caput succedaneum happen and make

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position interpretation more challenging (Sherer *et al.*, 2002) [23]. The intrapartum transperineal ultrasonography is a safe method for determining the position of the foetal head and for anticipating the course of the delivery. It is very useful in analysing phenomena connected to the passage of the foetus through the birth canal. Intrapartum transperineal ultrasonography has been used to measure a number of characteristics, including the angle of progression (AOP) and head-perineum distance (HPD). Intrapartum transperineal ultrasound has proven to be simple to learn and perform, and it has also been shown to be successful at determining the length and type of labour. Intrapartum transperineal ultrasound aims to give medical teams unbiased data that can assist in identifying women in prolonged labour who have a low likelihood of giving birth vaginally, enabling an early indication of the need for a caesarean section and preventing unnecessary risks to the mother and foetus. (Hassan *et al.*, 2014) [12].

The angle of progression (AOP), which runs tangentially from the distal point of the pubic symphysis to the leading portion of the foetal skull, is the angle formed between these two structures (Montaguti *et al.*, 2018) [17].

The distance of the presenting part from the outlet is one of the crucial factors in labour that determines a successful outcome.

The smallest distance between the foetal skull's outer bony limit and the perineum is known as the head-perineum distance (HPD) (Wiafe *et al*, 2016) [24].

Aim of the Work
The purpose of this study is to assess the effectiveness of intrapartum transperineal ultrasound in predicting the type of birth and length of the second stage of labour by assessing parameters for the Angel of Progression and Head Perineum Distance.

Patients and Methods
Study design
This study is prospective and cross-sectional. At Tanta University Hospitals' Department of Obstetrics inpatient ward, 65 primigravida women participated in the study. commenced in August 2021 and concluded in August 2022.

Ethical considerations
After permission by a medical ethical council, the trial was launched. We notified all of the enrolled cases of the study's purpose. The patient was informed of any risks. With regard to the patients, there were no known risks from the ultrasound examination.

After thorough description of the trial, each patient and her husband who was enrolled in it provided written informed consent. The Tanta University Hospital's medical ethical commission verifies the permission.

Inclusion criteria
- Primigravida women in the second stage of labour who are between 37 and 40 weeks pregnant.
- pregnancy with a live singleton

- cephalic presentation
- Fetal head position at or above ischial spine and normal foetal heart rate.

Exclusion criteria
- Fetal abnormalities that are documented.
- Previous Cesarean section history
- Emergency conditions including aberrant foetal cardiac patterns and placental abruption require careful surveillance.

All patients in this study were subjected to
1. Complete history-taking (Full personal, present, past, menstrual and obstetric history.)
2. A full general exam that includes the abdomen, head, neck, chest, and lower limbs (the presence of obesity, the presence or absence of scars, the apparent size and shape of the uterus, any abnormalities, any other abdominal mass should be noted.)
3. Particular obstetric testing: Grips
4. Investigations that comprise
5. Standard laboratory tests such as (Complete blood count, renal function tests, liver function tests and coagulation profile)
a) Biometry using ultrasound
b) Transperineal ultrasonography
6. Digital transvaginal examination and intrapartum transperineal ultrasound (ITPU) examination were carried out. During the second stage of labour, ultrasound images were taken.

Statistical analysis
Using the Epi-Info statistical package developed by the World Health Organization and the Centers for Disease Control and Prevention, Atlanta, Georgia, USA, version 2002, the sample size and power analysis were computed.

Results
The mode of delivery revealed that 58 (89.2%) births were vaginal and 7 (10.8%) were caesarean sections. 11(16.9%) had moulding. 11(16.9%) had caput. The second stage's duration ranged from 40 to 129 minutes, with a mean value of 54.07 to 21.4.(Table 1).

Table 1: Distribution of studied cases according to Maternal Outcome

	Number	Percent
Mode of delivery		
Vaginal	58	89.2
CS	7	10.8
Length of 2nd stage (min)		
Range	40-129	
Mean±S.D.	54.07±21.4	

HPD was ranged between 1.0-4.0 cm with mean value 2.87±0.728. Angle of progression was ranged between 125-143° with mean value 134.74±5.032°(Table 2).

