Original Article

Head Perineal Distance and Angle of Progression to Predict Caesarean Delivery due to Labor Dystocia in Term Pregnancy with Active Phase of Labor

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Objective: To evaluate the predictive value of head perineal distance [HPD] and angle of progression [AOP] measured by transperineal ultrasound to predict of caesarean delivery due to labor dystocia in term pregnancy with active phase of labor.

Materials and Methods: The present report was a prospective study conducted at Bhumibol Aduyadej Hospital between January and December 2016. Term singleton pregnancy in cephalic presentation were enrolled when they entered the active phase of labor and abnormal partograph were not present during the time of enrollment. HPD and AOP were measured and then all participants received standard labor management. Data of transperineal ultrasound and obstetric outcome were obtained and analyzed to predict caesarean delivery due to labor dystocia.

Results: Among 400 participants enrolled in the present study, sixty-three cases (15.75%) underwent caesarean delivery due to labor dystocia. From the receiver operating characteristics curve, area under the ROC curve of HPD and AOP to predict cesarean delivery were 66% (95% CI, 59% to 73%) and 74% (95% CI, 68% to 80%), respectively. The cut-off point of HPD was 5.67 cm or greater, corresponding to a sensitivity of 88.69%, and a specificity of 34.42%. For AOP, 96 degrees or less, corresponded to a sensitivity of 71.42%, a specificity of 67.46%. According to binary logistic regression, AOP was associated with caesarean delivery due to labor dystocia significantly and independently [adjusted OR 4.46 (95% CI 2.06 to 9.21)], while the HPD was not [adjusted OR 1.80 (95% CI 0.72 to 4.51)].

Conclusion: AOP of 96 degrees or less can be used as a screening tool for labor dystocia in term pregnancy while the HPD cannot.

Keywords: Labor dystocia, Head perineal distance, Angle of progression

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Labor dystocia, which is referred to cephalopelvic disproportion and failure to progress, is the most common indication of primary caesarean delivery in many countries[1,2]. Diagnosis of labor dystocia is based on pattern of labor plotted in the World Health Organization [WHO] partograph. Abnormal pattern of partograph such as protraction disorders, arrest disorders, or second-stage disorder must be present in cases with diagnosis of labor dystocia[3]. These may lead to prolonged first stage of labor associated with complication such as caesarean's delivery during the first or second stage, chorioamnionitis, and neonatal admission in NICU[4]. Longer length in active phase of labor was associated with prolonged second stage[5], which increased risk of uterine atony, postpartum hemorrhage, perineal trauma, operative delivery, and chorioamnionitis[6,7]. In previous publications, transperineal ultrasound such as head perineal distance [HPD] and angle of progression [AOP] had been studied to predict mode of delivery in many situations. In cases with premature rupture of membrane[8] and labor induction[9], short HPD has fewer rate of caesarean delivery. During early second stage, AOP was significantly narrow in cases with operative vaginal delivery and caesarean delivery[10]. In cases with prolonged first stage of active phase, HPD and AOP were associated with successful vaginal delivery[11,12].

During an active phase of labor, before the WHO partograph show abnormal pattern, prediction of caesarean delivery due to labor dystocia is challenged and the role of transperineal ultrasound had not been studied in this scenario. The objective of the present study was to evaluate the predictive value of HPD and AOP to predict caesarean delivery of labor dystocia in the first stage active labor phase.

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Materials and Methods

The authors performed a prospective observational study conducted in pregnant women with gestational ages between 37 and 42 weeks admitted to delivery suit, Department of Obstetric and Gynecology, Bhumibol Adulyadej Hospital, for labor pain and delivery, between January and December 2016. Eligible cases were 1) singleton, 2) active phase of labor, 3) rupture amniotic membranes including both spontanoeus or artificial rupture, 4) cephalic presentation, and 5) no abnormal labor curve demonstrated by the WHO partograph at the time of enrollment. Exclusion criteria were pregnant women who had been caesarean delivery with indiction other than labor dystocia, intrauterine fetal death, known gross fetal anomaly, and private cases. All women gave their written informed consent and the study was approved by the Ethics Committee, Bhumibol Adulyadej Hospital. Upon arrival at the labor and delivery unit, the birth attendant (midwife or doctor) looking after the woman in labor evaluated fetal head descent and cervical dilatation by digital vaginal examination. Active phase of labor was defined according to the WHO[13] with the cervical dilatation at least 3 centimeters and presence of uterine contractions. The doctor performed artificial ruptured of membrane if the membrane was still intact. Transabdominal ultrasonography was evaluated for fetal occiput position following Akmal et al procedure[14]. Active labor management with low-dose oxytocin augmentation according to recommendation of the ACOG practice bullentin No. 49[15] had been performed to all eligible cases by residents and obstetric staffs blinded to the result of transperineal ultrasound. The ultrasound operator was not involved in the labor management.

