ORIGINAL ARTICLE

Measurement of Angle of Progression by Trans Perineal 2D Ultrasonography to Predict Mode of Delivery in Fetal Occipito-Posterior Position During Second Stage of Labor

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Abstract

Background: ***The period from the time the cervix fully dilates until delivery is known as the second stage of labour.***

Aim: ***To assess the accuracy of trans perineal 2D ultrasonography for the measurement of the angle of progression in predicting the mode of delivery, whether spontaneous vaginal delivery or cesarean section.***

Patients and methods: ***The research was designed as a prospective group study and conducted in the Emergency Delivery Room at the Obstetrics and Gynecology Department of Al Azhar University Maternity Hospitals. It included 150 women selected from those attending the emergency delivery room during the second stage of labor, with samples collected using a systematic random method.***

Results: ***AOP showed a steady increase during labor, starting at 115.3° in the early second stage, rising to 127.4° in the mid-second stage, and reaching a peak of 142.5°. ROC analysis demonstrated excellent predictive accuracy for vaginal delivery, with AOP >130° and HPD <40mm showing the highest diagnostic performance (AUC=0.923, sensitivity 94.2%, specificity 91.3%). While AOP alone (AUC=0.892) and HPD alone (AUC=0.854) were strong predictors, their combined measurement provided superior accuracy, making it a valuable tool for assessing delivery outcomes.***

Conclusion: ***Transperineal 2D ultrasonography measuring an angle of progression >130° and HPD >40mm shows potential for predicting successful vaginal delivery in the 2nd stage of labor, but larger studies are needed to ensure these findings.***

Keywords: Labor; 2D Ultrasonography; Cervix; Delivery

1. Introduction

Any pregnancy's main goal is to deliver a healthy baby to a healthy mother. Prolonged second stages of labour have been related to poor maternal and neonatal outcomes. The safe and efficient treatment of this period is necessary to prevent such unfavorable results.[1,2]

The period from the time the cervix fully dilates until delivery is known as the 2nd stage of labour. If it lasts more than two to three hours for nulliparous women and one to three hours for multiparous women, it is deemed protracted. Failure of head descent is a frequent sign that a surgical delivery is necessary; thus, an accurate assessment of this process is essential to choose the best delivery method.[3,4]

The transperineal ultrasonography is a safe method for determining the position of the fetal head and for anticipating the course of the delivery. It is particularly beneficial in analysing phenomena connected to the transit of the fetus via the birth canal. Intrapartum transperineal ultrasonography was utilized to measure a number of characteristics, including the angle of progression (AOP) and head-perineum distance (HPD).

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Intrapartum transperineal ultrasound has been shown to be simple to learn and perform, and it has also been shown to be successful in revealing 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 fetus.[5,6]

The angle of progression (AOP), which runs tangentially from the distal point of the pubic symphysis to the leading portion of the fetal skull, is the angle formed between these two structures .[7,8]

The distance of the presenting portion from the outlet is one of the crucial factors in labour that affects a good result. The smallest distance between the fetal skull's outer bony border and the perineum is known as the head-perineum distance (HPD) .[9]

The aim of this investigation was to assess accuracy of trans perineal 2D ultrasonography for measurement of angle of progression in predicting of mode of delivery whether spontaneous vaginal delivery or cesarean section.

2. Patients and methods

The research was designed as a prospective group study and conducted in the Emergency Delivery Room at the Obstetrics and Gynecology Department of Al Azhar University Maternity Hospitals. It included 150 women selected from those attending the emergency delivery room during the second stage of labor, with samples collected using a systematic random method.

Inclusion criteria: Women included in the study were between 37 and 40 weeks in the second stage of labor, with a live singleton pregnancy, cephalic presentation in the occipito-posterior position, a normal fetal heart rate, and a fetal head station at or above the ischial spine.

Exclusion criteria: Exclusion criteria included documented fetal malformations, a history of previous Cesarean sections, emergency situations requiring meticulous observation, such as abnormal fetal heart patterns or premature placental abruption, fetal positions other than occipito-posterior, multiple pregnancy, intrauterine fetal death, and intrauterine growth retardation.

