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Role of Measuring Intrapartum Angle of Progression as a Predictor for Mode of Delivery in Primigravidae

Sohaila Soliman Mohamed Soliman*, Elham Hussein Madany, Rasha Alsayed Khamiss, Asmaa Mostafa Al-Gedawy
Department of Obstetrics and Gynecology, Faculty of Medicine, Suez Canal University, Egypt
***Corresponding author:** Sohaila Soliman Mohamed Soliman, **Mobile:** 01009736730, **E-mail:** saldaktwrt@gmail.com

ABSTRACT

Background: One of the most vital components of the management of females through labor is evaluating their delivery progress. It is imperative to consider the extent of delivery progress when determining whether or not to intervene in a natural delivery. **Aim**: This investigation aimed to estimate the role of measuring intrapartum angle of progression (AOP) in prediction of mode of delivery in primigravidae women to improve fundings of fetus and mother.

Patients and methods: This investigation has been carried out as a descriptive cross-sectional investigation conducted in the Emergency Unit of Obstetrics and Gynecology Department, Suez Canal University, involving 127 participants of full-term primiparous women.

Results: The females who delivered vaginally had a significantly higher mean of AOP of 114.3 ± 7.13 compared to those with cesarean section (CS) , whose AOP was 94.48 ± 5.59, with a p-value lower than 0.001. Also, there was statistically significant variance among both groups in head station, as vaginal delivery (VD) had a lower head station than CS. AOP ≥98.5 had the highest diagnostic accuracy in predicting vaginal delivery, followed by cervical dilatation rate ≥2.75 and then head station ≥0.

Conclusion: In conclusion, our study found that the AOP positively correlates with VD; AOP ≥98.5 had the highest diagnostic accuracy in predicting vaginal delivery.

Keywords: Intrapartum angle of progression, Mode of delivery, Primigravidae

INTRODUCTION

One of the most crucial components of the management of females through labor is evaluating their delivery progress. It is imperative to consider the extent of delivery progress when determining whether or not to intervene in a natural delivery. Approximately forty-one to forty-five percent of deliveries are natural and need no medical assistance [(1)].

Labor dystocia, additionally referred to as aberrant progression of delivery, can be identified as a lack of progress in effacement, cervical dilatation, or presentation descent [(2)].

It has been proposed that transperineal sonography (TPUS) may be a beneficial instrument for predicting mode of delivery and following up on the progress of labor. A parameter known as the angle of progression is determined through the measurement of the angle among the long axis of the symphysis pubis and a line that extends tangentially from its most inferior border to the skull of fetus [(3)].

Cesarean delivery (CD) rates are considerably elevated in developing countries and are evaluated to constitute about one-third of deliveries. A successful trial of labor following cesarean (VBAC) has been proven to be more cost-effective compared to a repeat cesarean delivery and safer for the mother in both the index and subsequent deliveries in females who have been previously delivered by cesarean delivery [(4)].

The angle of progression is a reliable and reproducible method for evaluating the descent head of a fetus through labor [(5,6)].

This investigation aimed to estimate the role of measuring intrapartum angle of progression in prediction of mode of delivery in primigravidae females to improve outcomes of mother and fetus.

PATIENTS AND METHODS

This investigation had been performed as descriptive cross-sectional research carried out in the Emergency Unit of Obstetrics and Gynecology Department, Suez Canal University, involving 127 participants of full-term primiparous females from December 2022 to November 2023.

Inclusion criteria: Term pregnancy (thirty-seven to forty-two weeks of gestation), viable singleton pregnancy, vertex presentation with occiput anterior position, and in the active phase of labor (4 cm dilatation, 40% effacement).

Exclusion criteria: Multiple gestation, premature rupture of membranes, fetal growth restriction, fetal macrosomia**,** fetal distress, chronic illness (DM, HTN, etc.), any previous uterine surgeries, abnormal presentation, abnormal head position, and antepartum hemorrhage (placenta previa).

