Original Research

Can ultrasound on admission in active labor predict labor duration and a spontaneous delivery?

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BACKGROUND: Identifying predictive factors for a normal outcome at admission in the labor ward would be of value for planning labor care, timing interventions, and preventing labor dystocia. Clinical assessments of fetal head station and position at the start of labor have some predictive value, but the value of ultrasound methods for this purpose has not been investigated. Studies using transperineal ultrasound before labor onset show possibilities of using these methods to predict outcomes.

OBJECTIVE: This study aimed to investigate whether ultrasound measurements during the first examination in the active phase of labor were associated with the duration of labor phases and the need for operative delivery.

STUDY DESIGN: This was a secondary analysis of a prospective cohort study at Landspitali University Hospital, Reykjavík, Iceland. Nulliparous women at ≥37 weeks' gestation with a single fetus in cephalic presentation and in active spontaneous labor were eligible for the study. The recruitment period was from January 2016 to April 2018. Women were examined by a midwife on admission and included in the study if they were in active labor, which was defined as regular contractions with a fully effaced cervix, dilatation of ≥4 cm. An ultrasound examination was performed by a separate examiner within 15 minutes; both examiners were blinded to the other's results. Transabdominal and transperineal ultrasound examinations were used to assess fetal head position, cervical dilatation, and fetal head station, expressed as head-perineum distance and angle of progression. Duration of labor was estimated as the hazard ratio for spontaneous delivery using Kaplan-Meier curves and Cox regression analysis. The hazard ratios were adjusted for maternal age and body mass index. The associations between study parameters and mode of delivery were evaluated using receiver operating characteristic curves.

RESULTS: Median times to spontaneous delivery were 490 minutes for a head-perineum distance of ≤45 mm and 682 minutes for a head-perineum distance of >45 mm (log-rank test, P=.009; adjusted hazard ratio for a shorter head-perineum distance, 1.47 [95% confidence interval, 0.83–2.60]). The median durations were 506 minutes for an angle of progression of ≥93° and 732 minutes for an angle of progression of <93° (log-rank test, P=.008; adjusted hazard ratio, 2.07 [95% confidence interval, 1.15–3.72]). The median times to delivery were 506 minutes for nonocciput posterior positions and 677 minutes for occiput posterior positions (log-rank test, P=.07; adjusted hazard ratio, 1.52 [95% confidence interval, 0.96–2.38]) Median times to delivery were 429 minutes for a dilatation of ≥6 cm and 704 minutes for a dilatation of 4 to 5 cm (log-rank test, P=.002; adjusted hazard ratio, 3.11 [95% confidence interval, 1.68–5.77]). Overall, there were 75 spontaneous deliveries; among those deliveries, 16 were instrumental vaginal deliveries (1 forceps delivery and 15 ventouse deliveries), and 8 were cesarean deliveries. Head-perineum distance and angle of progression were associated with a spontaneous delivery with area under the receiver operating characteristic curves of 0.68 (95% confidence interval, 0.55–0.80) and 0.67 (95% confidence interval, 0.55–0.80), respectively. Ultrasound measurement of cervical dilatation or position at inclusion was not significantly associated with spontaneous delivery.

CONCLUSION: Ultrasound examinations showed that fetal head station and cervical dilatation were associated with the duration of labor; however, measurements of fetal head station were the variables best associated with operative deliveries.

Key words: angle of progression, delivery time, fetal head station, head-perineum distance, labor, transperineal ultrasound

Introduction

The duration of labor is highly individual. Prolonged labor is known to increase the risk of adverse outcomes for the mother and fetus and is associated with a negative birth experience.[1,2] Slow progress in labor occurs in 13% to 37% of nulliparous women, and dystocia

EDITOR'S CHOICE

is a frequent indication for cesarean delivery during labor.[3–5] Predicting who will deliver vaginally when entering labor would be beneficial to women. Several factors have been used to predict the need for cesarean delivery before labor, especially before labor induction[6–9] or in women who have had a previous cesarean delivery. Very few studies have been conducted about women expecting to go into spontaneous labor during admission to the labor ward.[10–12] Here, maternal characteristics, such as age, height, body mass index (BMI), and gestational age, and clinical factors, such as cervical dilatation and station and position of the

fetal head, were the factors investigated. Although cervical dilatation is relatively easily assessed with digital vaginal palpation, assessments of both head station and position are subjective and often inaccurate.[13–16]

Transabdominal and transperineal ultrasound examinations are increasingly used as adjuncts to clinical assessment during labor, as fetal head position and descent into the pelvic cavity are more accurately determined with ultrasound imaging than digital imaging.[16–18] The International Society of Ultrasound in Obstetrics and Gynecology has published guidelines for the use of ultrasound in labor.[19] We have shown that these methods can be used to follow labor progress

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Why was this study conducted?