Transperineal ultrasound

Transperineal ultrasound was done by one ultrasound operator (Kanjanasignh T) immediately after digital VE, recorded in demographic data. The ultrasound machine was the Sonoacer R3 (Samsung Medison Co. Ltd., Seoul, Korea) machine equipped with a 2 to 8 MHz convex transabdominal probe. Parameters of transperineal ultrasound in the present study were HPD and AOP. To perform transperineal ultrasound, cases were in lithotomy position with empty bladder. Parameters were measured when uterine contraction was absent.

Head perineal distance

With a transducer placed transversely at the posterior fourchette and angulated until the shortest of fetal skull contour can be identified, the distance between the outer bony limit of the fetal skull and the perineum was measured HPD[12] (Figure 1).

Angle of progression

With a transducer placed in mid sagittal position between the labia minoras and rocked until the long axis of pubic symphysis and fetal skull could be demonstrated, a first line was drawn from the inferior portion of pubic symphysis along with the long axis of pubic symphysis. The second line was drawn from the inferior portion of pubic symphysis tangentially to the fetal skull contour. This image was printed and the angle between two lines was measured as AOP by protractor[16] (Figure 2).

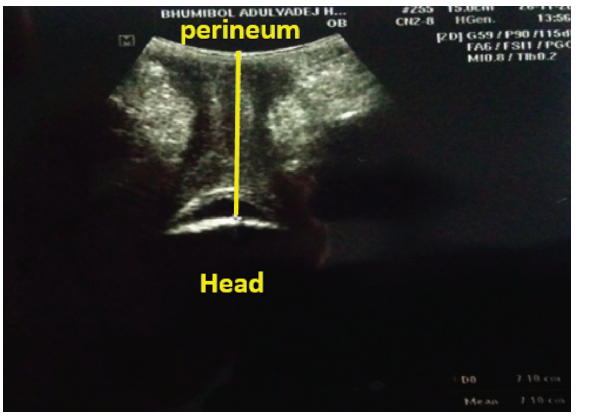

Figure 1. Transperineal ultrasound image of head perineal distance.

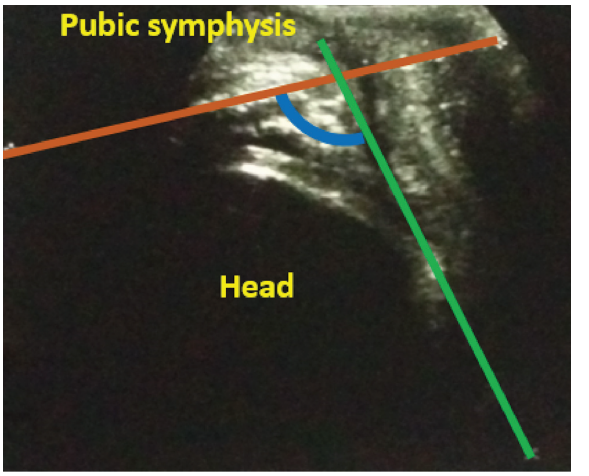

Figure 2. Transperineal ultrasound image of angle of progression.

Labor dystocia

Caesarean delivery due to labor dystocia can be performed at least when the cervical dilate 4 centimeters or more with cervical effacement at 80% or greater with regular uterine contraction at least two hours in the presence of abnormal labor curve such as protraction disorder, arrest disorder, or second stage disorder[3]. Vaginal delivery included either spontaneous or operative vaginal delivery.

Statistical analysis

Sample size was calculated using the diagnosis test formula with sensitivity of 95% and acceptable error of 0.06 (the present study was conducted when the first author was in maternal fetal medicine fellowship training program in Bhumipol Aduyadej Hospital. At first, the authors attempted to use an error of 0.05, and found that they could not archive the sample size of 562 cases). The incidence of caesarean delivery due to labor dystocia at Bhumipol Aduyadej Hospital according to the present study's inclusion criteria between June 1 and November 31, 2015 were 13%. The calculated sample size was 389 cases.

