



Prediction of delivery mode by ultrasound-assessed fetal position in nulliparous women with prolonged first stage of labor

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KEYWORDS: labor; occiput posterior; transperineal; ultrasound

ABSTRACT

Objectives To ascertain if fetal head position on transabdominal ultrasound is associated with delivery by Cesarean section in nulliparous women with a prolonged first stage of labor.

Methods This was a prospective observational study performed at Stavanger University Hospital, Norway, and Addenbrooke's Hospital, Cambridge, UK, between January 2012 and April 2013. Nulliparous pregnant women with a singleton cephalic presentation at term and prolonged labor had fetal head position assessed by ultrasound. The main outcome was Cesarean section vs vaginal delivery, and secondary outcomes were association of fetal head position with operative vaginal delivery and duration of remaining time in labor.

Results Fetal head position was assessed successfully by ultrasound examination in 142/150 (95%) women. In total, 19/50 (38%) women with a fetus in the occiput posterior (OP) position were delivered by Cesarean section compared with 16/92 (17%) women with a fetus in a non-OP position ($P = 0.01$). On multivariable logistic regression analysis, the OP position predicted delivery by Cesarean section with an odds ratio (OR) of 2.9 (95% CI, 1.3–6.7; $P = 0.01$) and induction of labor with an OR of 2.4 (95% CI, 1.0–5.6; $P = 0.05$). Fetal head position was not associated with operative vaginal delivery or with remaining time in labor. The agreement between a digital and an ultrasound assessment of OP position was poor (Cohen's kappa = 0.19; $P = 0.18$).

Conclusion OP fetal head position assessed by transabdominal ultrasound was significantly associated with delivery by Cesarean section. Copyright © 2014 ISUOG. Published by John Wiley & Sons Ltd.

INTRODUCTION

Ultrasound is the preferred method for detecting fetal head position during labor, with an accuracy superior to that of digital examination^{1–5}, and a technique that is easier to learn⁶. However, the clinical value of the ultrasound diagnosis of the occiput posterior (OP) position of the fetus has been difficult to document, and studies show inconsistent results^{7–11}. This may be due to differences between study populations and the timing of the ultrasound examination. Before or early in labor, around 30% of fetuses are in the OP position, but most rotate spontaneously. The frequency of the OP position at delivery is 5–7%^{7,8,12,13}. A systematic review concluded that ultrasound assessment of fetal position in early labor was of little value and should not be recommended¹⁴. This has led to a general view among obstetricians that ultrasound examination of the fetal head position may be useful before an operative vaginal delivery, but not in the first stage of labor.

The aim of this study was to investigate whether transabdominal ultrasound assessment of fetal head position is associated with rate of Cesarean section in nulliparous women with a prolonged active first stage of labor.

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METHODS

This prospective observational study in nulliparous women with a prolonged first stage of labor was performed at Stavanger University Hospital, Norway, and Addenbrooke's Hospital, Cambridge, UK, between January 2012 and April 2013. The ethics committees approved the study (REK 2011/731 in Norway and 11/EE/064 in the UK) and the study was registered in Clinical Trials.gov with identifier NCT01610453. Women with a live singleton fetus in cephalic presentation at or after 37 weeks' gestation according to a second-trimester scan, were considered eligible for the study. The primary aim of this study was to investigate a possible association between delivery mode and ultrasound-assessed fetal level in the birth canal. Power calculations prior to the start of the study showed a need for a sample size of 146 women; these results have been published previously¹⁵.

In the present study we focused on ultrasound assessment of fetal head position. The main outcome was Cesarean section *vs* vaginal delivery. Secondary outcomes were operative vaginal delivery and remaining time in labor. The research team comprised nine doctors and three midwives. Women were recruited to the study if a member of the research team was in attendance during their visit to the clinic, and all gave written informed consent.

In Stavanger University Hospital, prolonged active first stage of labor was diagnosed in accordance with the recommendations of the World Health Organization (i.e. when cervical dilatation crossed the action line 4 h delayed from the alert line), and in Addenbrooke's Hospital prolonged labor was defined according to the guidelines of the UK National Institute for Health and Care Excellence (i.e. dilatation of < 2 cm in 4 h). When prolonged labor was diagnosed, oxytocin augmentation was considered in accordance with local guidelines.

The birth attendant responsible for the labor evaluated fetal head position by digital vaginal examination just before or immediately after the ultrasound examination. The research team and birth attendants were blinded to each others' assessments. Transabdominal ultrasound measurements were performed using Voluson *i* ultrasound equipment (GE Medical Systems, Zipf, Austria) with a 3.5–7.5-MHz three-dimensional curved multifrequency transabdominal transducer in Stavanger University Hospital, and Samsung Medison Accuvix XG equipment (Samsung Medison, Medical Imaging Systems Ltd, London, UK) with a 4–6-MHz convex transabdominal transducer in Addenbrooke's Hospital. The ultrasound operator was not involved in clinical decisions or management of the labor.