Predicting the duration of labor and a spontaneous delivery on admission could be valuable. The performance of ultrasound as an admission test using head-perineum distance (HPD), angle of progression (AoP), fetal head position, and cervical dilatation was investigated.

Key findings

HPD and AoP were associated with a spontaneous delivery with area under the receiver operating characteristic curves of 0.68 and 0.67 (best cutoff levels of ≥45 mm and ≤93°), respectively. Durations of labor expressed as the hazard ratio for spontaneous delivery were 1.90 for HPD (95% confidence interval [CI], 0.83−2.60), 2.07 for AoP (95% CI, 1.15−3.72), and 3.11 for cervical dilatation (95% CI, 1.68−5.77). Fetal head position was not associated with labor duration or mode of delivery.

What does this add to what is known?

Ultrasound can be used as an admission test in active labor. Fetal head station was associated with labor duration and spontaneous delivery. Cervical dilatation was associated with labor duration. Fetal head position was neither associated with labor duration nor mode of delivery.

in terms of fetal head station and position.[20,21] Identifying predictive factors for a normal outcome early in the labor process would be desirable and of value for planning labor care, allowing for better targeted interventions and resources when labor dystocia is more likely to arise. Previous studies using transperineal ultrasound before spontaneous or induced labor have shown that it is possible to use these methods to predict outcome.[22−24] A prediction model in normal and prolonged nulliparous labors has even been constructed.[25] Here, we aimed to investigate how ultrasound assessments during the first examination in the active phase of labor were associated with duration of labor phases and delivery mode.

Materials and Methods

This was a secondary analysis of a prospective cohort study at Landspitali University Hospital in Reykjavík, Iceland, between January 2016 and April 2018. We examined 99 women with ultrasound longitudinally through the active phase of labor. The fetal head descent and fetal rotation patterns in this group have been published.[20,21] Here, we focused on the predictive value of the first ultrasound examination.

Women more than 18 years old at ≥37 weeks' gestation with a single fetus in cephalic presentation and in spontaneous onset of labor on admission were eligible for the study and recruited in a nonconsecutive manner. The study population corresponded to the definition of group 1 in the Robson 10-group classification system (nulliparous women in spontaneous labor).[26] Oral and written information about the study were provided by a midwife on admission to the labor ward, and written consent was obtained before inclusion.

Active labor was defined by a clinical examination as a fully effaced cervix, dilated at least 4 cm in the presence of regular contractions in agreement with the World Health Organization (WHO) recommendations.[27,28] Women were included after the initial examination if they were in confirmed active phase of labor or when the active phase of labor was diagnosed in the women who had been admitted in the latent phase.

A midwife examined the cervical dilatation clinically at admission. An ultrasound examination was performed by 1 of 2 obstetricians trained in both transabdominal and transperineal scanning within 15 minutes. Results of the ultrasound examination were not revealed to the labor ward staff, and the ultrasound examiners were not involved in clinical decisions regarding the laboring women.

The main outcome measure was duration of the active phase of labor estimated as the likelihood for spontaneous delivery and expressed by a hazard ratio (HR). Secondary outcomes were duration of the second stage of labor, duration of the active pushing phase, and mode of delivery. Independent test variables were ultrasound findings of head-perineum distance (HPD), angle of progression (AoP), fetal head position, and cervical dilatation. The guidelines at the hospital have no upper limit for the duration of the active phase of labor, but the second stage of labor should not be longer than 4 hours and active pushing phase no longer than 2 hours.

The ultrasound device used was Voluson *i* (GE Medical Systems, Zipf, Austria) with a 3.5- to 7.5-MHz 3D curved multifrequency transabdominal transducer. The ultrasound examination was composed of both a transabdominal scan and a transperineal scan. To determine the fetal head position, the transabdominal approach was used first. For this purpose, views of the fetal spine, orbits, and midline structures of the fetal head and choroid plexus were obtained. When this was not possible, because of deep engagement of the fetal head, the transperineal approach was used to determine the position, obtaining views of the midline structures, thalami, and choroid plexuses. The fetal head position was defined as the position of the occiput marked on a clock-face graph with half-hour intervals. The occiput posterior (OP) position was categorized as at or past the 4-o'clock position and at or before the 8-o'clock position as described by Akmal et al.[29,30]

Furthermore, during the transperineal scan, AoP, HPD, and cervical dilatation were assessed. AoP was measured in the sagittal plane as the angle between the longitudinal axis of the pubic symphysis and a line from the most inferior edge of the symphysis tangentially to the lowest contour of the fetal head.[31] The HPD was measured in

the frontal plane (transverse plane related to the perineum) as the shortest distance from the transducer to the fetal skull.[24,32] After measuring the HPD, the transducer was tilted posteriorly until the cervix could be seen.[33−35] Both the anterior-posterior and transverse diameters of the cervical dilatation were measured, and the mean value was used for calculations. All measurements were done between contractions.

