Annals of Clinical and Analytical Medicine
Original Research

The effect of perioperative hypotension on perfusion index in infants in cesarean delivery with spinal anesthesia

Erdinç Koca
Department of Anesthesiology and Reanimation, Malatya Training and Research Hospital, Malatya, Turkey

Abstract

Aim: The perfusion index (PI) is maintained as the rate of pulsatile blood flow to nonpulsatile flow in the peripheral extremity and is used as a rapid indicator of microcirculatory changes.

Material and Methods: Fifty patients a gestational age of 38-42 weeks and a planned elective cesarean were included in our study. Patients who did not develop hypotension after spinal anesthesia and were not administered ephedrine (Group 1) and newborn patients who developed hypotension and needed ephedrine (Group 2) were divided into 2 groups.

Results: There was no statistical difference in PVI and PI measurements between Group1 and Group 2.

Discussion: Negative effects on PI, PVI and APGAR scores that may develop in the newborn can be prevented with rapid and adequate fluid replacement and appropriate vasoconstrictive treatment.

Keywords

Perfusion Index, Cesarean, Hypotension, Newborn

DOI: 10.4328/ACAM.21216 Received: 2022-04-27 Accepted: 2022-06-16 Published Online: 2022-06-20
Corresponding Author: Erdinç Koca, Department of Anesthesiology and Reanimation, Malatya Training and Research Hospital, Malatya, Turkey.
E-mail: drerdinckoca@hotmail.com P: +90 530 223 96 25 / +90 530 223 96 24 F: +90 422 325 34 38
Corresponding Author ORCID ID: https://orcid.org/0000-0002-6691-6711

Introduction

Evaluation of perfusion in peripheric tissues is best achieved through simple and noninvasive monitoring methods, one of which is the PI. When based on the new-generation pulse oximetry signal, PI has been shown to indicate precise and real-time alterations in peripheric blood flow [1]. In addition, the plethysmographic variability index (PVI) allows for continuous, noninvasive dynamic follow-up of circulating blood volume and has been reported to evaluate fluid replacement [2].

Despite the advantages of spinal anesthesia, including speed of administration and effective sensory and motor blockage, hemodynamic instability following such anesthesia for cesarean surgery remains quite a severe complication [3]. The severity and duration of hypotension are more important than the development of hypotension after spinal anesthesia. It has been emphasized in many studies that when hypotension is treated quickly, it does not result in harm to the fetus or affect Apgar scores, but a prolonged period of hypotension reduces uteroplacental blood flow. This causes fetal acidosis and a lower Apgar score is seen. [4].

Ephedrine has been recommended for decreasing the frequency of hypotension [5]. It has direct and indirect action pathways, especially activating beta receptors (β1 and β2). However, it may lead to supraventricular tachycardia, tachyphylaxis, and fetal acidosis [6].

In this study, our goal was to analyze the influence of perioperative maternal hypotension on newborn PI and PVI values.

Material and Methods

Our study was conducted in the Anesthesia Clinic of the XXX Training and Research Hospital, with the approval of the ethics committee in 2021. Fifty patients at 38–42 weeks of gestation and who had planned an elective cesarean were included in our study. Patients requiring emergency surgery, patients above maternal ASA 2 (American Society of Anesthesiology), patients whose newborns showed the presence of congenital disease, patients with newborns with a low Apgar score after birth, and those whose newborn showed the presence of respiratory and/or cardiac anomalies as a result of chorioamnionitis were excluded. The patients were divided into two groups: those who did not develop hypotension after spinal anesthesia and were not administered ephedrine (group 1) and those who developed hypotension and needed ephedrine (group 2). A decrease of more than 30% from the basal value or a decrease below 90 mmHg was considered hypotension. All newborns had 1st and 5th minute Apgar scores recorded, and at the 5th minute after birth, the Masimo Radical 7 (Masimo Corp., Irvine, CA, USA) pulse oximeter probe was attached to the index finger of the right hand (preductal) and protected from light (Figure 1). HR (Heart Rate), SpO2 (peripheral capillary oxygen saturation), PI, and PVI were recorded. Measurements were taken with the above pulse oximeter when the newborn was calm and not crying.

Statistical Method

Data analysis was carried out using the IBM SPSS version 26.0 statistical program (Chicago, IL, USA). Skewness and Kurtosis values were used to test the normality of the data distribution. Descriptive statistics data were presented as means and standard deviations for the quantitative variables. Demographic data of the groups were compared with one-way analysis of variance (one-way ANOVA). Mixed-design ANOVA was employed to analyze significant differences between the groups with repeated measurements. For the sphericity assumption, Mauchly's test and MANOVA were used. Duncan's test was chosen for the between-group post-hoc test. Bonferroni adjustment was made for confidence interval correction. Significant differences in group means (PI and PVI) for newborns were evaluated by independent samples t-test. A p-value of <0.05 was accepted as numerically significant.