Fetal head position was assessed by ultrasound using the method described by Youssef *et al.*¹⁶. Fetal head position was recorded as the position on a 'clock' divided into half-hourly sections. Positions from 02.30 to 03.30 h were recorded as left occiput transverse and positions from 08.30 to 09.30 as right occiput transverse. Positions from 04.00 to 08.00 were recorded as OP, and positions from 10.00 to 02.00 as occiput anterior (OA) position^{9,12,17}.

Statistical analysis

Predictive values for vaginal delivery were evaluated by cross-table analysis and the chi-square test; continuous variables were compared using the Mann–Whitney *U*-test. Fetal head position, spontaneous onset of labor, maternal age, gestational age and body mass index (BMI) were included in a multivariable logistic regression analysis, with Cesarean section *vs* vaginal delivery as the dependent variable. The time from the ultrasound examination to delivery was evaluated using Kaplan–Meier survival analysis and compared using the log rank test. Data for women who underwent Cesarean section were censored. Agreement between categorical variables was compared using Cohen's kappa. Data were analyzed with the statistical software package SPSS statistics version 21.0 (IBM SPSS, Armonk, NY, USA).

RESULTS

In total, 87 women at Stavanger University Hospital and 63 women at Addenbrooke's Hospital were included in the study. Fetal head position was assessed successfully using ultrasound in 142/150 (95%) women. Maternal characteristics, labor and fetal outcome, differentiated into OP or non-OP position as assessed by ultrasound, are presented in Table 1. In all, 19/50 (38%) women with a fetus in the OP position were delivered by Cesarean section *vs* 16/92 (17%) women with a fetus in a non-OP positions ($P=0.01$). In the OP group, 10/19 (53%) deliveries by Cesarean section were carried out because of prolonged first stage of labor, 5/19 (26%) because of prolonged second stage and 4/19 (21%) because of fetal distress. The corresponding numbers in the non-OP group were 6/16 (38%) because of prolonged first stage of labor, 6/16 (38%) because of prolonged second stage and 4/16 (25%) because of fetal distress.

The overall sensitivity of predicting Cesarean section using the ultrasound-assessed OP position as the test variable was 54% (95% CI, 38–70%), the false-positive rate was 29% (95% CI, 21–38%), the positive predictive value was 38% (95% CI, 26–52%), the negative predictive value was 83% (95% CI, 74–89%), the positive likelihood ratio (LR+) was 1.9 and the negative LR (LR–) was 0.65.

On multivariable logistic regression analysis, the OP position predicted delivery by Cesarean section with an odds ratio (OR) of 2.9 (95% CI, 1.3–6.7; $P=0.01$) and induction of labor with an OR of 2.4 (95% CI, 1.0–5.6; $P=0.05$). Maternal age, gestational age and BMI had no confounding effects. The time from ultrasound examination to delivery was not significantly longer for women with a fetus in the OP position ($P=0.37$; log rank test). Figure 1 shows the time from ultrasound examination to vaginal delivery, with data censored in the event of a Cesarean section.

We observed a tendency to more operative vaginal deliveries associated with a non-OP position, but this was not statistically significant. In total, 13/50 (26%)

fetuses in the OP position were delivered by operative vaginal delivery compared with 35/92 (38%) fetuses in a non-OP position ($P=0.15$). Information on mode of delivery related to ultrasound-assessed fetal position when prolonged labor was diagnosed is presented in Table 2.

Fetal head position was evaluated successfully by digital assessment in only 48/150 (32%) women. Digitally-assessed OP position did not significantly predict delivery by Cesarean section ($P=0.47$). We observed a