All data were collected and managed using Research Electronic Data Capture tools hosted at Landspitali University Hospital.[36] The study was approved by the Landspitali Ethics Committee (reference number 26/2015).

Statistical analysis

The associations between spontaneous vaginal delivery and all operative deliveries related to ultrasound-measured HPD, AoP, and cervical dilatation as continuous variables were evaluated using receiver operating characteristic (ROC) curves. To find the best cutoff levels of HPD and AoP for predicting spontaneous delivery, Youden J statistic was employed.

To evaluate the differences in the time interval from inclusion to spontaneous vaginal delivery according to fetal head station, position, and cervical dilatation, we used Kaplan-Meier methods and Cox regression analyses. The Kaplan-Meier method was used to generate plots for fetal head station categories, OP vs non-OP positions, and cervical dilatation of <4 to 5 cm vs ≥6 cm. The plots were compared using a log-rank test. Cox regression analyses were used to calculate the HR as an estimate of the likelihood ("risk") of spontaneous delivery using the same categories for HPD, AoP, cervical dilatation, and occiput positions for comparison. Cesarean and operative vaginal deliveries were censored.

We used the statistical software package R Core Team (2018), R: A language and environment for statistical computing (R Foundation for Statistical Computing, Vienna, Austria; https://www.R-project.org/).

Results

Study population

Here, 100 women were included; however, 1 woman withdrew her consent. The study population characteristics and labor outcomes are shown in Table 1. Clinically assessed cervical dilatation at inclusion was 4 cm in 26 women, 5 cm in 30 women, 6 cm in 19 women, 7 cm in 16 women, and 8 cm in 6 women. Moreover, in 2 women, the cervical dilatation was 9 and 10 cm. At inclusion, 49 women had confirmed rupture of membranes.

Spontaneous delivery

Overall, 75 of 99 women achieved a spontaneous delivery, and 24 women were delivered operatively. Of the 24 women, 8 delivered by cesarean delivery, and 16 delivered by instrumental vaginal delivery. All but one of the operative deliveries were owing to prolonged first or second stage of labor (further details can be found in a longitudinal study describing the patterns of fetal head descent).[21] Compared with 40 of 47 women (85%) who had a fetus in the non-OP position, 35 of 52 women (67%) that had a fetus in the OP position at inclusion delivered spontaneously (P=.06). ROC curve analyses for the associations between HPD and AoP at inclusion in the prediction of a spontaneous delivery are shown in Figure 1. HPD was associated with spontaneous delivery with an area under the ROC curve (AUC) of 0.68 (95% confidence interval [CI], 0.55−0.80), whereas AoP was associated with spontaneous delivery with an AUC of 0.67 (95% CI, 0.55−0.80). The best cutoff levels of HPD and AoP for predicting spontaneous

TABLE 1

Characteristics of the study population of 99 nulliparous women with a singleton fetus at term, examined with ultrasound early in the active phase of labor

Characteristics	Median (range) or n (%)
Age	27.0 (18.0−40.0)
Body mass index (kg/m^2)	23.3 (16.7−36.3)
Oxytocin augmentation	41 (41.4)
Epidural analgesia	61 (61.6)
Spontaneous delivery	75 (75.8)
Ventouse delivery	15 (15.2)
Forceps delivery	1 (1.0)
Cesarean delivery	8 (8.1)
Blood loss (mL)	400 (100−2000)
Episiotomy	13 (13.3)
Degrees of perineal tear	
None	19 (19.2)
1°	22 (22.2)
2°	53 (53.5)
3°	5 (5.1)
Birthweight (g)	3540 (2480−5000)
Apgar score at 1 min	9 (2−10)
Apgar score at 5 min	10 (5−10)
Gestational age (d)	280 (259−293)

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FIGURE 1
Receiver operating characteristic curves
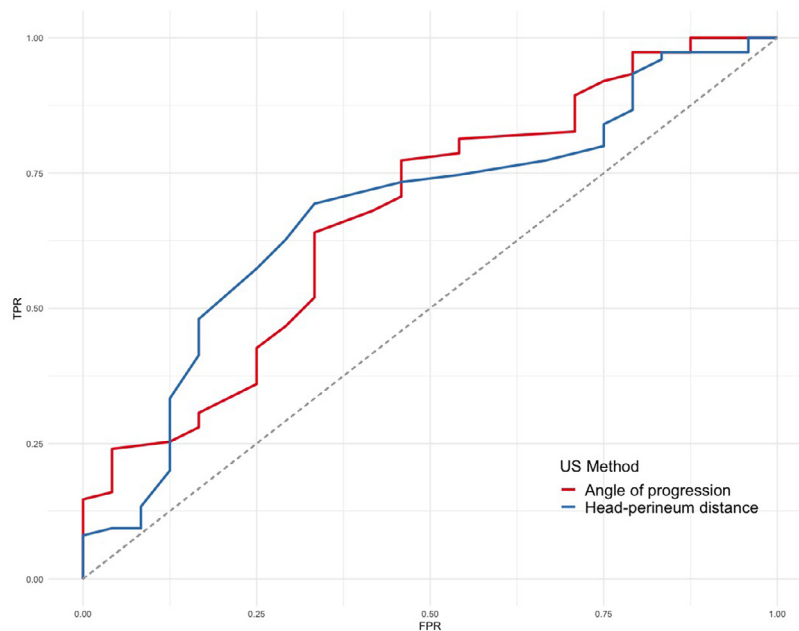
ROC curves for angle of progression and head-perineum distance measurements in the prediction of spontaneous vaginal delivery in nulliparous women in active spontaneous labor at term on admission.