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Sample Size

The sample size has been determined utilizing the following equations:
(7)

$$N = \frac{FP + TN}{(1 - p)}$$

$$FP + TN = Z^2_{\alpha/2} \frac{SP(1 - SP)}{W^2}$$

N = Sample Size
P = prevalence of the condition in the test population in the previous study, 64.4% **(8,9)**.
Z=2
α\2 = 1.96 (the critical value that separates the central ninety-five percent of the Z distribution from the five percent in the tail)
SP = specificity of the test = 65.6% **(9)**
W = width of confidence interval = 10% **(8)**
Based on the previous calculations, 127 participants were required.

Data collection tools:
Questionnaire: For basic information as (age, last menstrual period, gestational age, history of present illness and drug, etc.), the questionnaire was filled out from each participant by the physician.

METHODS
All cases have been subjected to the following:
Physical examination and general examination: Were done by the physician, including the necessary parameters for each participant as vital signs and BMI. Local examination: Abdominal: Inspection, assessment of fundal level, assessment of fetal lie, assessment of fetal presentation, assessment of uterine contractions, and assessment of fetal heart rate. Vaginal Examination: Inspection of any abnormalities and cervix, fetal membrane examination, and fetal head examination. **Investigations:** Lab: CBC, PT, PTT, INR, **and** ABO grouping and imaging; transabdominal ultrasound for assessment of fetal viability, fetal presentation, amniotic fluid index, fetal presentation, fetal position, and transperineal transperitoneal ultrasound for measurement of AOP.

Steps of measuring intrapartum AOP
This was done as follows: A full-term primiparous woman in the active labor phase was examined for cervical dilatation and effacement. The head position was confirmed to be occiput anterior through ultrasound and prevaginal examination. The head station was determined through per vaginal examination and ultrasound methods. Transabdominal imaging in the sagittal and axial planes is the optimal method for sonographic evaluation of position of head of fetus. The fetal spine's position has been determined by placing probe of ultrasound transversely on the maternal abdomen to acquire an axial view of the trunk of the fetus **(10)**. A curved probe of HITACHI **(**ARIETTA 65**)** ultrasound **(produced in Japan by Hitachi, Ltd.))** was used. The probe is convex (5-1 MHz) with a single crystal transducer. In the Radiology Unit, Suez Canal University, AOP was measured in the active phase of labor using transperitoneal ultrasonography.

AOP assessment
We measured AOP as follows: the ultrasound probe has been situated between labia below pubic symphysis, allowing a sagittal view of the symphysis pubis and the leading position of the head of fetus. A line was drawn between the calipers and contour of skull of the fetus, and the angle between these lines was determined. The patient has been then taken to the emergency room for assessment of uterine contractions, intravenous fluids, prophylactic antibiotics, an artificial amniotomy, continuous assessment of fetal heart rate with CTG, and follow-up of fetal head progression using the partogram with PV examination almost hourly. **Partogram:** The graphic record of maternal and fetal data during labor (2^{nd} stage) plots cervical dilation against time, fetal heart rate, contractions, and other vital signs. The active phase of labor is denoted by a four-centimeter cervical dilation with a minimum rate of 1 cm/h **(11).**

Statistical analysis of the data
The data have been coded and input into the computer statistical program. The Statistical Package for the Social Sciences (SPSS software package version 20.0, IBM Corp., Armonk, NY) has been utilized in order to proceed with the processing of the collected data. Quantitative variables have been presented in the form of mean, standard deviation (SD), and range, and were compared by the student t-test. While qualitative data were presented in the form of numbers and percentages and were compared by Fisher's exact test. The normality of the distribution has been confirmed using the Shapiro-Wilk test. An assessment of the significance of the findings obtained has been carried out at a level of five percent. 4. ROC curve analysis was used to study the cutoff values of **vaginal delivery predictors.**

Ethical Considerations
Through carrying out this investigation, the following ethical considerations have been taken into consideration: All the participants in the study provided written consent, including all the needed information, before participation, and the procedure

was explained to them by the physician. The data were kept strictly confidential for research purposes only. The data were exclusively utilized in this investigation. Every patient who participated in the investigation was granted the right to withdraw at any time, without providing a reason, and without any adverse effects on their daily life. All the participating patients were informed about the results of the study. The participants were provided with the researcher's phone number and all available communication methods, allowing them to return at any time for any necessary clarification. No disclaimer or conflict of interest existed in the investigation.