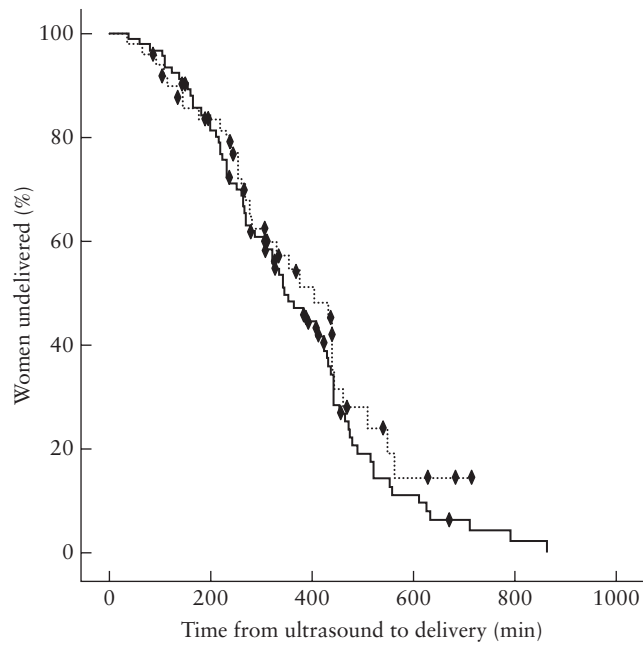


Figure 1 Kaplan–Meier plot of time from ultrasound examination to delivery in 142 nulliparous women with prolonged first stage of labor, showing those with occiput posterior (OP) fetal head position (.....) and those with non-OP position (—). Data of women who delivered by Cesarean section (CS) were censored. ♦, timing of CS.

low agreement between digital and ultrasound assessment of OP position (Cohen's kappa = 0.19; $P=0.18$).

We lacked information on the position at delivery in five of the 107 vaginal deliveries. All vaginal deliveries among women with non-OP positions according to ultrasound assessment were in the OA position at delivery. Fifty fetuses were found to be in the OP position when the ultrasound examination was performed; 19 were delivered by Cesarean section, 26 rotated spontaneously and were delivered vaginally in the OA position, four remained in the OP position at vaginal delivery, and in one case information on position at delivery was missing.

DISCUSSION

Ultrasound-assessed OP position was associated with delivery by Cesarean section in nulliparous women with a prolonged first stage of labor. In this study we assessed the use of transabdominal ultrasound for evaluating fetal head position. We have reported previously the predictive value of transperineal ultrasound in the same study population and found that both fetal level and head position showed good predictive value in a multivariable

Table 2 Association between mode of delivery and ultrasound-assessed fetal head position in 142 women with prolonged first stage of labor

Mode of delivery	Fetal head position			P
	OA	OT	OP	
Spontaneous vaginal	30/59 (51)	11/59 (19)	18/59 (31)	0.28
Operative vaginal	22/48 (46)	13/48 (27)	13/48 (27)	0.30
Cesarean section	9/35 (26)	7/35 (20)	19/35 (54)	0.02

Data are given as n/N (%). OA, occiput anterior; OP, occiput posterior; OT, occiput transverse.

Table 1 Characteristics of study population, labor and fetal outcome, according to ultrasound assessment of fetal head position in 142 women with prolonged first stage of labor

Characteristic	Non-OP position (n = 92)	OP position (n = 50)	P*
Maternal			
Age (years)	29 (18–41)	30 (18–44)	0.85
Body mass index (kg/m ²)	24 (17–37)	23 (17–42)	0.58
GA at assessment (weeks)	40 (37–42)	40 (37–42)	0.89
White European ethnicity	80 (87)	42 (84)	0.63
Labor			
Induction of labor	28 (30)	15 (30)	0.92
Augmentation of labor	81 (88)	41 (82)	0.47
Epidural analgesia	86 (93)	45 (90)	0.46
Cesarean section delivery	16 (17)	19 (38)	0.01
Operative vaginal delivery	35 (38)	13 (26)	0.15
Postpartum bleeding (mL)	400 (150–2000)	450 (100–2500)	0.31
Neonatal			
Birth weight (g)	3625 (2430–5020)	3548 (2560–4770)	0.61
Apgar score at 1 min	9 (2–10)	9 (4–10)	0.45
Apgar score at 5 min	10 (4–10)	10 (6–10)	0.22
UA pH (n = 109)	7.23 (7.02–7.33)	7.23 (7.00–7.36)	0.87
UA base deficit (n = 107)	3 (–1 to 13)	3 (–2 to 12)	0.68

Data are given as median (range) or n (%). *Mann–Whitney U -test or chi-square test. GA, gestational age; OP, occiput posterior; UA, umbilical artery.

analysis¹⁵. Since many clinicians have been reluctant to adopt the transperineal approach, and use only transabdominal ultrasound to assess fetal position¹⁸, we felt that it was important to report the clinical value of the transabdominal ultrasound-assessed fetal position alone. However, we recommend the use of both approaches during labor.

Somewhat surprisingly, we found a high rate (38%) of operative vaginal delivery in cases with a non-OP position on ultrasound assessment. A possible explanation is that prolonged labor in cases with the OP position is due to malposition, and prolonged labor in cases with a non-OP position is due to too few contractions. Thus, oxytocin augmentation in the OA group may successfully progress labor into the second stage and make an operative vaginal delivery possible. A recently published study documented an association between operative vaginal delivery and transverse position in the second stage of labor¹⁹.