ROC, receiver operating characteristic curves.

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delivery were ≤45 mm and ≥93°, respectively. In addition, these levels were used for stratification into groups for comparison of labor duration. Ultrasound measurement of cervical dilatation with an AUC of 0.50 (95% CI, 0.38−0.63) was not associated with spontaneous delivery. The test characteristics of ultrasound measurements in predicting spontaneous delivery are presented in Table 2.

Duration of labor
At inclusion, fetal station measurements expressed as ultrasound-measured HPDs were ≤45 mm in 60 women and >45 mm in 39 women. The estimated median times in active labor when HPDs were ≤45 and >45 mm were 490 and 682 minutes, respectively (log-rank test, *P*=.009). The probability of being delivered is illustrated with Kaplan-Meier curves (1-survival) in Figure 2. The HR for a spontaneous vaginal delivery showed a shorter duration of labor

associated with a smaller HPD (HR, 1.90; 95% CI, 1.16−3.11), but the association was not significant after adjusting for maternal age and BMI (HR, 1.47; 95% CI, 0.83−2.60).

Fetal station measurements expressed as AoP were ≥93° in 69 women and <93° in 30 women. The estimated median times in active labor were 506 minutes in the former and 732 minutes in the latter group (log-rank test, *P*=.008), and the probability of being delivered is shown in Figure 3. The HR for a spontaneous delivery associated with wider AoP values was 2.06 (95% CI, 1.19−3.56) and remained significant after adjusting for maternal age and BMI (HR, 2.07; 95% CI, 1.15−3.72).

Of 99 fetuses, 52 were in the OP position at inclusion. The estimated median time in active labor was not significantly associated with fetal position at inclusion, that is, 506 minutes in non-OP positions vs 677 minutes in OP positions (log-rank test, *P*=.07). The HR for

a spontaneous delivery associated with non-OP positions illustrated as a Kaplan-Meier plot (1-survival) in Figure 4 was 1.51 (95% CI, 0.96−2.38), and it did not change after adjusting for maternal age and BMI (HR, 1.54; 95% CI, 0.97−2.46).

Ultrasound assessment of cervical dilatation showed that 64 women had a dilatation of 4 to 5 cm and 23 women had a dilatation of ≥6 cm; however, in 12 women, cervical dilatation could not be measured. Dilatation could be assessed in 40 of 49 women with ruptured membranes and 45 of 48 women with intact membranes (*P*=.26). The estimated median durations of active labor were 429 minutes for a cervical dilatation of ≥6 cm and 704 minutes for a cervical dilatation of 4 to 5 cm (log-rank test, *P*=.002). The HR for spontaneous delivery associated with greater dilatation illustrated as a Kaplan-Meier plot (1-survival) in Figure 5 was 2.45 (95% CI, 1.38−4.36), and after adjusting

TABLE 2
Test characteristics of ultrasound measurements of head-perineum distance and angle of progression in predicting spontaneous vaginal delivery

| Characteristics	Sensitivity	FPR	PPV	NPV	PLR	NLR
HPD (mm)						
≤40	0.33 (0.23–0.45)	0.12 (0.03–0.32)	0.89 (0.72–0.98)	0.30 (0.19–0.42)	2.67	0.76
≤46	0.67 (0.45–0.84)	0.33 (0.16–0.55)	0.87 (0.75–0.94)	0.41 (0.26–0.58)	2.08	0.46
≤50	0.80 (0.69–0.88)	0.75 (0.53–0.90)	0.77 (0.66–0.86)	0.29 (0.11–0.52)	1.07	0.80
≤60	0.97 (0.91–1.00)	0.95 (0.79–1.00)	0.76 (0.66–0.84)	0.33 (0.01–0.91)	1.02	0.64
AoP (°)						
≥110	0.24 (0.15–0.35)	0.04 (0.00–0.21)	0.95 (0.74–1.00)	0.29 (0.19–0.40)	5.76	0.79
≥100	0.57 (0.45–0.69)	0.33 (0.16–0.55)	0.84 (0.71–0.93)	0.33 (0.20–0.48)	1.72	0.64
≥93	0.79 (0.68–0.87)	0.54 (0.33–0.74)	0.82 (0.71–0.90)	0.41 (0.22–0.61)	1.45	0.47
≥90	0.87 (0.77–0.93)	0.71 (0.49–0.87)	0.79 (0.69–0.87)	0.41 (0.18–0.67)	1.22	0.46
≥80	1.00 (0.95–1.00)	0.88 (0.68–0.97)	0.78 (0.69–0.86)	1.00 (0.29–1.00)	1.14	0.00