RESULTS

The mean age of the participants was 22.94 ± 4.05 years. Additionally, the majority of the participants were overweight, with a mean BMI of 25.24 kg/m^2. The mean gestational age of subjects was 39.07 ± 1.12 based on the date, while it was 38.66 ± 0.84 according to ultrasound measurements. The mean EFBW of the study subjects was 3.126 ± 0.381 kg (Table 1).

Table 1: Maternal and fetal characteristics of the cases under investigation (number = 127)

Variable	Mean ± SD.	Range
	Maternal	
Age (years)	22.94 ± 4.05	15.0 – 34.0
Weight (kilogram)	68.34 ± 7.22	55.0 – 87.0
Height (cm)	164.5 ± 3.13	158.0 – 172.0
BMI (kg/m^2)	25.24 ± 2.36	21.26 – 30.85
	Fetal	
Gestational age by date	39.07 ± 1.12	37.0-42.0
Gestational age by US	38.66 ± 0.84	37.0-40.0
Fetal weight (kg)	3.126 ±0.381	2.490-3.900

SD: Standard deviation, US: ultrasound, BMI: Body mass index.

The mean cervical dilatation was 5.17 ± 1.23 cm. The majority of the study participants (51.2%) had head station values +1 (at starting time). The mean effacement of the cervix was measured at 52.28± 12.36 (Table 2).

Table 2: Pervaginal examination characteristics and AOP among the studied cases (n = 127)

Variable	Range	Mean ± SD.
Cervical dilatation (centimeters)	4.0 – 8.0	5.17 ± 1.23
Cervical effacement (%)	40.0 – 80.0	52.28±12.36
Cervical dilation rate (Cm/hr.)	0.6-1.6	1.18 ± 0.20
AOP in active phase (º)	89-128	111.1±10.05
	N	%
Head station		
-1	5	3.9
0	55	43.3
1	65	51.2
2	2	1.6

AOP: Angel of progression

The majority of the studied group (83.5%) had VD (Table 3).

Table 3: Distribution of the cases under investigation regarding mode of delivery (n = 127)

Variable	Mode of delivery	
	No.	%
CS	21	16.5%
VD	106	83.5%

VD: Vaginal delivery, CS: Cesarean section.

The females who delivered vaginally had a significantly greater mean of AOP of 114.43 ± 6.96 compared to those with CS, whose AOP was 94.48 ± 5.59. Also, statistically significant variance has been detected among both groups in head station as VD had a lower head station than CS (Table 4).

Table 4: Comparison of pervaginal examination characteristics and AOP of the cases under investigation regarding mode of delivery (n = 127)

Variable	VD (n = 106)	CS (n = 21)	P-value
Cervical dilatation (Cm)	5.21 ± 1.25	5.0 ± 1.18	0.480[1]
Cervical effacement (%)	52.0±11.64	54.76±15.37	0.350[1]
Cervical dilation rate (Cm/hr.)	1.24 ± 0.15	0.88± 0.17	**<0.001*[1]**
AOP in active phase (º)	114.43±6.96	94.48±5.59	**<0.001*[1]**
Head station			
-1	2(1.9%)	3(14.3%)	
0	44(41.5%)	11(52.4%)	**0.044*[2]**
1	58(54.7%)	7(33.3%)	
2	2(1.9%)	0(0%)	

AOP: Angel of progression, SD: Standard deviation, VD: Normal vaginal delivery, CS: cesarean section, 1: Student t-test, 2: Fisher exact test used, *: Statistically significant.