An association between OP position and delivery by Cesarean section is reported inconsistently in the literature. Results depend on the study population and on the timing of the ultrasound examination. Although it is well known that the OP position is often found in women who deliver by Cesarean section²⁰, this does not mean that the OP position diagnosed during labor can predict Cesarean section. A systematic review concluded that ultrasound assessment of fetal head position before the start of labor should be avoided because of uncertain predictive value¹⁴. Ultrasound results might influence birth attendants' perception of the possibility of a successful vaginal delivery and increase the rate of Cesarean section^{14,21}. The present study differs from previous studies because we selected a subgroup of nulliparous women in a prolonged first stage of labor, in which ultrasound assessment of fetal head position could predict mode of delivery.

Other subgroups may also benefit from ultrasound assessment during labor. Exact knowledge of fetal position and level is required by the obstetrician when performing operative vaginal delivery^{4,16,22–25}. In a randomized controlled trial (RCT), ultrasound assessment reduced the incidence of incorrect diagnosis of fetal head position, but did not prevent morbidity²⁶. Digital examination could be replaced by ultrasound in women with prelabor rupture of membranes, but studies are needed to document possible benefits. Manual correction of malposition is possible during the second stage of labor when the precise position is known²⁷. Maternal position may influence fetal rotation during labor, and an ongoing RCT is evaluating the influence of maternal position in the management of OP position during the first stage of labor²⁸. Asynclitism can also be diagnosed by ultrasound^{29,30} and is associated with second-stage arrest, but it is a normal finding during the first stage of labor³¹.

In a previous study, we found no clinical value in diagnosing the OP position in nulliparous women with prolonged labor¹⁰. We believe that the results of the present study are more reliable because it was a two-center

study with a larger population than that of the previous one. A good prognostic test should have an LR+ > 10 and an LR- < 0.1³². In the present study, we found statistically significant differences, but clinically less impressive test characteristics (LR+, 1.9; LR-, 0.65). We think that anamnestic information, clinical examination and transabdominal and transperineal ultrasound assessment should be combined and prospectively tested in predictive models^{33,34}. In this study we tested only variables known at the time of the ultrasound examination in the multivariable analysis, and we did not include oxytocin augmentation and epidural analgesia because around 90% of the women had epidural analgesia and oxytocin augmentation. Longitudinal studies are important in investigating changes during labor³⁵, and a recently published longitudinal study did not find any influence of epidural analgesia on fetal rotation during labor³⁶. The use of a sonopartogram including fetal position and level and cervical dilatation might change the method of surveillance of labor in the future^{37,38}.

Ultrasound assessment of fetal head position is usually easy, however it can be difficult to assess at low fetal head stations, and a transperineal approach can be helpful³⁹. Digital assessment of the fetal head position is difficult in early labor and in obstructed labor. In the present study, precise determination of position was achieved by digital examination in only 32% of women, and agreement with ultrasound assessment was poor.

Strengths of the study include a prospective design, two centers in different countries, 12 ultrasound examiners and a blinded study design including only a subgroup of clearly defined nulliparous women with prolonged labor. However, the study does have some limitations. The primary aim was to investigate fetal level in the birth canal, and the size of the study population was calculated based on this primary aim. We performed a retrospective power analysis using alpha of 0.05, power 80, assuming sizes of groups are in the ratio 2:1. Expecting a 40% rate of delivery by Cesarean section in the OP group *vs* 15% in the non-OP group, the total study population would be 115 women. Fetal position was not recorded consistently in women who delivered by Cesarean section, and we lacked information on position at delivery in five cases. It has been noted that an oblique position of the fetal spine will increase the probability of spontaneous rotation⁴⁰, but this variable was not included in our protocol. One limitation of the study is that the definition of prolonged labor was different in the two centers, however, the results were similar. The Cesarean section rate in the OP group was 37% in Stavanger University Hospital compared with 40% in Addenbrooke's Hospital, and in the non-OP group it was 14% and 21%, respectively. Another limitation is that only one ultrasound examination was performed in each woman, and the precise position of the fetal head immediately before intervention was not known. This explains why position at delivery in some cases differed from the ultrasound-assessed position. Repeat ultrasound examinations may be necessary to ascertain whether the position persists or is part of the second cardinal rotational

movement. However, in accordance with the protocol, our aim was to investigate the predictive value of ultrasound when a prolonged first stage of labor is diagnosed.

In conclusion, transabdominal ultrasound assessment of fetal head position was associated significantly with delivery by Cesarean section in nulliparous women with a prolonged first stage of labor. This information could be useful for planning delivery and timing interventions.

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