Data are expressed as point estimates or point estimates (95% confidence intervals)

AoP, angle of progression; *FPR*, false-positive rate; *HPD*, head-perineum distance; *NLR*, negative likelihood ratio; *NPV*, negative predictive value; *PLR*, positive likelihood ratio; *PPV*, positive predictive value.

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FIGURE 2
Duration of labor by HPD measurement at the first examination
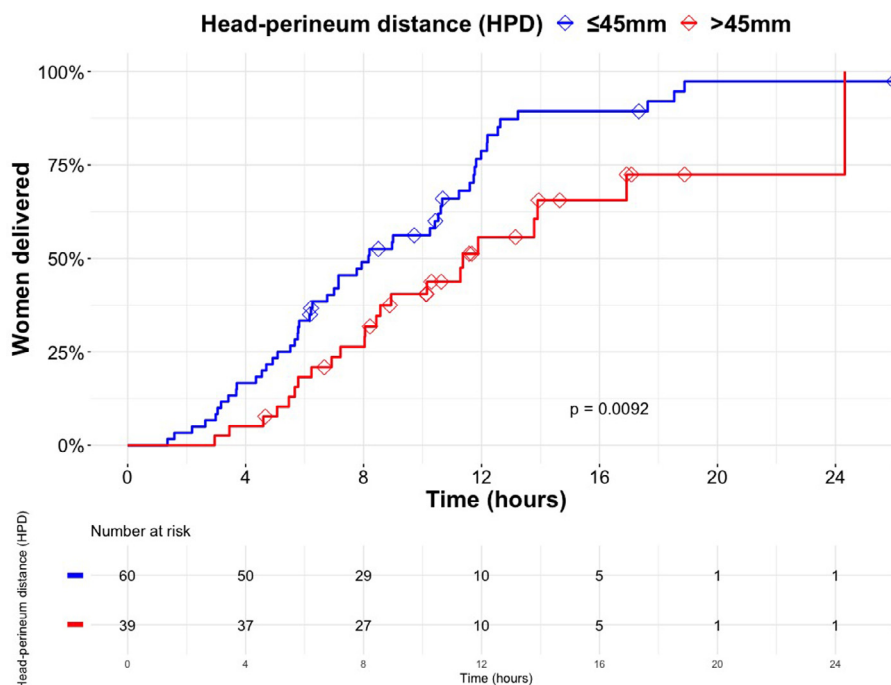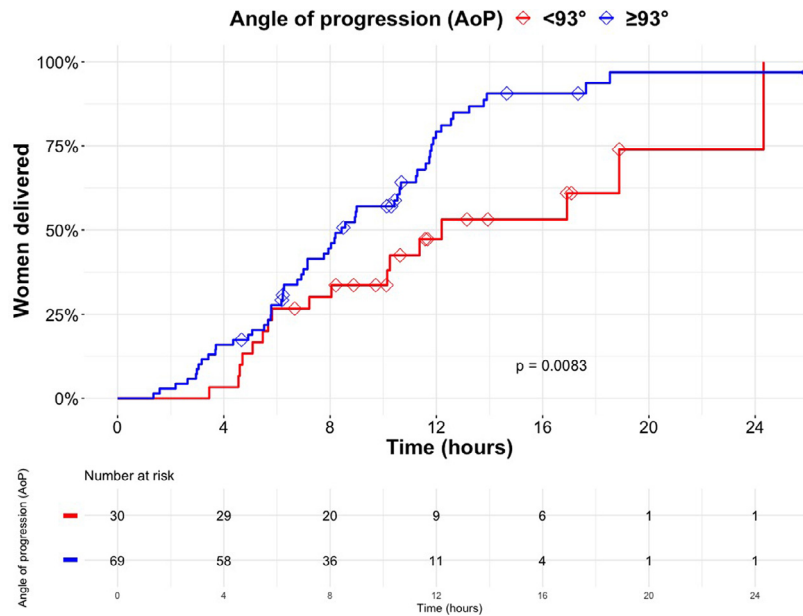

The curves are stratified as head-perineum distances of ≤45 and >45 mm. Cases with operative delivery were censored (*diamonds* on survival lines).

