Original Research Article

Intrapartum ultrasound to predict vaginal labor: a prospective cohort study

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ABSTRACT

Background: Non-invasive transperineal ultrasound has been used to detect the descent of the fetal head using head-perineum distance (HPD) and angle of progression (AOP). The aim was to evaluate HPD and AOP as predictors of vaginal delivery in the first stage of labor.
Methods: This was a prospective cohort study in Riga Maternity Hospital in Latvia from May till August 2016. The study included only nulliparous women with singleton pregnancies and cephalic presentation. Ultrasound was used to measure HPD and AOP. Data was collected on demographics, labor parameters and outcome.
Results: Of 36 women enrolled, 26 (72.2%) had a vaginal delivery. The area under the receiver–operating characteristics curve for the prediction of vaginal delivery was 0.865 (95% confidence interval (CI) 0.75-0.98) using HPD as the test variable and the area under the curve was 0.877 (95% CI 0.77-0.99) for AOP. The median HPD was lower in the women delivering vaginally than in the women delivering by cesarean section (P<0.001). HPD was ≤40 mm in 18 (50%) women, of whom all delivered vaginally. HPD was >40 mm in the other 18 women, of whom 8 (22.2%) delivered vaginally (P<0.001). AOP was ≥105° in 22 (61.1%) women and, of these, 21 delivered vaginally. AOP was <105° in the other 14 (38.9%) women, of whom 5 delivered vaginally (P<0.001).
Conclusions: HPD ≤40 mm and AOP ≥105° are both predictive of vaginal delivery in the first stage of labor.

Keywords: Angle of progression, Head perineum distance, Intrapartum ultrasound, Transperineal ultrasound

INTRODUCTION

Women in active labor are clinically assessed to determine cervical dilation and fetal station by regular digital vaginal examinations (digital VE).[1] Digital VE's have been deemed unreliable and subjective.[2] Akmal et al. reported that digital VE failed to determine the fetal head position in 34% of laboring women, and incorrectly determined head position in 51% of patients in whom the position could be defined.[3,4]

Digital VE are shown to be associated with infection ascending to the fetus, chorioamnionitis, endometritis and shortened time interval to delivery in preterm labor.[5,6] Digital VE have also been shown to frequently be experienced as painful and embarrassing to the women being examined.[7]

Non-invasive transperineal ultrasound has been used to detect the descent of the fetal head using head-perineum distance (HPD), described as shortest distance from the fetal head to the perineum, and angle of progression (AOP) described as the angle between a line through the midline of the pubic symphysis and a line from the inferior apex of the symphysis to the leading part of the fetal skull.

An angle of progression of 120° or greater is an excellent predictor of a successful vaginal delivery.[4] These parameters are objective evaluations of fetal head station and are shown to have low intra- and interoperator variability.[8-11]

The aim of this study was to assess the value of HPD and AOP in predicting the mode of delivery when measured in the first stage of labor.

METHODS

This was a prospective cohort study in Riga Maternity Hospital in Latvia from May till August 2016. The study was approved by the Stradins Council of Ethics, and included only nulliparous women with singleton pregnancies, cephalic presentation and normal Body mass index (BMI). Written informed consent was obtained from all participants prior to enrolment.

Onset of first stage of labor was diagnosed as regular contractions and cervical dilation 3-4 cm. The measurements were obtained by doctors at the Riga Maternity Hospital making a brief visit to the patient only to obtain the ultrasound measurement data, which was later re-affirmed with Image-J. Transperineal ultrasound was used to measure HPD and AOP. The HPD cutoff value for prediction of vaginal delivery was chosen in accordance with other studies, and the AOP cutoff value was calculated from the predictive value found in this study.[12] The examination was conducted with a Philips VISIQ ultrasound system. The ultrasound transducer was covered with gel and a sterile glove, and pressed firmly to the labia majora when obtaining the measurements. To measure HPD the transducer was held in a transverse plane on the vulva at the level of the posterior commissure and pressed against the pubic rami, and the distance from the fetal head to the perineum was measured and recorded. AOP was measured in the sagittal plane, by drawing a line through the long axis of the symphysis and another line tangential to the fetal head and measuring the angle in between the two lines.

Statistical analysis

The predictive values of the ultrasound measurements were derived with cross-table analysis and receiver-operating characteristic curves computing the area under the curve (AUC) as a discriminator. The AUC was considered to have discriminatory potential if the lower limit of the 95% CI interval exceeded 0.5. Fisher's exact and Mann-Whitney U tests were used to test parameters, and $P < 0.001$ was considered statistically significant. Data was analyzed with the statistics package SPSS v.23.

RESULTS

Clinical characteristics of the study population are shown in Table 1. Of 36 women enrolled, 26 (72.2%) had a vaginal delivery (22 women spontaneously and 4 women with vacuum). 10 women had a cesarean section, 2 due to fetal distress, 7 due to failure to progress and 1 due to cephalopelvic disproportion.

Table 1: Demographics and clinical characteristics of 36 nulliparous women in the first stage of labor.