Head station, cervical dilatation rate, and AOP were significant predictors for vaginal delivery (Table 5).

Table 5: Diagnostic performance of different vaginal delivery predictors.

Test Result Variable(s)	AUC	Std. Error	Asymptotic Significance	Asymptotic ninety-five percent Confidence Interval	
				Lower Bound	Upper Bound
Cervical dilatation	0.577	0.058	0.269	0.463	0.691
Cervical effacement	0.367	0.063	0.055	0.243	0.491
Head station	0.641	0.069	**0.042***	0.507	0.776
Cervical dilatation rate	0.141	0.053	**<0.0001***	0.036	0.245
AOP	0.936	0.033	**<0.0001***	0.871	1.000

AOP: Angel of Progression, Std: Standard, *: Statistically significant

AOP ≥98.5 had the highest diagnostic accuracy in predicting vaginal delivery, followed by cervical dilatation rate ≥2.75 and then head station ≥0 (Table 6).

Table 6: Diagnostic performance of various vaginal delivery predictors 'cutoff points.

Test Result Variable(s)	Cutoff	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Head station	≥0	73.0	66.0	68.2	70.9	69.5
Cervical dilatation rate	≥2.75	85.5	71.0	74.7	83.0	78.25
AOP	≥98.5	95.1	76.2	80	94	85.7

PPV: positive predictive value NPV: negative predictive value

A significant direct correlation between AOP and both the rate of cervical dilatation and changes in head station (p=<0.001), (p=0.016) respectively. Nevertheless, no statistically significant changes were found in the relationship between AOP during the active phase of labor and BMI or the age of women (Table 7).

Table 7: Correlation between AOP in active phase and different parameters (n = 127)

Variable	AOP in active phase	
	R	**P**
Age (years)	-0.082	0.358
BMI (kg/m^2)	0.048	0.591
Cervical dilation rate	**0.491***	**<0.001***
Head station	**0.213***	**0.016***

r: Pearson coefficient *: Statistically significant at $p \leq 0.05$

DISCUSSION

Regarding demographic data of the studied cases, the mean age of our subjects was 22.94 ± 4.05 years. Most of them were overweight, with a case BMI of 25.24 ± 2.36 kg/m^2. The mean cervical dilatation was 5.17 ± 1.23 cm. It dilated at a mean rate of 1.18 ± 0.20. The least value of head station was -1 and the maximum value was two with the majority of participants having station +1 (51.2%). Their cervical mean effacement was 52.28± 12.36.

Our study reported that a significant direct correlation has been detected among AOP and both cervical dilatation rate and head station changes with a p-value lower than 0.001 and a p-value lower than 0.016, respectively.

This came in accordance with an investigation by **Elkadi *et al*., [8]** who stated that a significant association has been detected between angle of progression and both cervical dilatation rate and head station changes. This is due to the similarity between our study and his study in participants' characteristics as GA, maternal age, and sample size.

There were statistically insignificant changes in terms of the relation between angle of progression in active phase of labor and BMI and the age of subjects, which denies any positive association between these variables, and that too is in agreement with many others [4,8,12,13].

Our results are also corroborated by numerous additional investigations in the literature. **Brunelli *et al*. [12]** discovered that the angle of progression was advantageous in predicting spontaneous vaginal birth and determining the period of the 2nd stage of labor. This information might be beneficial in the counseling and management of labor cases. These results are also corroborated by the results of **Minajagi *et al*. [13]**.

In our study, women with VD had a significantly higher mean AOP of 114.3 ± 7.13 compared to those with CS, whose AOP was 94.48 ± 5.59, with a p-value of lower than 0.001. Also, a statistically significant variance has been detected among both groups in head station, as VD had a lower head station than CS (p = 0.044). Nevertheless, no statistically significant changes were found in the relationship between AOP through the active phase of labor and BMI, or the age of women.

