Prediction of spontaneous vaginal delivery by transperineal ultrasound

performed just after full cervical dilatation is determined

（分娩第二期における経会陰超音波検査の有用性の検討

－子宮口全開大直後の分娩進行の評価による自然分娩の予測—）

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Prediction of spontaneous vaginal delivery by transperineal ultrasound performed just after full cervical dilatation is determined

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Abstract

Purpose To investigate whether transperineal ultrasound examination just after full cervical dilatation is determined can predict the mode of delivery.

Methods This was a prospective observational study of pregnant women. After full cervical dilatation was determined by vaginal examination during labor, transperineal ultrasound was immediately performed and the head direction (HD), progression distance (PD), and angle of progression (AoP) were measured. The cases were divided into two groups: spontaneous vaginal delivery and operative delivery due to failure of progression. Differences between the groups were statistically analyzed using Student's t-test and Fisher's exact test.

Results Of the 50 women, 42 had spontaneous vaginal deliveries and 8 had vacuum extractions. The spontaneous delivery group had significantly higher HD, PD, and AoP values than the vacuum extraction group. The areas under the receiver-operating characteristic curves for the prediction of spontaneous vaginal delivery were 0.850 for HD, 0.827 for PD, and 0.783 for AoP. The optimum cut-off points and positive predictive values were 83° and 92.9% for HD, 56 mm and 94.9% for PD, and 146° and 94.3% for AoP, respectively.

Conclusion Transperineal ultrasound examination just after full cervical dilatation was determined was useful in predicting spontaneous vaginal delivery.

Introduction

Progression of fetal head descent has generally been assessed by digital vaginal examination (VE). However, this method is subjective, has low reproducibility, and is associated with a high inter-observer error [1-5]. In recent years, transperineal ultrasound has been reported to provide an objective measurement of fetal head progression with lower inter-observer and intra-observer errors [6-12]. Transperineal ultrasound performed for the observation of labor progress has also been reported to facilitate the predictions of the delivery mode and duration of time until delivery [7, 13-15]. However, the studies that reported these applications either lacked a fixed, clearly defined measurement time during the second stage of labor [7] or had transperineal ultrasound performed after failure to progress of labor [13-15]. The delivery process changes over time; therefore, a fixed time for examination, which should be early in the second stage of labor, is considered necessary in order to produce results that can be better applied in clinical practice.

Accordingly, this study aimed to investigate whether transperineal ultrasound just after full cervical dilatation is determined, that is, in the early second stage of labor, can predict the mode of delivery.

Materials and methods

This was a prospective observational study conducted from April 2012 to March 2015 at Ogachi Chuo Hospital, Kakunodate General Hospital, and Akita University Hospital. We recruited pregnant women at term (≥37 weeks) with a live singleton fetus in cephalic presentation. Only cases for which a member of the research team was present in the labor ward were included in this study. The study protocol was approved by the local ethics committees, and informed consent was obtained from all patients.

Birth attendants (a midwife or doctor) evaluated cervical dilatation by digital VE. After VE was performed and full cervical dilatation was determined, transperineal ultrasound was performed by a member of the research team. The birth attendants were blinded to the ultrasound findings to avoid bias in the decisions regarding the follow-up labor procedures. For nulliparous women, failure to progress in labor was defined as when the second stage exceeded 3 hours if regional anesthesia had been administered or 2 hours in the absence of regional anesthesia. For parous women, it was defined as when the second stage exceeded 2 hours with regional anesthesia or 1 hour without [16]. Vacuum extraction was performed if the clinical station was equal to or lower than +2 cm from the ischial spines [17]. However, when failure to progress was considered likely because of arrest of engagement of the head or because the labor progress was slower than normal labor, vacuum extraction was performed [18].

Transperineal ultrasound was performed using a Voluson *i, S8* (GE Medical Systems, Zipf, Austria) ultrasound machine equipped with a 3.5-7.5-MHz three-dimensional (3D) transabdominal transducer. Women were asked to lie in the lithotomy position. The ultrasound transducer covered with a plastic grove was placed on the perineum in a mid-sagittal position between the labia, below the pubic symphysis. Care was taken to obtain a sagittal view with the maximum contour of the fetal head and the pubic bone as a reference for the maternal pelvis. Examinations were performed in the absence of contractions.