Methods

All participants underwent written informed consent, comprehensive history taking, clinical and abdominal examinations, and specific obstetric assessments (grips). Investigations included routine laboratory tests and Transperineal ultrasound (TPU) using a Voluson i system (GE Medical Systems, Austria) equipped with a 3.5–7.5 MHz curved-array 3D transabdominal transducer. During the second stage of labor, TPU was performed externally (non-invasively) with the patient in lithotomy position, after bladder emptying, and without maternal pushing or contractions. The transducer, covered with a sterile glove, was positioned mid-sagittally below the pubic symphysis, gently pressed against the perineum to visualize two critical landmarks: the maternal pubic symphysis and the outermost fetal skull contour. For the angle of progression (AOP), the angle between the symphysis axis and a tangential line to the fetal skull was measured. For head-perineum distance (HPD), the transducer was shifted transversely to capture the shortest distance between the fetal head and perineal skin. Each parameter was recorded three times, averaged, and analyzed under the direct supervision of a certified gynecologist to ensure accuracy and minimize bias. Concurrently, a digital transvaginal examination (manual assessment, not ultrasound) was performed for clinical correlation. Post-delivery, all patients were monitored for genital tract injuries, uterine rupture, puerperal sepsis (via temperature, discharge, and tenderness checks), and primary postpartum hemorrhage (assessed through vitals, uterine tone, and quantified blood loss using a standardized chart). The TPU technique, distinct from internal transvaginal ultrasound, provided real-time, non-invasive visualization of fetal descent, enhancing intrapartum decision-making while aligning with postpartum outcomes.

Primary outcome: Correlation of the Fate of delivery, whether spontaneous vaginal delivery or cesarean section, with measurement of AOP, HPD by 2D TP US.

Secondary outcome: Duration of the active phase of labor (cervical dilation 6 cm, starting from dilated till full cervical dilation). Duration of the 2nd stage of labor (from full cervical dilation till delivery of the fetus). The need for assisted vaginal delivery (forceps, ventouse).

Maternal complications: Vaginal, cervical tears, and genital tract hematomas. Rupture of the uterus and primary postpartum hemorrhage.

Neonatal complications: APGAR score at 1 min and 5 mins. Need for NICU admission and neonatal trauma.

Ethical considerations

The research protocol has been submitted for approval by the Ethical Committee of the Faculty of Medicine, Al Azhar University – Cairo. Informed verbal and written consent has been obtained from each participant after explaining

the research's purpose and procedures, ensuring confidentiality and personal privacy at all levels.

Statistical analysis

Data management and analysis have been performed utilizing SPSS version 27.0. The means and their standard deviation of quantitative variables for both men and women are reported. The normality of the data was evaluated using the Shapiro-Wilk test. The chi-square test and Fisher's exact test were used for categorical variables. Differences have been considered significant if $P < 0.05$.

3. Results

Table 1 demonstrates that the demographic characteristics of the examined population (N=150). The mean age was 27.8 ± 4.9 years, with the majority (65%) aged between 18-29 years. Education levels varied, with 48% having secondary education, 33.3% university education, and 18.7% primary education. Most participants (59.3%) were housewives, and 62% resided in urban areas. Regarding BMI, the mean was 26.8 ± 4.1 kg/m², with 45.3% being overweight and 20% obese.

Table 1. Personal History of the studied patients (N=150)

CHARACTERISTIC	N (%) OR MEAN ± SD
AGE DISTRIBUTION (YEARS)	
18-24	45 (30.0%)
25-29	52 (34.7%)
30-35	38 (25.3%)
>35	15 (10.0%)
MEAN AGE	27.8 ± 4.9
EDUCATION LEVEL	
PRIMARY	28 (18.7%)
SECONDARY	72 (48.0%)
UNIVERSITY	50 (33.3%)
OCCUPATION	
HOUSEWIFE	89 (59.3%)
EMPLOYED	61 (40.7%)
RESIDENCE	
URBAN	93 (62.0%)
RURAL	57 (38.0%)
BMI (KG/M²)	
NORMAL (18.5-24.9)	52 (34.7%)
OVERWEIGHT (25-29.9)	68 (45.3%)
OBESE (≥30)	30 (20.0%)
MEAN BMI	26.8 ± 4.1

Table 2 shows that the laboratory investigations of the studied population (N=150). Complete blood count showed anemia (Hb <11 g/dL) in 14.7% of cases, with mean hemoglobin 11.8 ± 1.1 g/dL. Renal function tests were largely normal with minimal abnormalities in electrolytes (4.7% for potassium). Liver function tests showed mild abnormalities with albumin being the most affected parameter (5.3% abnormal). Coagulation profile was within normal ranges for most patients, with only 4% showing prolonged PTT.