Kaplan-Meier curves of time from the first examination in the active phase of labor to delivery in 99 nulliparous women in spontaneous labor

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FIGURE 3
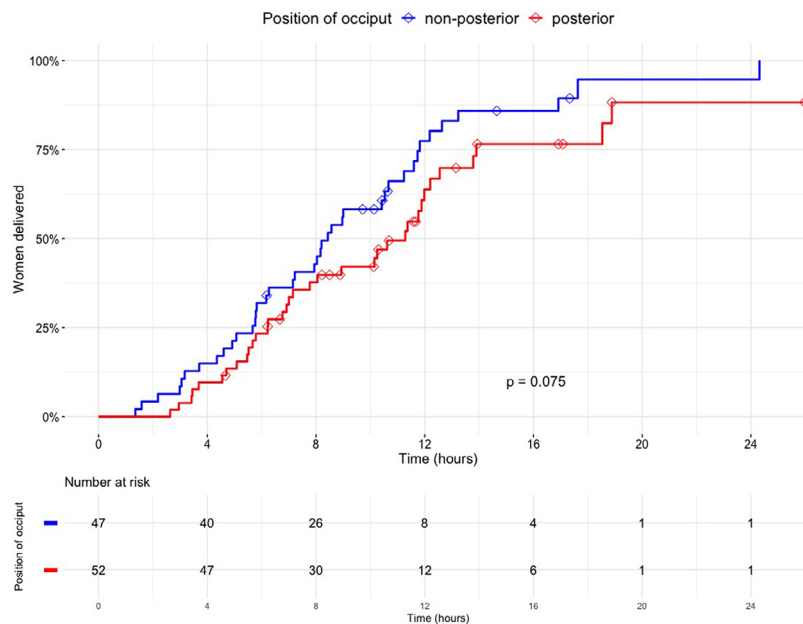**Duration of labor by AoP measurement at the first examination**

The curves are stratified as angles of progression of ≥93° and <93°. Cases with operative delivery were censored (*diamonds* on survival lines).

Kaplan-Meier curves of time from the first examination in the active phase of labor to delivery in 99 nulliparous women in spontaneous labor

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FIGURE 4
**Duration of labor by occiput position at the first examination**

The curves are stratified as nonocciput posterior and occiput posterior positions. Cases with operative delivery were censored (*diamonds* on survival lines).

Kaplan-Meier curves of time from the first examination in the active phase of labor to delivery in 99 nulliparous women in spontaneous labor

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FIGURE 5
Duration of labor by cervical dilatation at the first examination
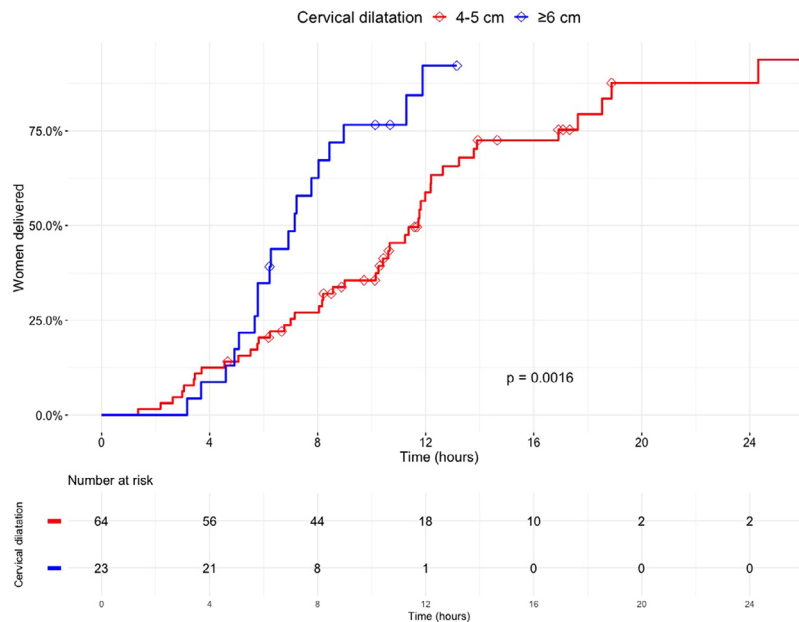
The curves are stratified as ultrasound-assessed cervical dilatations of 4 to 5 cm and ≥6 cm. Cases with operative delivery were censored (*diamonds* on survival lines).

Kaplan-Meier curves of time from the first examination in the active phase of labor to delivery in 99 nulliparous women in spontaneous labor

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for maternal age and BMI, it was 3.11 (95% CI, 1.68−5.77).

Duration of the second stage
The estimated median durations of the second stage of labor were 92 minutes if the HPD was ≤45 mm at inclusion and 109 minutes if the HPD was >45 mm (*P*=.06). The HR for a spontaneous delivery related to smaller HPD values was 1.61 (95% CI, 0.97−2.64), but the association was not significant after adjusting for maternal age and BMI (HR, 1.50; 95% CI, 0.85−2.65). The estimated median durations of the second stage of labor were 93 minutes if the AoP was ≥93° at inclusion and 124 minutes if the AoP was <93° (*P*=.04). For larger AoP values, the HR for spontaneous delivery was 1.76 (95% CI, 1.02−3.04), and after adjusting for maternal age and BMI, it was 1.59 (95% CI, 0.88−2.88).

