

Assessment of the Impact of Prolonged Cesarean Section on Neonatal PH

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ABSTRACT

Background: Prolonged predelivery time in cesarean-section (C-section) may be associated with worse neonatal outcomes such as lower umbilical cord acid-base profile. This study investigated the association between surgical and anesthetic predelivery time intervals and neonatal acidosis in pregnant women delivering via C-section under spinal anesthesia.

Methods: This cross-sectional study was conducted on 70 pregnant women candidates for elective cesarean C-section, referred to Yas Hospital.

Results: Umbilical artery pH<7.3 was observed in 27 (38.6%) out of 70 included participants. The study variables including maternal age, hypertension, and gestational diabetes were not associated with umbilical pH level. 1-minute Apgar scores were linearly associated with pH (β : 0.170, 0.100 to 0.239, p-value<0.001). Among all evaluated surgical and anesthetic intervals, induction of spinal anesthesia to delivery (β : -0.008, -0.012 to -0.004, p-value<0.001), and skin incision to uterine incision interval (β : -0.006, -0.009 to -0.002, p-value=0.002) interval time had a significant linear association with PH.

Conclusion: The duration of induction of spinal anesthesia to delivery and skin incision to the uterine incision in non-emergent C-sections is linked to lower neonatal umbilical pH which shows the importance of optimizing the timing of elective C-section surgeries and reducing the risk of neonatal acidosis for obstetricians and anesthesiologists.

Introduction

Cesarean section (C-section) is a common surgical procedure performed in obstetrics, with 21.1% of global livebirths in 2015 delivered via C-section [1]. Selection of appropriate method of anesthesia for

patients may reduce adverse outcomes, as the induction of anesthesia has shown to influence uterine blood flow and vascular resistance and consequently fetal oxygenation and pregnancy outcome for both the mother and the fetus [2-3]. For instance, in early studies, considerable fall in blood pressure was observed in 20% of C-section deliveries [4]. Spinal anesthesia has become

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the mainstay choice for Cesarean section in non-emergent cases of delivery. Despite its benefits, maternal hypotension and consecutive fetal bradycardia and asphyxia may lead to several complications including low Apgar scores and neonatal acidosis [5]. Among these risks is the potential for neonatal acidosis, a condition in which the newborn's umbilical cord or blood pH is lower than normal, indicating acidemia. Neonatal acidosis has been proven to be associated with adverse neonatal outcomes, including mortality, neonatal hypoxic ischemic encephalopathy, intraventricular hemorrhage, periventricular leukomalacia, and cerebral palsy [6-8]. The length of the C-section operation is a factor that may lead to neonatal acidosis [9]. The duration of surgery, especially the time from skin incision to delivery could be viewed as a time when the fetus is exposed to risk factors of neonatal acidosis. Thus, it can be surmised that reduction of this duration may improve maternal and neonatal outcomes [10]. Given the significant morbidity and mortality risk associated with neonatal acidosis, it is important to better understand the factors that contribute to this condition in the context of C-section delivery and spinal anesthesia. In this regard, umbilical cord gas analysis can be used as a robust surrogate outcome of both short term and long term neonatal outcome [11]. This paper aims to conduct a retrospective study on the impact of C-section surgical duration on neonatal umbilical cord acid-base profile and acidosis in patients with spinal anesthesia.

Methods

This cross-sectional study was conducted on 70 pregnant women candidates for elective C-section, referred to Yas Hospital. Pregnant women with a singleton pregnancy, gestational age of 37 to 40 weeks (according to first-trimester ultrasound), and reassuring NST who were candidates for elective C-section, were enrolled in the study.

Exclusion criteria were IUGR or low birth weight (less than 2500 grams) fetuses, use of non-spinal anesthesia methods, neonatal anomalies, sedative usage before C-section, and allergy to anesthetic agents.

Before surgery, all women received 500 cc Ringer with 40 mg of pantoprazole and 2 g of cefazolin prophylaxis. Spinal anesthesia was performed by an expert anesthesiologist. Anesthesia was performed at the L3 or L4 level using a needle number 24 or less, after the cerebrospinal fluid returned, 10-15 mg of bupivacaine was injected. Ephedrine or phenylephrine were injected if maternal hypotension occurred. Prophylaxis doses of vasopressor or its continuous injection were done at the discretion of the anesthesiologist.

The time intervals were calculated and recorded by the researcher. Induction of spinal anesthesia to delivery interval was measured from injection of bupivacaine through the spinal needle until delivery of the fetus

outside the uterus. Induction of spinal anesthesia to skin incision interval was measured from injection of bupivacaine in the spinal needle until start of the pfannensteil skin incision. Skin incision to uterine incision interval was measured from start of pfannensteil skin incision until start of uterine incision. Uterine incision to delivery interval was measured from start of uterine incision until delivery of fetus outside the uterus.

Immediately after delivery, an ABG test was done for all offspring. The blood gas samples were obtained using pre-heparinized 3 ml syringe from fetal umbilical artery. Finally, the correlation between surgical and anesthetic pre-delivery time intervals and neonatal acidosis was investigated.

The study was approved by the ethics committee of the Tehran University of Medical Sciences (IR.TUMS.MEDICINE.REC.1400.735) according to the Helsinki Declaration. All participants signed informed written consent for enrollment in the study.

All analyzes were performed using SPSS software version 24 and the significant level was considered less than 0.05. The distribution of quantitative variables was first checked for normality, and then the Mann-Whitney U test or independent t-test was used to compare quantitative data based on the type of distribution, and the chi-square test was used to compare qualitative variables. The significance level in the tests was considered less than 0.05.

