Prediction of vaginal deliveries using fetal head descent assessed by transperineal ultrasound

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Abstract: This study evaluated the use of transperineal ultrasound for predicting successful vaginal deliveries. This was a prognostic cohort design study conducted between March and May 2016 at the Karawang District Hospital, Indonesia. Inclusion criteria were term pregnancy, singleton live birth with head presentation, and active phase of labor. The fetal head-to-perineum distance and the angle of progression in the relaxation phase and between contractions were assessed by transperineal ultrasound. Data were analyzed using the Mann–Whitney U test, and the optimal cut-off was determined using receiver operating curves (ROC). A total of 306 women delivered vaginally during the study period. The cut-off for fetal head-to-perineum distance as a predictor of vaginal delivery was 43.5 mm (sensitivity, 91%; specificity, 78%), with an area under the curve of 82% (95% confidence interval [CI], 69%–95%; p < 0.01); the angle of progression was 107° (sensitivity, 80%; specificity, 97%), with an area under the curve of 96.4% (95% CI, 87%–99%, p < 0.01). In conclusion, fetal head-to-perineum distance and angle of progression can predict the success of vaginal deliveries.

1. Introduction
Identifying fetal head descent, to avoid vaginal delivery complications, is a challenge in obstetric practices [1]. Fetal head descent is routinely used to predict delivery progression during vaginal deliveries. In case of abnormality in fetal head descent, a sign of descent arrest, the treating obstetrician must intervene and use additional instruments or proceed to perform a cesarean section [2-4]. Over-diagnosis of delivery arrest secondary to delayed descent increases the rate of cesarean sections. A new method is needed to distinguish whether a woman has a high or low likelihood for vaginal delivery. Intrapartum ultrasound may be a means of confirming fetal head descent during active labor.

2. Methods
This was a prognostic cohort design study conducted from March to May 2016 at the Karawang District Hospital, Indonesia. Inclusion criteria included term pregnancy, singleton live birth with head presentation, and active phase of labor. Exclusion criteria included abnormal fetal presentation, cephalopelvic disproportion, and cesarean section pregnancy termination with indication of descent non-arrest. This study initially identified 323 women who were examined using transperineal ultrasound. Fetal head-to-perineum distance and the angle of progression were predicted within the relaxation phase on an empty bladder and between contractions. Analyses were carried out using Mann–Whitney test, and the optimal cut-off was determined using receiver operator curves (ROC). Bivariate analyses were conducted from several different cut-off points, and variables were selected for
multivariate analysis if p value was <0.25. Finally, area under the curve (AUC) was used to evaluate result quality.

3. Results
A total of 323 women aged between 15 and 45 years were included in the study (Table 1). Gestational ages ranged from 37 to 41 weeks. Body mass index (BMI) ranged from 25 to 38 kg/m². Examination of women’s obstetric histories revealed previous cesarean section (3.4%), primigravida (39%), multigravida (61%), and labor induction (47.3%). Spontaneous delivery was the most common delivery method (94.7%), followed by instrumental delivery (4%) and cesarean section (1.3%).

| Table 1. Demographic characteristics of the participants |
|--------------------------------------------------------|
| Parameter                          | Median (range) or N (%) |
|------------------------------------|------------------------|
| **Maternal Characteristics**       |                        |
| Mother’s age                       | 28 (15–45) *           |
| Gestational age                    | 39 (37–41) *           |
| BMI                                | 29 (25–38) *           |
| 25–29 kg/m²                        | 210 (65) +             |
| 30–33 kg/m²                        | 87 (27) +              |
| > 34 kg/m²                         | 26 (8) +               |
| Previous C-section                 | 11 (3.4) +             |
| Primigravida                       | 129 (39) +             |
| Multigravida                       | 194 (61) +             |
| **Delivery Characteristics**       |                        |
| Labor induction                    | 153 (47.3) +           |
| Spontaneous                        | 170 (52.7) +           |
| Augmentation                        | 18 (5) +               |
| **Delivery mode**                  |                        |
| Spontaneous                        | 306 (94.7) +           |
| Instrumental                       | 13 (4) +               |
| C-section                          | 4 (1.3) +              |
| **Neonatal Characteristics**       |                        |
| Low birth weight                   | 3100 (2500–4000)*      |

Tests of inter-rater reliability were performed on 50 participants with a one-time calculation of fetal head-to-perineum distance and the angle of progression by the first observer, followed by re-evaluation by the second observer. The Cronbach’s alpha score was 0.92 with a 0.86 intraclass correlation coefficient (ICC) score for angle of progression, and 0.99 with a 0.98 ICC for fetal head-to-perineum distance, indicating a good agreement between the observers.

The normality test was performed to determine the sample data distribution. An abnormal data distribution was confirmed via the Kolmogorov Smirnoff test (p > 0.05). The Mann–Whitney U test was used to evaluate the angle of progression between the spontaneous delivery group and the instrumental delivery group, with an end result of p = 0.024 (Table 2).
The angle of progression and fetal head-to-perineum distance were significant on Chi-square test (Table 3). During multivariate or logistic regression test, these variables could predict a vaginal delivery using AUC: 96.4% (confidence interval [CI]: 95%, 97%–99%) and 82.4% (CI: 95%, 69%–95%).

