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Neonatal outcome and delivery mode in labors with repetitive fetal scalp blood sampling

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ABSTRACT

Objective: To investigate if repeat (≥3) fetal scalp blood sampling (FBS) is associated with increased risk of caesarean delivery and worse neonatal outcome than occasional (1–2) FBS.
Study design: Prospective cohort study of women undergoing intrapartum FBS at Karolinska University Hospital, Sweden. FBS with lactate analysis was performed if the attending doctor found the cardiotocography (CTG) tracing suspicious or abnormal. Lactate concentration was measured bedside. As a routine in all deliveries, acid-base analyses were performed on umbilical artery and vein blood immediately after delivery. Main outcome measures were metabolic acidemia in umbilical artery at delivery, Apgar score <7 at 5 min and caesarean delivery.
Results: During the study period there were 2134 FBSs performed on 1070 laboring women with a median of two samplings (range 1–8). There were no differences in Apgar score <7 at 5 min or metabolic acidemia in umbilical artery blood at birth between labors with 1–2 FBS and ≥3 FBS. Among women who underwent 1–2 FBS, 23% had a caesarean delivery as compared with 42% of those having ≥3 FBS. After adjustment for confounders, repeat FBS remained an independent risk factor for caesarean delivery (adj OR 2.05; 95%C.I 1.5–2.8).
Conclusion: Fetal monitoring with repetitive FBS (≥3) during labors with CTG changes is safe for the baby, but the rate of caesarean delivery is doubled as compared to labors where 1–2 FBS are needed. Still, more than 50% of women with repetitive FBS will be delivered vaginally, and 1/3 of these spontaneously.
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Introduction

Fetal scalp blood sampling (FBS) was developed as a method of intrapartum fetal surveillance parallel to the development of cardiotocography (CTG), and introduced in clinical practice in the 1960's, using pH analysis on fetal scalp blood. During the 1980's lactate analysis was evaluated for use in FBS, and is currently used at most labor wards in Sweden [1]. Intrapartum CTG has low specificity with many non-acidemic fetuses having CTG changes, and FBS with lactate analysis can be used to exclude metabolic acidemia in cases of non-reassuring CTG, as false negative tests are unlikely [2]. Since fetal lactate increases specifically during anaerobic metabolism, FBS also reliably detect fetuses at risk of developing hypoxemia [3–5].

Lactate concentration in fetal scalp blood correlates with lactate and pH in the umbilical artery, and is shown to be more sensitive than fetal scalp pH in predicting low Apgar score at 5 min and hypoxic ischemic encephalopathy [6]. The cut-off value is based on a large population, and has a good agreement with gold standard pH analysis regarding frequency of intervention [2,6]. Cut-off values for intervention must however always be considered in the light of the meter that is used.

The guidelines for use of FBS lies in the hands of CTG interpretation, which is affected by inter observer variation [7–10]. If the CTG tracing has indicated FBS early in first stage of labor or if labor is prolonged, there are no clear guidelines how to continue fetal surveillance during the remaining part of labor if the first FBS shows normal results. The National Institute of Health and Clinical Excellence (NICE) has published the recommendation that a resident should obtain an obstetric opinion from a consultant if a third FBS is considered necessary, but this recommendation is based on consensus rather than scientific evidence [11]. A retrospective study from 2011 showed an increased risk of operative delivery and admission to neonatal intensive care unit

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(NICU) in cases with FBS in early labor (cervical dilatation ≤3 cm), but no increased prevalence of birth acidemia. However, the chance of a vaginal delivery was still 48% [12].

We hypothesized that in most cases with a normal result at the first FBS, there is no development of acidemia. Prolonged duration of mild/moderate CTG changes, causing repetitive FBSs during labor, might influence the threshold for operative interventions, but without increased frequency of fetal or neonatal acidemia or worse neonatal outcome. The aims of the present study were to evaluate if women with repetitive FBS (≥3) during labor had increased rates of fetal acidemia, operative interventions and/or worse neonatal outcome, as compared with women having had one or two FBS during labor.

Materials and methods

We performed a prospective observational cohort study of women undergoing FBS during labor. The study was carried out at the labor ward at Karolinska University Hospital from February 2009 through February 2011. Inclusion criteria were simplex pregnancy, gestational length ≥34 weeks, cephalic presentation and indication for FBS during labor according to the attending obstetrician. Ethical approval was granted by the Regional Ethics Committee of Stockholm (2008/1618-31, 2011/478-32).