The 3D volumes were examined after delivery using SonoVCADlabor software, by an operator blinded to the labor outcome. We measured three parameters from the sagittal plane [10,11] (Figure 1), namely the head direction (HD; the angle between the infrapubic line, perpendicular to the most caudal part of the pubic symphysis, and a line drawn perpendicular to the widest diameter of the fetal head), progression distance (PD; the shortest distance [in mm] between the infrapubic line and the leading edge of the fetal skull, excluding the caput succedaneum), and angle of progression (AoP; the angle between a line through the midline of the pubic symphysis and a line running tangentially from the anterior edge of the symphysis to the fetal skull).

Statistical analysis

The study population was divided into two groups according to the mode of delivery, spontaneous vaginal delivery or operative delivery.   Operative delivery for an abnormal fetal heart trace was excluded in the final analysis.   Differences between the two groups were assessed using Student's t-test and Fisher's exact test.

To evaluate the predictive value for spontaneous vaginal delivery, receiver operating characteristic (ROC) curves were plotted, and equality of the area under the curve was tested.   Data were analyzed using the statistical software package JMP Statistics for Mac OSX version 9 (JMP Software, Cary, NC, USA).   For all statistical tests, P<0.05 was considered to be statistically significant.

Results

Fifty-three women were included in the study: 9 from Ogachi Chuo Hospital, 12 from Kakunodate General Hospital, and 32 from Akita University Hospital.   Of these, 3 were excluded because of vacuum extraction due to abnormal fetal heart rate.   Forty-two women delivered via spontaneous vaginal delivery, and 8 women delivered by vacuum extraction because of failure to progress; there were no Cesarean sections. Women with any kind of fetal position were included in this study.   The characteristics of the study population are shown in Table 1.

Transperineal ultrasound examinations were performed without any discomfort. The mean interval between full cervical dilatation determined by VE and the ultrasound examination was 6 minutes (range 0-15 minutes).   The mean interval between full cervical dilatation and delivery was 26.5 minutes (range 3-158 minutes).

The HD, PD, and AoP were significantly higher in the spontaneous vaginal delivery group than in the vacuum extraction group (Figure 2).   The areas under the ROC curves for the prediction of spontaneous vaginal delivery were 0.850 for HD, 0.827 for PD, and 0.783 for AoP.   The optimum cut-off points for the prediction of spontaneous vaginal delivery were 83° (sensitivity: 92.8%; specificity: 62.5%; positive predictive value [PPV]: 92.9%; negative predictive value [NPV]: 62.5%), 56 mm (sensitivity: 81.0%; specificity: 75.0%; PPV: 94.4%; NPV: 42.9%), and 146° (sensitivity: 78.6%; specificity: 75.0%; PPV: 94.3%; NPV 40.0%) for HD, PD, and AoP, respectively (Figure 3).

Discussion

To our knowledge, this is the first study to show that HD, PD, and AoP measured by transperineal ultrasound just after full cervical dilatation is determined could predict spontaneous vaginal delivery.

The use of transperineal ultrasound during labor in predicting the mode of delivery and the duration of time until delivery has been previously reported [7,13-15], although VE has been reported to not facilitate prediction of the mode of delivery [14, 15, 19]. However, these previous reports did not clearly define a timing for the ultrasound, with this being performed either during the second stage of labor [7] or after failure to progress of labor [13-15]. In the present study, transperineal ultrasound was performed precisely immediately after full cervical dilatation was determined, that is, in the early second stage of labor. A consistent timing for the examination enables a more accurate comparison of the methods of delivery. Herein, the PPVs for spontaneous vaginal delivery of HD, PD, and AoP were 92.9%, 94.4%, and 94.3%, respectively, and it should also be noted that transperineal ultrasound is minimally invasive and does not require special technical training [9]. Therefore, it could be a feasible screening test for the prediction of spontaneous vaginal delivery in the early second stage of labor. With the awareness of a high likelihood of spontaneous delivery, it may be possible to prevent excessive medical intervention.

Henrich et al. [20] reported that HD was indicative of the direction of the fetal head and was related to the difficulty of vacuum extraction. In the present study, we found that a larger HD was associated with a higher probability of spontaneous delivery and that the mode of delivery was influenced by the direction of the fetal head.

Gilboa et al. [21] reported that PD correlated with fetal head station but not with the mode of delivery in cases of prolonged second stage of labor. They mentioned that while PD was accurate for high stations, the assessment became difficult for low stations, because the caudal birth canal is curved. In the present study, however, a relationship with the mode of delivery was observed despite the fetal head being at station 0 to +3 by VE in 47 of 50 cases; this was similar to in the study of Gilboa et al [21]. Thus, just after full cervical dilation is determined, PD may be useful for predicting the mode of delivery, irrespective of the fetal head descent.