Characteristic	Median (range) or n (%)
Maternal	
Maternal age (years)	27.5 (20 – 40)
Body mass index (kg/m^2)	23 (19-29)
Labor	
Oxytocin augmentation	25 (69)
Cesarean section delivery	10 (28)
Due to fetal distress	2
Cephalopelvic disproportion	1
Prolonged first stage	7
Operative vaginal delivery vacuum	3
Neonatal	
Birthweight (grams)	3835 (2460-5100)
Apgar score	
At 1 minute	8 (6-9)
At 5 minutes	9 (8-10)

The area under the receiver–operating characteristics (ROC) curve for the prediction of vaginal delivery was 0.865 (95% confidence interval (CI) 0.75-0.98; P <0.001) using HPD as the test variable (Figure 1) and the area under the curve was 0.877 (95% CI 0.77-0.99; P <0.001) for AOP (Figure 2).
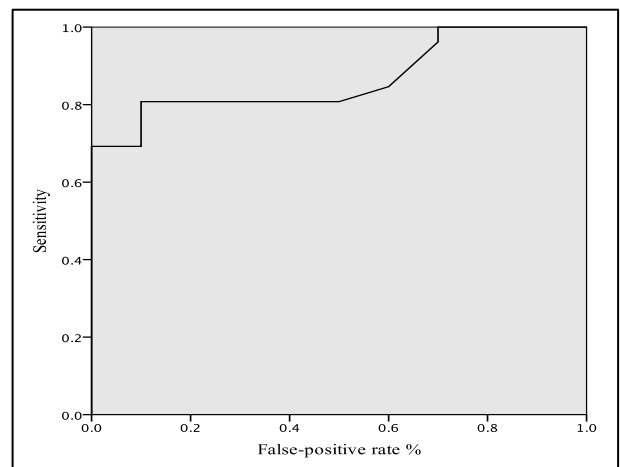

Figure 1: Receiver–operating characteristics curve for head–perineum distance in nulliparous women in the first stage of labor in the prediction of vaginal delivery (area under the curve = 0.865, P <0.001).

The median HPD was lower in the women delivering vaginally than in the women delivering by cesarean section (Mann-Whitney U= 35.0; P <0.001) (Figure 3). HPD was ≤40 mm in 18 (50%) women, of who all delivered vaginally. HPD was >40 mm in the other 18 (50%) women, of whom 8 (22.2%) delivered vaginally, a difference of 77.8% (95% CI 66.56–86.14; P <0.001). AOP was ≥105° in 22 (61.1%) of the women, of which 21 (58.33%) delivered vaginally. AOP was <105° in the other 14 (38.9%) women, of whom 5 (19.2%) delivered

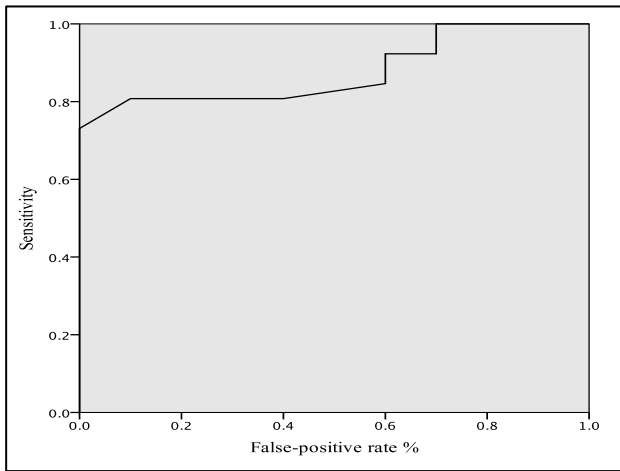vaginally. A difference of 76.25% (95% CI 41.79-92.41; P <0.001).

Figure 2: Receiver–operating characteristics curve for angle of progression in nulliparous women in the first stage of labor in the prediction of vaginal delivery (area under the curve = 0.877, P <0.001).
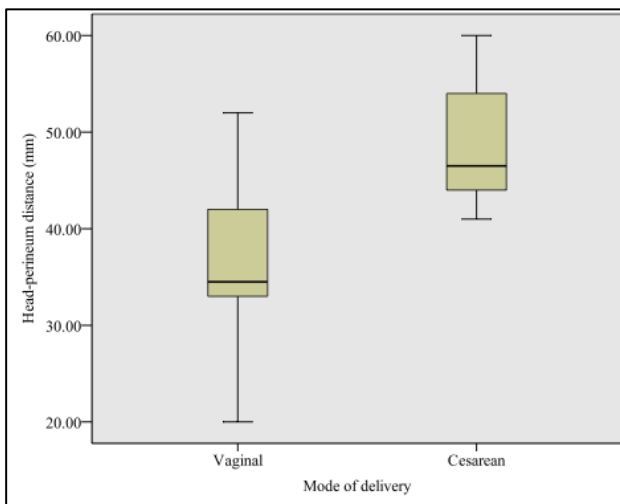

Figure 3: Head–perineum distance in nulliparous women in the first stage of labor, comparing those who went on to deliver by Cesarean section (n = 10) with those who delivered vaginally (n = 26) (Mann–Whitney U = 35.0; P <0.001).

DISCUSSION

We found that transperineal ultrasound measurements of HPD and AOP in the first stage of labor contributes clinically significant information about the chance for vaginal labor outcome in nulliparous women. All of the women who had HPD <40 mm had a vaginal delivery, and other studies have emphasized that using a cutoff value of 40 mm for HPD is predictive of vaginal delivery, which is further substantiated by this study.[10] The reproducibility of AOP has been illustrated as well as the low intra- and inter observer variation for HPD.[10,13,14]

In others studies an AOP of 120° and 110° have been used as a cutoff.[8,12] In present study we found that the cutoff value of 105° was predictive of vaginal delivery, and this range of 15° difference may be due to inter-observer variation.

An argument can be made for HPD being more synchronously reproduced from study to study than AOP, and due to the lower variability HPD may be considered a more reliable indicator.

Further studies are needed on the predictive and implementable value of transperineal ultrasound when it is influencing clinical decision-making. Present study indicates that intrapartum ultrasound may assist doctors and midwives in predicting labor outcome. If intrapartum ultrasound measurements made in the first stage of labor is successfully implemented into clinical practice, this patient group may benefit from a reduced number of medical interventions and the prompt initiation of medical interventions when they are required, with the prospect of reducing maternal and fetal morbidity and mortality.

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