The angle of progression cut-off point for predicting a successful vaginal delivery was 107°, with a sensitivity of 80% and a specificity of 97%. The fetal head-to-perineum distance cut-off point was 43.5 mm, with a sensitivity of 91% and a specificity of 78%.

**Table 3. Successful spontaneous delivery and instrumental delivery prediction using bivariate and multivariate analyses**

| Variable                        | Spontaneous delivery (n = 306) | Instrumental delivery (n = 13) | p     | Non-adjusted | Adjusted |
|---------------------------------|--------------------------------|--------------------------------|-------|--------------|----------|
| **Angle of progression**        |                                |                                | p     | OR           | CI 95%   |
| <107°                           | 6 (2.2%)                       | 3 (80%)                        | <0.001* | 0.64         | 1.06–7.34|
| ≥107°                           | 309 (97.8%)                    | 1 (20%)                        |       | 0.047*       | 23.3     | 1.03–523.5|
| **Fetal head-to-perineum distance** |                                |                                |       |              |          |
| <43.5 mm                        | 310 (98.1%)                    | 1 (20%)                        | <0.001* | 7.33         | 1.13–47.60|
| ≥43.5 mm                        | 5 (96.6%)                      | 4 (80%)                        |       | 0.033*       | 0.34     | 0.01–0.86|

*p < 0.05; adjust based on strength

4. Discussion

The median age and BMI of the participants were 28 years and 29 kg/m², respectively. For patients with a BMI between 25 and 29 kg/m², there were 202 spontaneous deliveries, 9 instrumental deliveries, and 2 cesarean sections. For patients with a BMI between 30 and 33 kg/m², there were 80 cesarean sections and 4 instrumental deliveries. For patients with a BMI of >34 kg/m², there were 23 spontaneous deliveries, 1 instrumental delivery, and 2 cesarean sections. Thus, this study found no correlation between BMI and the rate of cesarean sections.

The cases studied here included 129 primigravida, 120 spontaneous deliveries, 6 instrumental deliveries, and 3 cesarean section deliveries. The fetal head-to-perineum distance for cesarean section deliveries was 46–56 mm and the angle of progression was 96°–106°. This result showed that the fetal head-to-perineum distance of <43.5 mm and an angle of progression of >107° could predict a successful vaginal delivery in primipara women. Previous studies showed that transperineal ultrasound could predict successful vaginal deliveries in primipara women [2,6].

There were 194 multigravida women, including 11 subjects with a history of previous cesarean sections, 185 women who underwent spontaneous deliveries, 8 women who underwent instrumental deliveries, and 1 woman who received a caesarian section. For the participant who underwent cesarean section, the fetal head-to-perineum distance was 45 mm and the angle of progression was 96°. This indicated that fetal head-to-perineum distance and angle of progression could predict successful vaginal delivery. Other studies showed that transperineal ultrasound could predict successful vaginal deliveries in multipara women [5,6].

Eleven subjects with a history of previous cesarean sections underwent subsequent vaginal deliveries. There is no evidence pertaining to the rates of successful vaginal deliveries in women with...
previous cesarean sections. However, the angle of progression and fetal head-to-perineum distance can predict the success of vaginal deliveries and can be used as guidelines for women with a history of previous cesarean sections [7,8].

In this study, transperineal ultrasound predicted vaginal delivery on the first active phase of labor. The cut-off score for the angle of progression as a predictor of vaginal delivery success was 107°, with a sensitivity of 80% and a specificity of 97%, indicating that 75% women successfully underwent a vaginal delivery with an AUC of 96.4% (95% CI, 87%–99%). The cut-off for the fetal head-to-perineum distance as a predictor of vaginal delivery success was 43.5 mm, with a sensitivity of 91% and a specificity of 78%, indicating that 89% women proceeded with a vaginal delivery with an AUC of 82.4% (95% CI, 69%–95%). Torkildsen et al. showed that, during the first active phase of labor, 110° was the cut-off point for predicting a successful vaginal delivery in 88% patients, with an AUC of 76% (p > 0.05) [2]. They also found that a 40-mm fetal head-to-perineum distance could predict 92% vaginal deliveries with an AUC of 81% (p < 0.05) [2].

5. Conclusion
It can be concluded that the angle of progression and fetal head-to-perineum distance can predict a successful vaginal delivery. With a cut-off point, of 107° angle of progression, about 80% sensitivity and 97% specificity was achieved, and as many as 75% subjects underwent a successful vaginal delivery with an AUC of 96.4%. At the fetal head-to-perineum distance cut-off point of 43.5 mm, there was 91% sensitivity and 78% specificity. About 89% subjects proceeded to vaginal deliveries with an AUC of 82.5%. Future research should focus on transperineal ultrasound as a predictor of success for women undergoing labor induction and on associations between ultrasound findings and delivery method.

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