Table 2: Relation between Mode of delivery and HPD and angle of progression

	Mode of delivery				P value
	Vaginal		**CS**		
	At rest	At contraction	At rest	At contraction	
HPD					
Range	1.7-4.6	1-4	3.7-4.7	3-4	P1<0.001*
Mean±S.D.	3.36±0.657	2.75±0.668	4.44±0.336	3.86±0.378	P2<0.001*

AOP					
Range	125-143	132-157	125-132	132-146	P1=0.004*
Mean ± S.D.	135.34±4.905	145.38±6.895	129.71±2.928	140.57±5.503	P2=0.035*

P1: comparison between modes of delivery at rest
P2: comparison between modes of delivery at contraction

There was a positive highly statistically significant correlation between AOP with vaginal delivery patients versus CS delivery patients in the study of the relationship between mode of delivery and HPD and angle of progression, but a negative highly statistically significant correlation between HPD and vaginal delivery patients versus CS delivery patients (Table 3).

Table 3: Correlation between Length of 2nd stage and HPD and angle of progression

	Length of 2nd stage	
	r	P
HPD	0.362	0.003*
Angle of Progression	-0.490	<0.001*

Table (4) shows ROC curve analysis between mode of delivery and TPU data and shows that CS mode can be predicted at cut off value >3.5 cm according to HPD and ≤132 according to angle of progression with sensitivity of 85.7% and 100% respectively and specificity of 91.4% and 74.1% respectively.

Table 4: ROC curve analysis between mode of delivery and TPU data

	Cut off value	Sensitivity	Specificity	AUC	P value
HPD	>3.5	85.7	91.4	0.906	<0.001*
Angle of Progression	≤132	100	74.1	0.833	<0.001*

AUC: Area under the ROC curve

Discussion
Our findings corroborated those of Hadad *et al*. (2021) [11], who reported that of the 197 women included in their study, 166 (84.3%) spontaneously gave birth vaginally, 31 (15.7%) underwent surgery, 23 (11.6%) used vacuum extraction, and 8 (4.0%) underwent caesarean delivery.
61 (27.6%) caesarean deliveries, 7 (3.2%) forceps deliveries, and 153 (69.2%) vaginal deliveries were shown by Carvalho Neto *et al*. in 2021 [4]. Due to the study's use of regional analgesia during labour and VBAC instances, there was a significant percentage of caesarean deliveries.
Also, 143 (76.5%) participants in the Chan *et al*. (2019) [5] study were included in the analysis; of these, 116 (81.1%) were part of the group receiving instrumental delivery, and 27 (18.9%) were part of the group receiving caesarean birth. Due to the study's focus on patients with extended second stages of labour, a significant number of caesarean deliveries occurred.
Our findings were consistent with a research by Carvalho Neto *et al*. (2021) [4], which found that vaginally delivered women had higher AOP levels. The second stage's mean AOP was 135.1°± 19.90° compared to 119.1°± 12.10° for CS deliveries. Using the ROC curve in the second stage of labour for the vaginal birth endpoint, they arrived at an AOP cut-off point of 129.9°. Also, they noted increased HPD values in women who gave birth surgically. In the second stage, the mean HPD was 3.42 ± 0.84 cm as opposed to 4.17 ± 0.54 cm. who gave birth vaginally. They determined an HPD cutoff point for the caesarean endpoint of 4.3 cm using the ROC curve.
Marsoosi *et al*. (2015) [16] found comparable findings in the study of 70 Iranian women, with approximate AOP values of 132.9° ±17.1° vs. 111.8° ± 5.6° for vaginal and surgical deliveries, respectively, in the second stage.