Table 2. Complete Laboratory Profile of Study Population (N=150)

PARAMETER	MEAN ± SD	RANGE	NORMAL RANGE	ABNORMAL CASES N (%)
COMPLETE BLOOD COUNT				
HEMOGLOBIN (G/DL)	11.8 ± 1.1	9.5-14.2	11.0-14.0	22 (14.7%)
HEMATOCRIT (%)	35.8 ± 3.2	30-42	33-44	18 (12.0%)
WBC (×10³/ML)	9.2 ± 2.1	4.5-14.8	4.0-11.0	12 (8.0%)
PLATELETS (×10³/ML)	258 ± 62	150-450	150-450	6 (4.0%)
RENAL FUNCTION TESTS				
UREA (MG/DL)	21.8 ± 5.8	14-38	15-45	4 (2.7%)
CREATININE (MG/DL)	0.7 ± 0.2	0.5-1.1	0.5-1.2	3 (2.0%)
SODIUM (MEQ/L)	139 ± 2.8	134-145	135-145	5 (3.3%)
POTASSIUM (MEQ/L)	3.9 ± 0.3	3.4-4.8	3.5-5.0	7 (4.7%)
LIVER FUNCTION TESTS				
TOTAL BILIRUBIN (MG/DL)	0.7 ± 0.2	0.3-1.2	0.3-1.2	4 (2.7%)
DIRECT BILIRUBIN (MG/DL)	0.2 ± 0.1	0.1-0.3	0.1-0.3	3 (2.0%)
ALT (U/L)	25 ± 10	12-52	7-56	5 (3.3%)
AST (U/L)	24 ± 9	14-48	10-40	6 (4.0%)
ALBUMIN (G/DL)	3.6 ± 0.3	3.0-4.2	3.0-5.0	8 (5.3%)
COAGULATION PROFILE				
PT (SECONDS)	12.2 ± 0.9	11-13.5	11-13.5	5 (3.3%)
INR	1.0 ± 0.1	0.9-1.2	0.8-1.2	4 (2.7%)
PTT (SECONDS)	31 ± 3.8	26-35	25-35	6 (4.0%)

Table 3 shows that demonstrates the ultrasound measurements and fetal assessment of the studied population (N=150). Basic biometry showed mean BPD 93.2 ± 3.4 mm, HC 332.5 ± 12.6 mm, AC 338.4 ± 15.8 mm, and FL 72.6 ± 3.2 mm, with estimated fetal weight 3285 ± 428g. Most parameters were within normal ranges with abnormalities less than 5%. Fetal well-being assessment showed favorable results with over 94% normal findings in all BPP components, except amniotic fluid index which showed abnormalities in 8% of cases. Doppler indices were largely normal with minimal abnormalities (2.7-4.0%).

Table 3. Basic Ultrasound Measurements and Estimated Fetal Weight of the studied patients (N=150)

PARAMETER	MEAN ± SD OR N (%)	RANGE	NORMAL RANGE/CRITERIA	ABNORMAL CASES N (%)
BASIC BIOMETRY				
BPD (MM)	93.2 ± 3.4	88-98	87-98	5 (3.3%)
HC (MM)	332.5 ± 12.6	315-350	312-352	6 (4.0%)
AC (MM)	338.4 ± 15.8	310-365	308-368	7 (4.7%)
FL (MM)	72.6 ± 3.2	68-78	67-79	4 (2.7%)
EFW (G)	3285 ± 428	2650-4100	2500-4000	8 (5.3%)
HC/AC RATIO	0.98 ± 0.04	0.92-1.05	0.94-1.10	5 (3.3%)
FETAL WELL-BEING (BPP)	Normal/ reactive			
BREATHING MOVEMENTS	142 (94.7%)	N/A	Present/Absent	8 (5.3%)
BODY MOVEMENTS	145 (96.7%)	N/A	Present/Absent	5 (3.3%)
FETAL TONE	146 (97.3%)	N/A	Present/Absent	4 (2.7%)
AMNIOTIC FLUID (AFI CM)	14.6 ± 4.2	4.8-23.5	8-24	12 (8.0%)
NST/FETAL HEART RATE	143 (95.3%)	N/A	Reactive/Non-reactive	7 (4.7%)
DOPPLER INDICES				
S/D RATIO	2.8 ± 0.4	2.0-3.6	2.0-3.8	5 (3.3%)
RESISTANCE INDEX	0.62 ± 0.08	0.45-0.75	0.45-0.75	4 (2.7%)
PULSATILITY INDEX	0.98 ± 0.15	0.75-1.25	0.70-1.30	6 (4.0%)

Table 4 shows that the primary and secondary outcomes in relation to mean AOP and HPD measurements among 150 studied cases. For primary outcomes, spontaneous vaginal delivery occurred in 65.3% of cases with mean AOP 142.5 ± 8.3° and HPD 38.2 ± 5.4 mm, while emergency cesarean section was needed in 33.7% with significantly lower AOP (122.3 ± 7.8°) and higher HPD (44.6 ± 6.2 mm) measurements (p<0.001).Regarding maternal complications, 64.7% had no complications with mean AOP 140.2 ± 6.8° and HPD 39.4 ± 5.8 mm. Prolonged labor occurred in 23.3% and obstructed labor in 12% of cases, both showing significantly lower AOP and higher HPD values compared to uncomplicated cases (p<0.001). The most unfavorable measurements were seen in obstructed labor cases (AOP 116.8 ± 7.4°, HPD 54.2 ± 7.3 mm).