Results

After screening and implementing the inclusion criteria, a total of 70 participants were included in the analysis. All parturient women delivered viable infants. Mean maternal age of the included participants was 29.41 ± 1.95 years with a gestational age of 38.37 ± 0.35 years. History of hypertension was seen in 2.9% of the participants, while gestational diabetes was seen in 10% of the participants. 5-minute and 10-minute Apgar scores were omitted from the statistical analysis, as all newborn cases reached the score 10 (Table 1). Demonstrates baseline maternal and neonatal characteristics of the included subjects.

Mean neonatal pH was 7.31 ± 0.04 , only one case had PH less than 7.2 (PH=7.14). Out of all study variables, Umbilical artery pH < 7.3 was observed in 27 (38.6%) out of 70 included participants. 1-minute Apgar scores were linearly associated with pH (β : 0.170, 0.100 to 0.239, p-value < 0.001).

Among all evaluated surgical and anesthetic intervals, induction of spinal anesthesia to delivery (β : -0.008, -0.012 to -0.004, p-value < 0.001), and skin incision to uterine incision interval (β : -0.006, -0.009 to -0.002, p-value = 0.002) interval time had significant linear association with PH. There was no case of significant hypotension that need to maternal resuscitation. The results of statistical analyses and association between study variables and outcomes are available in (Table 2).

Table 1- Neonatal and maternal characteristics of the included participants

Variables	Maternal and neonatal characteristics	Values
Maternal age (years)		29.41±1.95
Gestational age (weeks)		38.37±0.35
Hypertension		2 (2.9%)
Gestational diabetes		7 (10%)
1-minute Apgar score		8.99±0.12
5-minute Apgar score		10.0±0.00
Neonatal arterial pH		7.31±0.04
Umbilical artery pH<7.3		27 (38.6%)
Surgical time intervals, median (Interquartile range)		
Induction of spinal anesthesia to delivery interval (min)		11(9-12)
Induction of spinal anesthesia to skin incision interval (min)		3(2-4)
Skin incision to uterine incision interval (min)		5(3-6)
Uterine incision to delivery interval (min)		2(2-3)

Table 2- Univariate association between study variables and neonatal pH profile and acidosis status derived from arterial blood gas evaluation

Parameters	Neonatal pH (linear)	Regression coefficient	95% CI	P value
Maternal age (years)		-0.002	-0.007 to 0.003	0.410
Gestational age (weeks)		-0.005	-0.033 to 0.022	0.697
Hypertension		0.018	-0.039 to 0.076	0.525
Gestational diabetes		0.016	-0.016 to 0.048	0.322
1-minute Apgar score		0.170	0.100 to 0.239	<0.001
Induction of spinal anesthesia to delivery interval (min)		-0.008	-0.012 to -0.004	<0.001
Induction of spinal anesthesia to skin incision interval (min)		0.002	-0.004 to 0.008	0.471
Skin incision to uterine incision interval (min)		-0.006	-0.009 to -0.002	0.002
Uterine incision to delivery interval (min)		-0.005	-0.012 to 0.002	0.193

Discussion

Umbilical artery blood gas analysis has long been established as a reliable indicator of preceding fetal hypoxia and is implemented in routine workup of several established guidelines for high risk deliveries [12-13]. Cesarean section in general has been shown to be a protective factor for low umbilical artery pH in the newborn, while prolonged labor is known as a potential risk factor for acidosis [14-15]. While the exact mechanisms underlying the association between prolonged C-section surgical duration and neonatal acidosis are not fully understood, several factors may play a role. These include the effects of anesthesia on fetal oxygenation, uterine contractions and blood flow, and neonatal resuscitation time. As such, the window between the induction of spinal anesthesia and delivery is assumed a period of fetal compromise [16].

Notwithstanding that previous studies have emphasized the importance of skin incision intervals for maternal and neonatal outcomes in both emergent and elective C-sections [17], this study demonstrates that the higher time between spinal anesthesia induction and delivery, and skin incision and uterine incision were linked to lower neonatal umbilical PH.

Evidence from early studies demonstrated that induction of general anesthesia to delivery intervals of more than 8 minutes and uterine incision to delivery intervals of more than 3 minutes were linked with substantially more occurrences of newborn acidosis and a higher frequency of low 1-minute Apgar scores [18]. For spinal anesthesia, prolongation of uterine incision-to-delivery interval by more than 3 minutes was found to be the only important factor influencing fetal outcome, as determined by an increased acidosis and by depressed Apgar scores. 18 However, in a more recent study by Hassanin et al., cut off values for induction to delivery interval greater than 27 min (90% sensitivity and 76.3% specificity) and BMI values greater than 35 had considerable predictive value for umbilical pH<7.2. 3 Additionally, a prospective cohort study by Conner et al. reported a concomitant increase in BMI and primary incision to delivery interval as well as higher incidence of infants with umbilical artery pH below 7.2 but not Apgar scores<7 in higher BMI strata [19]. It can therefore be concluded that unanticipated neonatal acidemia frequency might be reduced by minimizing the predelivery time following spinal placement.

Despite the segmentation and thorough evaluation of each time interval for correlations with neonatal acidosis,

we did not evaluate maternal outcomes or causal mediators of perinatal acidosis including vasopressor use, confounders such as maternal obesity, and although controversial [20-21], maternal hypotension [10, 16, 22].

Future controlled investigations should incorporate these factors to address potential confounders in large-scale studies. All things considered, the findings from this study will provide valuable information for obstetricians and anesthesiologists to optimize the timing of elective C-section surgeries and reduce the risk of neonatal acidosis.

Conclusion

The duration of induction of spinal anesthesia to delivery and skin incision to the uterine incision in non-emergent C-sections is linked to lower neonatal umbilical pH which shows the importance of optimizing the timing of elective C-section surgeries and reducing the risk of neonatal acidosis for obstetricians and anesthesiologists.

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