Similar findings were found when 71 European women in the second stage of labour were analysed by Ghi *et al*. (2018) [9]. For vaginal and surgical deliveries, respectively, the mean AOPs were 140.0° ± 20.2° and 122.9° ± 16.7°, respectively.
According to Kalache *et al*. (2009) [13], who analysed 41 women who had a prolonged second stage of labour, the AOP cut-off point for the same outcome was 120 degrees.
According to Kandil *et al*. (2020) [14], women who gave birth vaginally had a statistically significant higher mean angle of advancement (120.3 ± 11.9°) than those who gave birth via caesarean section (89.1 ± 10.7°), with a P value of 0.001. The mean Head perineal distance was 5.04 ± 0.48 cm for women giving birth by CS versus 3.8 ± 0.63 cm for women giving birth vaginally.
Analysis of replicated measurements taken by the same observer at roughly the same time on 75 patients was done in the study by Barbera *et al*. (2009) [3]. During the second stage of labour, an angle of at least 120 degrees was invariably linked to a subsequent spontaneous vaginal delivery. The mean angle of descent, as determined by the most recent TPU inspection, was only 108 degrees in six pregnancies that ended in caesarean sections.
According to a research by Ciaciura-Jarno *et al*. (2016) [7], all patients with an AoP above 126 degrees had a vaginal birth at full dilation. This finding is consistent with our own findings. The angle of progression was greater in the group of women who delivered vaginally, and the head-perineum distance and the head-symphysis distance were smaller in this group. These ultrasound parameters were measured at the start of the second stage of labour differently in the groups of women who delivered vaginally and those who underwent caesarean sections.
According to several studies, a successful vaginal delivery is related with an AoP of 120 degrees (Sainz *et al*., 2015, Sainz *et al*., 2016) [22, 21]. Some research, however, revealed that AoP cut-off values of 105–145.5° were related to challenging or unsuccessful instrumental delivery (Cuerva *et al*., 2014, Antonio Sainz *et al*., 2016) [8, 21]. The date of the AoP measurement, the types of pelvis used, and the parity of the individuals, however, vary widely between these investigations.
Nageeb *et al*. (2022) [18] observed similar findings; the mean HPD was 2.96 cm. There is a significant difference between the vaginal and CS groups (p=0.0005), and there is also a significant difference between CS caused by various factors and CS indicated by failure to proceed (p = 0.001).
According to Chan *et al*. (2015) [6], AOP and HPD had a strong correlation during uterine contraction (r = 0.703) and relaxation (r = 0.647). Natural log of time to normal spontaneous delivery in the subgroup of primiparous women shows the highest association with HPD and AOP during uterine contraction (r = 0.742), making delivery time prediction comparable to utilising cervical dilatation.
The AoP detected by transperineal ultrasound at the start of the second stage, according to Rouse *et al*. (2017) [20], may be able to predict the delivery method. A narrow AoP <153 degrees at complete cervical dilatation increased the likelihood of a prolonged second stage of labour and the need for a surgical delivery in pregnant women.

In singleton, term pregnancies with a foetus presenting in cephalic position, Nassr *et al* systematic 's review and meta-analysis from 2022 provide evidence of the clinical applicability of the AoP as measured at the beginning of the second stage of labour while at rest and not during a contraction by TPUS.

Results from pooled studies showed the AoP to predict spontaneous vaginal delivery in this population had a moderate diagnostic performance, with a sensitivity of 80% (95% CI, 71% & 86%) and specificity of 81% (95% CI, 72% & 88%). For predicting spontaneous vaginal birth, an AoP measured by TPUS and ranging from 108 to 119 had the highest sensitivity (94%; 95% confidence interval, 88%; 97%) and the highest specificity (82%; 95% interval, 66%; 92%).

Additionally, Hadad *et al*. (2021) [11] reported that a wider angle of progression, a shorter head-perineum distance and head-symphysis distance (both during rest and while pushing), and a lower foetal head station as determined by digital vaginal examination were significantly associated with spontaneous vaginal delivery and a shorter duration of pushing (less than an hour). With an area under the curve of 0.82 (95% confidence interval, 0.76-0.87; P.0001) and 0.75 (95% confidence interval, 0.67-0.79; P.0001), respectively, only the angle of progression at rest and the delta angle of progression were independently linked with a spontaneous vaginal delivery.

Moreover, Ali & Hebbar (2019) [1] noted that the rate of vaginal delivery increased when the trans-perineal foetal head-perineum distance reduced. The frequency of caesarean deliveries grew in a manner similar to that of the foetal head-perineum distance. Fetal head-perineum distance exhibited the highest degree of prediction at a cut-off of 5.5 cm (sensitivity 97%, specificity 88.1%).

Conclusion

It is critical to identify the elements that can predict how a birth will go for nulliparous women because doing so could lead to better perinatal outcomes. Using intrapartum ultrasound, measurements of a number of parameters, such as the angle of progression (AOP) and head-perineum distance (HPD), have been made.

The duration of the second stage of labour was connected with the intrapartum ultrasonography measurements of AOP and HPD, which may help anticipate the type of delivery based on clinical indicators. The mode of delivery and length of pushing can be predicted with ultrasound at the start of the active second stage of labour; the best predictors are the angle of progression at rest with cut-off values >3.5 cm according to HPD and 132 according to angle of progression with sensitivity of 85.7% and 100% respectively and specificity of 91.4% and 74.1% respectively.

According to our findings, there was a positive highly statistically significant correlation between AOP and vaginal delivery patients compared to CS delivery patients, while there was a negative highly statistically significant correlation between HPD and vaginal delivery patients compared to CS delivery patients.

Regarding the correlation between the length of the second stage and the HPD and the angle of progression, it was found that there was a positive and highly statistically significant correlation between the two variables while there was a negative and highly statistically significant correlation between the two variables.

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Author's Contribution

Conflict of Interest

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