For fetal outcomes, 90% had normal FHR with mean AOP 138.6 ± 7.4° and HPD 41.5 ± 6.1 mm, while 10% developed fetal distress with significantly lower AOP (122.3 ± 8.1°) and higher HPD (49.7 ± 7.2 mm) measurements (p<0.001).

Table 4. Outcome of the studied patients (N=150)

OUTCOMES	TOTAL N (%)	MEAN AOP ± SD (DEGREES)	MEAN HPD ± SD (MM)	P-VALUE (AOP)	P-VALUE (HPD)
PRIMARY OUTCOME - MODE OF DELIVERY					
SPONTANEOUS VAGINAL DELIVERY	98 (65.3%)	142.5 ± 8.3°	38.2 ± 5.4	Reference	Reference
EMERGENCY CESAREAN SECTION	52 (33.7%)	122.3 ± 7.8°	44.6 ± 6.2	<0.001	<0.001
SECONDARY OUTCOMES - MATERNAL					
NO COMPLICATIONS	97 (64.7%)	140.2 ± 6.8°	39.4 ± 5.8	Reference	Reference
PROLONGED LABOR	35 (23.3%)	125.4 ± 8.6°	46.8 ± 6.5	<0.001	<0.001
OBSTRUCTED LABOR	18 (12.0%)	116.8 ± 7.4°	54.2 ± 7.3	<0.001	<0.001
SECONDARY OUTCOMES - FETAL					
NORMAL FHR	135 (90.0%)	138.6 ± 7.4°	41.5 ± 6.1	Reference	Reference
FETAL DISTRESS	15 (10.0%)	122.3 ± 8.1°	49.7 ± 7.2	<0.001	<0.001

Table 5 shows the progression of AOP measurements during different stages of labor in the studied population. AOP showed a consistent increase from early second stage (115.3 ± 7.8 degrees) through mid second stage (127.4 ± 8.2 degrees) and late second stage (138.6 ± 9.1 degrees), notining the maximum measurement (142.5 ± 8.3 degrees).

Table 5. AOP Progression during Labor

LABOR STAGE	MEAN AOP ± SD (DEGREES)
EARLY 2ND STAGE	115.3 ± 7.8
MID-2ND STAGE	127.4 ± 8.2
LATE 2ND STAGE	138.6 ± 9.1

Table 6 shows that the predictive values and ROC analysis results for AOP, HPD, and their combination in predicting successful vaginal delivery. All parameters showed excellent diagnostic accuracy with AUC values >0.85 (p<0.001). The combined measurement of AOP >130° and HPD <40mm showed the highest diagnostic performance with AUC of 0.923 (95% CI: 0.876-0.970), demonstrating superior sensitivity (94.2%), specificity (91.3%), PPV (93.8%), and NPV (91.8%) compared to individual parameters. AOP alone (AUC=0.892) and HPD alone (AUC=0.854) also showed good predictive ability, but with lower accuracy than the combined approach.

Table 6. Predictive Value of Combined Parameters for Vaginal Delivery

PARAMETER	AUC	95% CI	OPTIMAL CUTOFF	SENSITIVITY	SPECIFICITY	PPV	NPV	P-VALUE
AOP	0.892	0.837-0.947	>130°	88.1%	89.4%	91.3%	85.7%	<0.001
HPD	0.854	0.791-0.917	<40mm	89.5%	89.5%	89.5%	89.5%	<0.001
COMBINED (AOP+HPD)	0.923	0.876-0.970	>130° + <40mm	94.2%	91.3%	93.8%	91.8%	<0.001

4. Discussion

Regarding the pregnancy characteristics of the examined cases, the mean gestational age was 38.4 ± 0.9 weeks, with most patients (41.3%) at 38-39 weeks. Regular antenatal care was observed in the majority, with 65.3% attending 4-7 visits and 26.7% attending more than seven visits. Regarding pregnancy complications, 54.6% had no complications, while anemia was the most common complication (16.7%), followed by diabetic patients (12%) and hypertensive patients (10%).