OP position and cervical dilatation at inclusion were not associated with the estimated duration of the second stage of labor.

The estimated median durations of the active second stage of labor were 62 minutes if the AoP was ≥93° at inclusion and 75 minutes if the AoP was <93° (*P*=.03). For larger AoP values, the HR for spontaneous delivery was 1.86 (95% CI, 1.05−3.32), and after adjusting for age and BMI, it was 1.97 (95% CI, 1.06−3.68). None of the other parameters examined were associated with the estimated duration of active pushing (Table 3).

Comment
Principal findings
Fetal head station measured with ultrasound as HPD and AoP in the early active phase of labor was associated with both the time remaining in labor and the duration of the second stage of labor. HPD and AoP were associated with a spontaneous delivery with AUCs of 0.68 and 0.67, respectively. Ultrasound-measured cervical dilatation in

the early active phase of labor was significantly associated with labor duration but not with delivery mode. Fetal head position at the first examination in the active phase of labor was neither associated with duration of labor nor delivery mode.

Results in context
The prediction of mode of delivery in nulliparous women in labor on admission using clinical factors has been investigated.[10,11,37−39] Turcot et al[39] found that cervical dilatation on admission could predict operative delivery; however, less than one-third of women had a cervical dilatation of ≥4 cm at inclusion. Janssen et al[11] found that less advanced cervical dilatation and higher fetal station predicted cesarean delivery and that a model developed on the basis of these findings and a few other factors predicted cesarean delivery with an AUC of 0.71. However, in their study, only one-quarter of women with a cervical dilatation of >4 cm were included.

TABLE 3
Cox regression analysis for risk ("likelihood") of a spontaneous delivery in nulliparous women examined at the diagnosis of the active phase of labor

Parameter	Unadjusted HR	95% CI	Adjusted HR	95% CI
Active phase				
Nonocciput posterior	1.51	0.96−2.38	1.54	0.97−2.46
HPD ≤45 mm	1.90[a]	1.16−3.11[a]	1.47	0.83−2.60
AoP ≥93°	2.06[a]	1.19−3.56[a]	2.07[a]	1.15−3.72[a]
Cervical dilatation of ≥6 cm examined with ultrasound	2.45[a]	1.38−4.36[a]	3.11[a]	1.68−5.77[a]
Second stage				
Nonocciput posterior	1.40	0.89−2.21	1.43	0.89−2.29
HPD ≤45 mm	1.61	0.97−2.64	1.50	0.85−2.65
AoP ≥93°	1.76[a]	1.02−3.04[a]	1.59	0.88−2.88
Cervical dilatation of ≥6 cm examined with ultrasound	1.57	0.91−2.70	1.76	0.98−3.16
Active second stage				
Nonocciput posterior	1.45	0.92−2.28	1.54	0.97−2.46
HPD ≤45 mm	1.55	0.94−2.55	1.52	0.87−2.65
AoP ≥93°	1.86[a]	1.05−3.32[a]	1.97[a]	1.06−3.68[a]
Cervical dilatation of ≥6 cm examined with ultrasound	1.43	0.83−2.47	1.50	0.84−2.68

AoP, angle of progression; *CI*, confidence interval; *HPD*, head-perineum distance; *HR*, hazard ratio.

[a] HRs with CIs not crossing 1.0 were assumed significant.

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Wilkes et al[38] found that a change in cervical dilatation and station 2 hours after admission was better in predicting cesarean delivery than the initial dilatation and station. de Souza et al[10] studied nulliparous and multiparous women with a cervical dilatation of <7 cm in both spontaneous and induced labors. Furthermore, a prediction model based on clinical factors on admission predicted cesarean delivery with an AUC of 0.78; however, the prediction was better using information obtained during labor.

The value of transperineal ultrasound in predicting labor outcomes has previously been investigated before the onset of labor and in laboring women.[22−25,40−42] In these studies, the cohorts were composed of mixed groups of parous and nulliparous women undergoing spontaneous and induced labors. Marsoosi et al[40] studied 70 nulliparous and parous women and suggested that AoP might predict vaginal delivery when measured on admission in active labor. Chor et al[42] studied hourly changes of several clinical and ultrasound parameters in nulliparous women in both induced and spontaneous labors and found that changes in progression distance could be of use in predicting cesarean delivery because of nonprogressive labor. Chan et al[41] studied nulliparous and multiparous women in active, induced, and spontaneous labors and suggested that a combination of AoP and HPD could be used to predict time to a normal spontaneous delivery. Torkildsen et al[5] studied women in prolonged labor and found HPD and AoP to predict vaginal delivery with AUCs of 0.81 and 0.76, respectively. Eggebø et al[25] studied nulliparous women in prolonged labor and found that a model combining maternal factors known to be associated with delivery mode with ultrasound factors could be useful in predicting vaginal delivery. In another study by Eggebø et al,[43] fetal head position was found to be of value in predicting cesarean delivery in nulliparous women with a prolonged first stage of labor. However, the study did not predict operative vaginal delivery or remaining time in labor. Comparisons with these studies suggest that the value of ultrasound in assessing fetal head station and reliably confirming position may be greater in predicting operative delivery when labor is prolonged than at the outset of spontaneous labor.