Intrapartum fetal surveillance with CTG followed Swedish guidelines [13]. All women had an admission CTG and if they were considered at low risk, they had intermittent CTG monitoring during labor every 2 h and in between auscultation of the fetal heart every 15 min [14]. If they were considered at high risk, had epidural or were commenced on oxytocin for augmentation of labor, they had continuous CTG monitoring. CTG interpretation followed the guidelines of the Swedish Society of Obstetrics and Gynecology (SFOG) [15], which are based on the guidelines of the International Federation of Gynecology and Obstetrics (FIGO) [16]. If a CTG trace was non-reassuring, but not indicative for immediate delivery, the attending doctor could decide upon FBS, which then was performed according to clinical routine, with the use of amnioscope, wiping the scalp of the fetus dry from amniotic fluid and applying silicone gel. After incision, approximately 5 μL was collected into a capillary tube, and analysis of lactate concentration was immediately performed at the bedside using Lactate Pro™ (KDK Corp. Kyoto, Japan). The meters were calibrated every 50th analysis, and the reported coefficient of variation is ≤4% [17]. Action was taken according to previously published guidelines [6].

As a second FBS often is an immediate recheck to exclude contamination of amniotic fluid or analysis error, we chose to divide the cohort into those with 1–2 or three or more FBS.

Sampling of umbilical artery and vein blood was performed immediately after delivery in all labors as a clinical routine. Complete acid-base status was analysed using ABL 800 Flex, (Radiometer, Copenhagen) and metabolic acidemia was defined as pH < 7.05 and base deficit $(BD)_{blood} > 12$ mmol/L [2]. Gestational age was based on ultrasound scanning performed in the first or early second trimester. Small and large for gestational age (SGA and LGA, respectively) was defined as a birth weight more than two standard deviations below (SGA) or above (LGA) the mean birth weight for gestational age according to the sex-specific Swedish fetal growth curves [18].

Statistical analysis was carried out using Statistica for Windows, version 12.0, (Statsoft Inc., Tulsa, OK, USA). Data are reported as medians, range and percentage due to non-normal distribution. Chi-square test and Fisher's exact test were applied for comparison of proportions, and Mann–Whitney *U*-test was used for comparison of continuous variables between groups. Logistic regression was used to calculate odds ratios (OR), 95% confidence intervals (CI) and to adjust for possible confounding effects of maternal age, gestational age, parity, previous caesarean delivery, induction of labor and oxytocin augmentation. Due to non-linearity of the continuous variables, maternal and gestational age were categorized as well as time from first sampling to delivery and cervical status at first FBS. All effects are presented. The model was validated with Hosmer Lemeshow test. $p < 0.05$ was considered to be significant.

Results

During the study period there were 2134 FBS performed on 1070 laboring women, which constituted 11% of all deliveries at this labor ward. FBS was used from a cervical dilatation of two cm and two thirds of the women had the first FBS taken during 1st stage of labor. Characteristics of the study population are shown in Table 1. In this population with FBS during labor, the proportion of nulliparous women was markedly higher than in the total delivering population (72%), labor was more often induced (35.5%), and 10% of the women had a history of previous caesarean delivery (27.4% of the multiparous). There were 297 women (27.8%) having at least one maternal complication (e.g. hypertension, preeclampsia or diabetes), 165 (15.4%) had at least one fetal complication (e.g. known intrauterine growth restriction, oligo- or

Table 1
Characteristics of the study population.

		Total population $N = 1070$	1–2 FBS $N = 795$	≥3 FBS $N = 275$	p-Value[a]
Maternal age (years)	≤24	137 (12.8)	106 (13.3)	31 (11.3)	0.378
	25–35	725 (67.8)	535 (67.3)	190 (69.1)	0.583
	≥36	208 (19.4)	154 (19.4)	54 (19.6)	0.924
Nulliparous		772 (72.1)	563 (70.8)	209 (76.0)	0.10
Previous caesarean delivery		109 (10.2)	75 (9.4)	34 (12.4)	0.16
Gestational age (weeks^{days})	34^0–36^6	36 (3.4)	30 (3.8)	6 (2.2)	0.207
	37^0–40^6	724 (67.7)	560 (70.4)	164 (59.6)	0.001
	≥41^0	310 (29.0)	205 (25.8)	105 (38.2)	<0.001
Induction of labor		380 (35.5)	263 (33.1)	117 (42.5)	0.005
Birth weight group[b]	SGA	48 (4.5)	31 (3.9)	17 (6.2)	0.109
	AGA	984 (92.5)	736 (92.9)	248 (91.2)	0.344
	LGA	32 (3.0)	25 (3.2)	7 (2.6)	0.627
Birth weight (grams)	<2500	30 (2.8)	22 (2.8)	8 (2.9)	0.902
	2500–3999	858 (80.2)	635 (80.1)	223 (81.7)	0.756
	4000–4500	149 (13.9)	113 (14.2)	36 (13.2)	0.643
	>4500	29 (2.7)	23 (2.9)	6 (2.2)	0.531

SGA, AGA, LGA = small, appropriate and large for gestational age.
[a] *p* Calculated with Chi square test between subgroups.
[b] SGA < 2 SD and LGA > 2 SD from the mean according to the sex-specific Swedish fetal weight curves [18].

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