All data were analyzed using the statistical software packages (SPSS version 18). Demographic data and parameters of transperineral ultrasound were compared according to the mode of delivery. Categorical data were presented as number (percentage) and were compared using Chi-square test (*p*-value). Continuous data were presented as median (interquatile range) and compared with the Mann-Whiney U test (*p*-value).

Receiver operating characteristics [ROC] curves was generated to evaluate sensitivity, specificity, positive predictive value, and negative predictive value of transperineal ultrasound to predicted caesarean delivery due to labor dystocia. Binary logistic regression analysis was performed to identify and adjust for potential confounders.

Results

Four-hundred cases were enrolled in the present study and 63 cases (15.75%) underwent caesarean delivery due to labor dystocia. Three hundred thirty-two cases underwent spontaneouse vaginal delivery and five cases underwent vaccum extraction. Factors that significantly associated with mode of delivery were HPD, AOP, parity, pregnant body weight, pregnancy body mass index, fundal height, cervical dilatation, cervical effacement, station of fetal head, and birth weight (Table 1).

ROC curves were generated for HPD and AOP in predicting caesarean delivery due to labor dystocia (Figure 3, 4). Area under the ROC curve of HPD and AOP were 66% (95% CI 59 to 73) and 74% (95% CI 68 to 80). Best discriminated cut-off point of HPD was equal or greater than 5.67 cm. Best discriminated cut-off point of AOP were 96 degrees or less.

The cut-off point of HPD to predict cesarean delivery was 5.67 cm or more, corresponding to a sensitivity of 88.89% (95% CI 78.44 to 95.41), a specificity of 34% (95% CI 29.36 to 39.76), a positive predictive value of 20.22% (95% CI 18.40 to 22.16), and negative predictive value 94.31% (95% CI 89.03 to 97.13). For AOP of 96 degrees or less, it corresponded to a sensitivity of 71.42% (95% CI 58.47 to 81.76), a specificity of 67.36% (96% CI 62.03 to 72.29), a

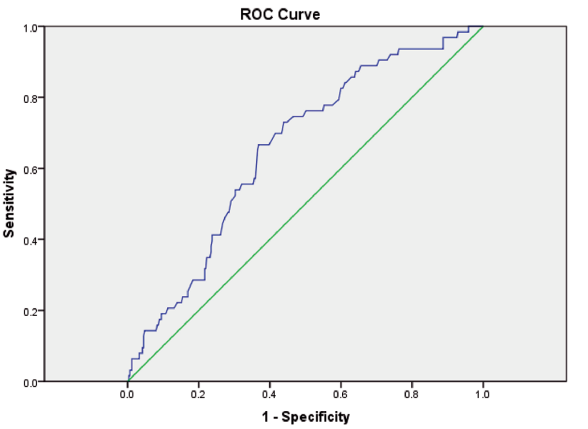

Figure 3. Receiver operating characteristics curve for head perineal distance in predicting caesarean delivery due to labor dystocia.

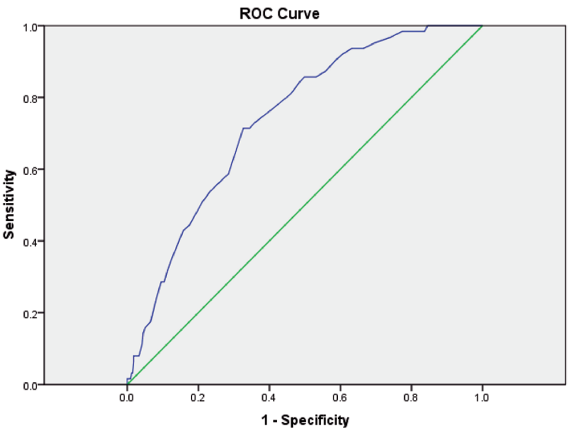

Figure 4. Receiver operating characteristics curve for angle of progression in predicting caesarean delivery due to labor dystocia.