Torkildsen et al. [14] and Eggebo et al. [15] reported that for primiparous women in a prolonged first stage of labor, the AoP and fetal head-perineum distance (the shortest distance from the fetal head to the perineum) could predict the mode of delivery, and found that the optimal cut-off values for vaginal delivery were 110° and 40 mm, respectively. Kalache et al. [13] reported that for pregnant women in a prolonged second stage of labor, spontaneous vaginal delivery or easy vacuum extraction would be possible

if the AoP was greater than 120°, and Barbera et al. [7] reported that a spontaneous vaginal delivery was likely if AoP was more than 120° in the second stage of labor.   In contrast, Ghi et al. [22] reported that, in the first 40 minutes of the second stage of labor, AoP was useful for predicting the mode of delivery, and that the mean AoP within 20 minutes of the start of the second stage of labor was 140° for the spontaneous vaginal delivery group. In the present study, the cut-off value of AoP for spontaneous vaginal delivery was 146°, which is close to the value reported by Ghi et al. [22].   However, as compared with the past reports, the cut-off values of AoP for spontaneous vaginal delivery were greater in the early second stage of labor than in the cases of prolonged labor.   In the studies on the early second stage of labor, the study population was not limited to the delivery time. However, the studies on prolonged labor did not include patients who delivered via spontaneous vaginal delivery or operative delivery before labor was prolonged. Therefore, this likely influenced the difference in the cut-off values of AoP between the early second stage of labor and prolonged labor.

To exactly assess the moment of full cervical dilatation, we have to perform VE continuously.   If it is difficult, VE performed every several minutes during labor may make it possible to determine the moment of full cervical dilatation exactly.   However, VE can be uncomfortable for the women, especially when the examination is performed frequently [23], and repeated VEs also increase the risk of ascending vaginal infection [24].   Therefore, we did not perform unnecessary VEs in the present study.   Instead, we determined the interval and strength of the uterine contractions by continuous cardiotocography and based on the women's symptom, and decided the time to perform VE on an individual case-basis.   As it would be very difficult to check the exact moment of full cervical dilatation, we instead performed transperineal ultrasound just after full cervical dilatation was 'determined,' and this may be a weak point of the present study.

Transperineal ultrasound has been shown to be useful in predicting the mode of delivery [7, 13-15], although its clinical applications have not been clearly established. Considering its objective results, transperineal ultrasound has the potential to play a major role in assessing the progress of delivery, which was previously accomplished via a subjective VE alone.   Transperineal ultrasound can be used to determine fetal head descent and fetal head position [8, 25, 26], although VE is superior for examining cervical dilatation [27, 28]; thus, VE cannot be completely eliminated.   However, as cervical dilatation does not need to be examined in the second stage of labor, introducing transperineal ultrasound could potentially reduce the number of VEs.   Furthermore, the women were cheered up and felt relieved and satisfied on seeing the transperineal ultrasound images and following the fetal head during labor, although these data are not shown.

Conclusion

Three types of measurements – HD, PD, and AoP – measured by transperineal ultrasound just after full cervical dilatation is determined were shown to be useful in predicting spontaneous vaginal delivery.   However, the sample size needs to be further increased in the future to confirm our findings, with investigation of whether these measures are useful in predicting the mode of delivery, including of Caesarean sections, being warranted.

Acknowledgments

Conflict of interest

Saeko Kameyama, Akira Sato, Hiroshi Miura, Jin Kumagai, Naoki Sato, Dai Shimizu, Kenichi Makino and Yukihiro Terada declare that they have no conflict of interest.

Human rights statements and informed consent

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions.   Informed consent was obtained from all patients for being included in the study.

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Figure legends

Figure 1　Transperineal ultrasound image (sagittal view) showing measurements of the head direction (HD), progression distance (PD), and angle of progression (AoP)

Figure 2　Boxplots of the head direction (a), progression distance (b), and angle of progression (c), according to the mode of delivery.

The minimum, lower quartile, median, upper quartile, and maximum values are indicated. *Student's t-test.

Figure 3　Receiver operating characteristic curves of head direction (a), progression distance (b), and angle of progression (c) for predicting spontaneous vaginal delivery

The optimum cut-off points are indicated with ◆.