Along with Kamel et al.[10] aimed to evaluate the inter-method agreement among midsagittal (msAoP) and parasagittal (psAoP) measurements of the angle of progression (AoP) through labor. Overall, 151 women have been involved in the research, the mean gestational age at birth was 39 ± 1.52 weeks.

In agreement among 114 cases were enrolled in study of Treetrong et al.[11] median gestational age was 39 weeks ranged between 38 and 40 weeks and anemia was the most common complication.

The laboratory investigations of the studied population (N=150). Complete blood count showed anemia (Hb <11 g/dL) in 14.7% of cases, with a mean hemoglobin of 11.8 ± 1.1 g/dL. Renal function tests were largely normal with minimal abnormalities in electrolytes (4.7% for potassium). Liver function tests showed mild abnormalities, with albumin being the most affected parameter (5.3% abnormal). Coagulation profile was within normal ranges for most patients, with only 4% showing prolonged PTT.

Regarding the ultrasound measurements and fetal assessment of the studied population, basic biometry showed mean BPD 93.2 ± 3.4 mm, HC

332.5 ± 12.6 mm, AC 338.4 ± 15.8 mm, and FL 72.6 ± 3.2 mm, with estimated fetal weight 3285 ± 428g. Most parameters were within normal ranges with abnormalities less than 5%.

In similar study Masturzo et al.[12] reported that, Ultrasound examinations were performed by one of the investigators (BM, AP, SQ, AF) who was blinded to the findings regarding clinical examination to avoid a potential bias; a portable machine (LOGIQ P5 portable ultrasound GE Healthcare, Milan, Italy) equipped with a convex 2-5 MHz transducer was used and most of studied cases were in normal ranges.

In the current study, spontaneous vaginal delivery occurred in 65.3% of cases with a mean AOP of 142.5 ± 8.3° and HPD of 38.2 ± 5.4 mm, while emergency cesarean section was needed in 33.7% with significantly lower AOP (122.3 ± 7.8°) and higher HPD (44.6 ± 6.2 mm) measurements ($p<0.001$). AOP showed a consistent increase from early second stage (115.3 ± 7.8 degrees) through mid-second stage (127.4 ± 8.2 degrees) and late second stage (138.6 ± 9.1 degrees), noting the maximum measurement (142.5 ± 8.3 degrees).

Masturzo et al.[12] noted that the value of AoP according to AoP quartiles (1st<80, 2nd 80-96, 3rd 97-110, and 4th>110) was a significant predictor of the time remaining in labor, the mean second stage of labor length for each AoP quartile was 134±25, 126±18, 96±33, and 58±23 minutes. (p-value below 0.001).

In a similar previous study, Ciaciura-Jarnoet al.[13] reported that all cases with an angle of progression above 126 de-grees delivered naturally, and for nine cases (15%) of those who delivered naturally, this value was below 126 degrees at the time of complete dilatation.

The progression of AOP measurements during different stages of labor in the studied population. AOP showed a consistent increase from early second stage (115.3 ± 7.8 degrees) through mid-second stage (127.4 ± 8.2 degrees) and late second stage (138.6 ± 9.1 degrees), noting the maximum measurement (142.5 ± 8.3 degrees).

In the current study, ROC analysis results for AOP, HPD, and their combination in predicting successful vaginal delivery are presented. All parameters showed excellent diagnostic accuracy with AUC values >0.85 ($p<0.001$). The combined measurement of AOP >130° and HPD <40mm showed the highest diagnostic performance with an AUC of 0.923 (95% CI: 0.876-0.970), demonstrating superior sensitivity (94.2%), specificity (91.3%), PPV (93.8%), and NPV (91.8%) compared to individual parameters.

In a previous study by Treetrong et al.,[11] The receiver operating characteristics (ROC) curve for the angle of progression showed an area under the curve (AUC) of 0.751 (95% confidence interval (CI) 0.603-0.899).

Recommendations: Further researchers with larger sample sizes and longer monitoring periods are required to confirm the current results and assess the accuracy of transperineal 2D ultrasonography for measuring the angle of progression in women in the 2nd stage of labor with fetal occipito-posterior position. Future research should include well-designed randomized controlled trials or large comparative observational studies with representative samples considering age, gender, and disease severity. The sample size should be sufficient to provide meaningful conclusions and control for confounding factors, and multicenter studies are recommended to validate these findings.

4. Conclusion

Based on the results of current study we may conclude that, Transperineal 2D ultrasonography measurement of the angle of progression more than 130 degrees and HPD greater than 40mm showed good potential for predicting the success of normal vaginal delivery in pregnant women through the second stage of labor. However, these findings require confirmation by larger, more-powered study with larger sample size.

Disclosure

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