Our findings are consistent with those of a different investigation, which determined that the possibility of a VD delivery increased as angle of progression increased and that the possibility of a cesarean section delivery increased as the progression angle decreased. Additionally, the researchers found no correlation between progression angle and birth weight, gestational age, MI, or gravidity [14].

In another investigation, a total of 137 cases had been involved in the analysis, and the median angle of progression for the investigation group was 153 degrees. The adjusted odds ratio (AOR) of needing an operative delivery was 2.6 times greater for cases with an adjusted odds ratio of 153 degrees or less, and the adjusted odds ratio of needing a cesarean delivery was nearly six times greater for cases with an adjusted odds ratio of 153 degrees or more (ninety-five percent confidence interval [CI]: 1.0, 6.2; p-value equal 0.04; adjusted odds ratio: 5.8, ninety-five percent CI: 1.2–28.3; p value equal to 0.03, respectively). Cases with an adjusted odds ratio of less than 153 degrees were at a greater risk of remaining pregnant for an extended period (adjusted hazard ratio: 1.8, ninety-five percent CI: 1.2–2.8, p-value equal to 0.005) [15]. The reason for this discrepancy is that the investigation undertaken by **Bibbo et al.** has been carried out on females who were in the 2nd stage of labor.

In accordance with another investigation that determined that seventy-seven (82.79 percent) were delivered vaginally and sixteen (17.2 percent) necessitated an emergency caesarean section. The mode of delivery and the induction-to-delivery interval were significantly correlated to AOP. The angle of progression was substantially wider in females who delivered vaginally compared to those who delivered by caesarean section [16].

The current study results found that angle of progression ≥98.5 had the highest diagnostic accuracy in predicting vaginal delivery, with 95.1% sensitivity and 76.2% specificity, followed by cervical dilatation rate ≥2.75 and then head station ≥0.

This is in agreement with another study found that AOP not less than ninety-seven degrees had the highest diagnostic characteristics. Another study stated that it was equal to or higher than 98 degrees [4,8]. These studies were similar to our study in women's characteristics and sample size.

Chan *et al*. [17] discovered that 116 of the 143 females had a successful instrumental birth, while twenty-seven underwent a cesarean delivery. The angle of progression predicted roughly eighty percent of successful device-assisted births as a result of the prolongation of the 2nd stage of labor, as indicated by the results of this study. In this research, the most efficient angle of progression cut-offs for predicting successful instrument delivery were 138.7 degrees at rest (86.2 percent sensitivity, 51.9 percent specificity) and 160.9 degrees in contraction (87.1 percent sensitivity, 74.1 percent specificity).

The reason for this discrepancy is that the research project undertaken by **Chan *et al*. [17]** carried out on females who had singleton term pregnancies with an extended 2nd stage of labor.

A previous investigation that investigated one hundred nulliparous and seventy-one multiparous pregnant females whose gestational age was equal and greater than thirty-nine weeks, demonstrated that

nulliparous females with a narrow angle of progression' under ninety-five degrees have a greater probability of cesarean delivery. Multiparous females exhibited a narrower angle of progression' compared to nulliparous females prior to the commencement of labor. Although, unlike nulliparous females, limited angle of progression' in multiparous females doesn't appear to be related to CD, and the majority of multiparous females deliver vaginally. In contrast to the outcomes of this investigation, our findings indicated that a prolonged time for induction and 2nd stage of labor were associated with a lower AOP in both primigravida and multigravida females [18].

These findings indicate that AOP positively correlates with the probability of normal vaginal delivery. This suggests that using this method is a good predictor of VD.

CONCLUSION

In conclusion, our study found that the angle of progression (AOP) positively correlates with vaginal delivery (VD); AOP ≥98.5 had the highest diagnostic accuracy in predicting vaginal delivery.

DECLARATIONS

- **Consent for publication:** I certify that each author has granted permission for the work to be submitted.
- **Funding:** No fund
- **Availability of data and material:** Available
- **Conflicts of interest:** None
- **Competing interests:** None

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