Table 1. Demographic data and transperineal ultrasound according to the mode of delivery

	Caesarean delivery (n = 63)	Vaginal delivery (n = 337)	*p*-value*
Race, n (%)			0.113
Thai	58 (92.0)	307 (91.1)	
Myanma	2 (3.2)	19 (5.7)	
Laos	2 (3.2)	11 (3.2)	
Vietnam	1 (1.6)	0 (0.0)	
Parity, n (%)			<0.001
Nulliparous	52 (82.5)	185 (54.9)	
Multiparious	11 (17.5.)	152 (45.1)	
Fetal head position, n (%)			0.876
Occiput anterior or transverse	36 (57.1)	189 (56.1)	
Occiput posterior	27 (42.9)	148 (43.9)	
Maternal age (years), median (IQR)	25 (21, 31)	25 (21, 29)	0.411
Gestational age (weeks), median (IQR)	39 (38, 40)	39 (38, 40)	0.076
Height (cm), median (IQR)	158 (154, 164)	159 (155, 163)	0.612
Pre-pregnancy weight (kg), median (IQR)	54 (47, 64)	52 (47, 60)	0.338
Pregnant body weight (kg), median (IQR)	71 (61.5, 80)	66 (60, 74)	0.032
Gestational weight gain (kg), median (IQR)	14 (11, 20)	14 (10, 17)	0.103
Pre-pregnancy BMI (kg/m^2), median (IQR)	21.3 (19.6, 25.5)	20.6 (18.6, 23.4)	0.113
Pregnancy BMI (kg/m^2), median (IQR)	28.0 (25.2, 31.3)	26.6 (23.9, 29.5)	0.006
Fundal height (cm), median, IQR)	34 (33, 36)	33 (31, 34)	0.001
Cervical dilatation (cm), median, IQR)	4 (4, 6)	5 (4, 6)	0.016
Cervical effacement (percent), median (IQR)	80 (60, 90)	80 (80, 100)	<0.001
Station of fetal head, median (IQR)	0 (-1, 0)	0 (0, 0)	0.034
Birth weight (g), median (IQR)	3,320 (2,990, 3,650)	3,120 (2,884, 3,340)	0.001
HPD (cm), median (IQR)	6.61 (6.10, 7.22)	6.10 (5.54, 6.80)	<0.001
AOP (degree), median (IQR)	93 (86, 99)	103 (95, 111)	<0.001

HPD = head perineal distance; AOP = angle of progression; BMI = body mass index; IQR = interquartile range

* *p*-value <0.05 means the difference between groups is statistically significant

Table 2. Test characteristics of transperineal ultrasound in predicting caesarean delivery due to labor dystocia in first stage active phase of labor

	HPD ≥5.67 cm	AOP ≤96 degree
Sensitivity, % (95% CI)	88.89 (78.44 to 95.41)	71.42 (58.47 to 81.76)
Specificity, % (95% CI)	34.42 (29.36 to 39.76)	67.36 (62.03 to 72.29)
PPV, % (95% CI)	20.22 (18.40 to 22.16)	29.03 (22.17 to 36.95)
NPV, % (95% CI)	94.31 (89.03 to 97.13)	92.65 (88.45 to 95.46)
LR+	1.36	2.19
LR-	0.32	0.42

HPD = head perineal distance; AOP = angle of progression; PPV = positive predictive value; NPV = negative predictive value; LR+ = positive likelihood ratio; LR- = negative likelihood ratio; CI = confidence interval

Table 3. Result of binary logistic regression analysis of the factors associated with caesarean delivery due to labor dystocia

	Adjusted odd ratio	95% CI	*p*-value
HPD ≥5.67 cm	1.81	0.72 to 4.56	0.205
AOP ≤96 degree	4.38	2.09 to 9.19	<0.001
Nulliparous	7.89	3.48 to 17.90	<0.001
Pregnant body weight	0.96	0.91 to 1.01	0.109
Pregnancy BMI	1.15	0.99 to 1.33	0.066
Fundal height	1.22	1.06 to 1.40	0.006
Cervical dilatation	1.10	0.86 to 1.43	0.477
Cervical effacement	0.97	0.95 to 0.99	0.002
Station of fetal head	1.32	0.69 to 2.53	0.404

HPD = head perineal distance; AOP = angle of progression; BMI = body mass index; CI = confidence interval

positive predictive value of 29.03% (95% CI 22.17 to 36.95), and negative predictive value 92.65% (95% CI 88.45 to 95.46) (Table 2).

Binary logistic regression was performed to adjust selected cut-off points of transperineal ultrasound and other potential confounders. Regarding to the cut-off points of transperineal ultrasound, only AOP equal or lesser than 96 degree was associated with caesarean delivery due to labor dystocia significantly independent (adjusted OR 4.38 (95% CI 2.09 to 9.19). Other potential confounding factors were parity, fundal height, and cervical effacement (Table 3).