Ultrasound AoP and HPD are different but interrelated methods for assessing fetal head station. We included both in our study and found a good correlation between the methods as shown before.[44] Both methods may be associated with the duration of labor and delivery mode because there were modest variations of the respective predictive values and their confidence limits. Both approaches in previous studies are of value to indicate the likelihood of successful descent of the fetal head through the birth canal and thus vaginal delivery.[5,31,32,45−48]

Ultrasound measurements of cervical dilatation are more challenging than the assessment of the position and measurements of HPD and AoP, especially after rupture of the membranes. Objective measurements are possible after training, and good repeatability has been shown.[33] Ultrasound cannot replace clinical assessment of cervical dilatation at late stages but has the potential to be used as an admission test.[35]

Clinical implications
Our results have shown the expected variations in the duration of the active phase of labor and that cervical dilatation at admission is associated with the duration of labor. In addition, we have shown that assessing the fetal head station with ultrasound has a role as it is not only associated with the duration of the active phase and second stage of labor but also associated with spontaneous vaginal delivery. We can confirm suggestions from previous studies that

the position of the fetal head at the diagnosis of the active phase does not seem to affect duration of labor or mode of delivery.[17,22]

Based on our results, measuring HPD and AoP on admission in the active phase of labor could identify those women who are at low risk of intervention and assessed as being more likely to have shorter durations of labor. These women could be reassured and offered a low-risk environment; however, based on measurements showing high fetal head station, other women who are assessed as having a higher risk could be observed more closely for signs of slow progress in terms of fetal descent and cervical dilatation. In addition, they could be better informed of more realistic expectations of labor duration and offered more effective pain relief as soon as active labor is diagnosed. Other supportive measures could also be ensured, such as one-to-one midwifery care. Furthermore, our results do not suggest that we have, as yet, a reliable method to find those women who ultimately will need an operative delivery as progress is so individual. Given the late occurrence of fetal head descent and rotation observed in our longitudinal study of the same group of women,[20] it is possible that change over time is a better predictor of outcome than a spot assessment at admission, as suggested by other researchers.[38,39,49,50]

Research implications

We investigated the association between ultrasound and spontaneous vaginal deliveries instead of cesarean delivery because we only had 8 such deliveries. Results based on such small numbers could be subject to greater errors; as such, this should be studied in larger groups. It is possible that fetal head station is more strongly associated with cesarean delivery than all operative deliveries. If confirmed, the results could be used to construct a labor admission test, helping to stratify risk along with other demographic and pregnancy risk factors.

Strengths and limitations

A strength of our study was the homogenous group of spontaneously laboring nulliparous women recruited and assessed when the active phase was diagnosed. In addition, we were able to report on ultrasound measurements of cervical dilatation and fetal position and station using methods that can be regarded as established. The ultrasound examiners were fetal medicine experts, which is not only a strength in documenting the potential value of ultrasound but also a potential limitation for external validation. To date, only a few obstetricians and midwives are trained in these methods, but that is likely to change. In 2018, the WHO changed the definition of the active phase of labor and recommended that cervical dilatation should be at least 5 cm at the start of the active phase of labor.[51] We used the WHO criteria recommended at the time when the study was planned and executed, such as regular contractions, cervix effaced, and dilatation of ≥4 cm.[27] Moreover, women were recommended to stay at home until contractions were regular.

That women had varying degrees of cervical dilatation at inclusion could be considered a limitation. We had no way of knowing the actual duration of the active phase of labor among most women because they were already in confirmed labor on admission. However, this reflects the reality of labor, and we were keen to observe whether outcomes could be predicted at the time of the ultrasound examination. Other limitations were the observational design and size of the cohort. The low cesarean delivery rate in this population was in line with usual audits from our hospital but differed from many other departments, which may have limited external validation.

Conclusions

We found that ultrasound assessments of fetal head station on entry to the labor ward in the active phase of labor were associated with labor duration and duration of the second stage of labor and modestly associated with spontaneous delivery. Cervical dilatation assessed with ultrasound at the same time was associated with duration of labor but not with spontaneous delivery. Ultrasound assessments of fetal head position were neither associated with labor duration nor mode of delivery. Ultrasound can be used to categorize women into low- and high-risk groups, but it cannot reliably define a subset of women needing operative delivery. ∎

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