Discussion

Evaluation of HPD and AOP with transperineal ultrasound is a quick, easy-to-learn, and well tolerated method to predict labor dystocia in first stage active phase of labor. In the present study, AOP of equal to or less than 96 degree was the only cut-off value of transperineal ultrasound that significantly associated with caesarean delivery due to labor dystocia. Other potential confounding factor were nulliparity, fundal height, and cervical effacement.

HPD had been studied to predict successful vaginal delivery in Stravanger hospital, Norway. Their caesarean delivery rate was as low as 14% and their populations were nulliparous women with high-risk for caesarean delivery such as prolonged first stage of labor[11,12]. In Bhumibol Aduyadej Hospital, the caesarean delivery rate was approximately 40%. For the difference in caesarean delivery rate, the present study was designed using HPD to predict caesarean delivery due to labor dystocia in lower risk populations. Eligible cases were either nulliparous or multiparous pregnant women in the active phase without abnormal labor curve. Previous studies showed that short HPD was associated with successful vaginal delivery in cases with premature rupture of membrane[8], labor induction[9], and prolonged first stage of labor[11,12]. Therefore, our hypothesis is long HPD is associated with labor dystocia in the present study's populations. However, there was no association of HPD with labor dystocia in the present study. This inconsistency may be because of difference in population with strong confounding factor such as parity.

On the other hand, the present study showed that small AOP was associated with caesarean delivery due to labor dystocia, which seems consistent with previous publications that showed that wide AOP was associated with successful vaginal delivery in nulliparous with prolonged first stage of labor[12]. Furthermore, there was a study of transperineal ultrasound in early second stage of labor. In that study, the AOP in vaginal delivery group was significant larger in vaginal delivery group compared to the operative delivery group[10].

The cut-off point of AOP in the present study was 96 degrees, while Eggebo et al[12] found the cut-off value of AOP to predict vaginal delivery in cases with prolonged first stage of labor was 110 degrees with sensitivity 68% and false positive 28%. The difference in cut-off value of AOP may be because the AOP can change overtime during active phase, and the present study performed the transperineal ultrasound to detected labor dystocia earlier.

The AOP of 96 degrees or less can predict caesarean delivery due to labor dystocia with positive likelihood ratio of 2.19, which was too low to be used to make decision of caesarean delivery due to labor dystocia. However, an AOP of 96 degrees or lower can used as a screening tool to define risk of labor dystocia. These may help to make decision, especially at hospitals where operative rooms are not available all the time.

The period of participant's enrollment was relatively wide and the results of transperineal ultrasound can change overtime during the intrapartum period. These may be the reason that cut-off value of transperineal ultrasound to identified labor dystocia with high positive likelihood ratio cannot be found.

The present study was a blinded prospective study without bias in clinical judgment of labor dystocia. Transperineal ultrasound was obtained by one ultrasound operator, so there was no variation in interobserver. However, there was a lack of systematic random sampling of study's population because the transperineal ultrasound could be obtained only when the research's ultrasound operator was available. Variation in decision to perform caesarean delivery due to labor dystocia could occur but at least, all cases with labor dystocia must archive the research's minimal criteria. Because of extremely low postpartum hemorrhage (one case in vaginal delivery and seven cases in caesarean delivery), the present study could not find association of transperineal ultrasound with postpartum-complications.

"Obstetric Care Consensus No. 1: Safe Prevention of the Primary Cesarean Delivery" was jointly released by the College and the Society for Maternal-Fetal Medicine in March 2014[2]. This guideline changed the definition of active phase from cervical dilation from 3 cm to 6 cm. With this narrower period of participant's enrollment, the transperineal ultrasound may present more interesting results. Unfortunately, Bhumibol Aduyadej Hospital did not adopt this guideline at the time when the present study was conducted. Finally, in the present study, parity was the confounder that had stronger effect than transperineal ultrasound. In further study, transperineal ultrasound should be studied in subgroups analysis of parity.

In conclusion, in term pregnancy with active phase of labor before presenting abnormal labor curve, AOP of 96 degrees or less had a value to predict caesarean delivery due to labor dystocia, while the HPD cannot be the predictor for caesarean delivery due to labor dystocia.

What is already known on this topic?

HPD and AOP can predict mode of delivery in nulliparous women with high risk of caesarean delivery such as labor induction and prolonged first stage of labor.

What this study adds?

AOP may be used as screening tool to predict caesarean delivery due to labor dystocia in either nulli or multi parous in active phase of labor before presenting abnormal labor curve.

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Potential conflicts of interest

The authors declare no conflict of interest.

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