Results

In our study, 50 newborns delivered by cesarean under spinal anesthesia were included. Of the newborns, 22 were female and 28 were male. The mean week of delivery was 39 in group 1 and 39.04 in group 2. The newborns' birth weights were 3240 grams in group 1 and 3378.2 grams in group 2. Apgar values in group 1 were calculated as 8.6 at the 1st minute and 9.2 at the 5th minute, and in group 2, they were 8.4 at the 1st minute and 9.2 at the 5th minute. Peripheral SpO2 was measured as 93.28 in group 1 and 93.8 in group 2. When the maternal data were analyzed, the mean age in group 1 was 31.24 years and the mean age in group 2 was 27.84 years; maternal group 1 was measured as PVI 17.52 and PI 2.9 and group 2 was PVI 17 and PI 2.52 (Table 1). There was no statistical difference in PVI and PI measurements between group 1 and group 2 (Table 2) (Figure 2-3). In the measurements, the PVI values of the group that did not develop hypotension were lower than those of the other group. Similarly, the PI values of group 1 were higher than

Table 1. Demographic Characteristics of infants and mothers

	Group 1	Group 2	Total
Gender	8F/17M	14F/11M	22F/28M
Birth Week	39	39,04	39,02
Weight (g)	3240	3378,2	3399
Apgar 1. Minute	8,6	8,4	8,5
Apgar 5. Minute	9,2	9,2	9,2
Spo2	93,28	93,8	93,36
Ephedrine Hydrochloride (Mg)	-	350	350
Maternal			
Length (cm)	164,4	156,8	160,6
Weight (kg)	78,52	75,84	77,18
Age	31,24	27,84	29,54
Gravity	2,84	2,32	2,58
Parity	1,68	1,08	1,38
PVI %	17,52	17	17,26
PI %	2,93	2,52	2,74

Table 2. Pleth variability index (%) and Perfusion index (%) in infants born

Newborn	Group 1 (n=25)	Group 2 (n=25)	P value
Pleth Variability Index Mean ± Std.deviation	25,10 ± 5,538	25,80 ± 6,764	0,679
Perfusion Index Mean ± Std.deviation	2,924 ± 1,1300	2,724 ± 0,7551	0,455

those of group 2. There was no statistical difference in terms of 1st and 5th minute Apgar scores.

Discussion



Figure 1. Masimo Radical 7 (Masimo Corp., Irvine, CA, USA) pulse oximeter probe was attached

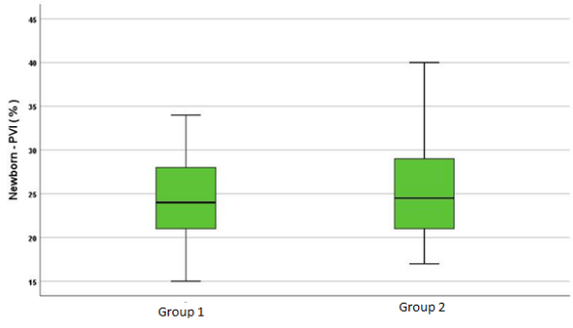

Figure 2. Pleth variability index (%) in infants born

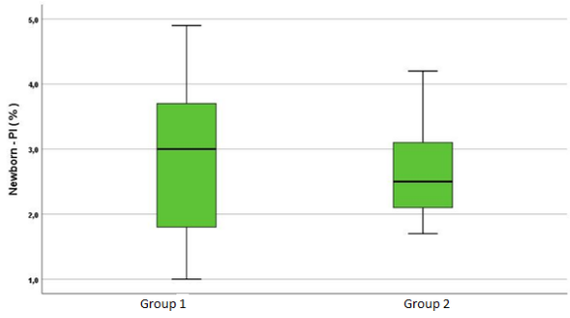

Figure 3. Perfusion index (%) in infants born

PI is the rate of pulsatile to non-pulsatile blood flow in the peripheral extremity and is used as a rapid indicator of microcirculatory changes. These parameters provide continuous information about tissue perfusion in a noninvasive manner. Due to its ease of use, it has become the preferred hemodynamic monitoring method in patient follow-up [7].

Kumar and Nadkarni defined alterations in PI values as an outcome of local vasoconstriction (low PI) or vasodilation (increased PI) in the skin [8]. Before the measurement, the newborn was protected from hypothermia and peripheral vasoconstriction was prevented. In particular, lower PI values (≤1.24) have been reported to be a precise indicator for evaluating the seriousness of neonatal pathology. Additionally, primary PI monitoring has been noticed to be beneficial in identifying preterm and term neonates with chorioamnionitis [9]. In our study, we included newborns who did not have any pathology in their follow-ups.

A reduced PI value in the pre-anesthesia period of elective cesarean surgery is a maternal indicator of an increased risk of neonatal morbidity, particularly resulting from early respiratory complications [10]. Increased anxiety is also known to affect vascular tone [11]. We took the PI measurement starting in the 10th minute, during a period when the newborn was calm and no crying was expected. The readings on the device were followed for 10 minutes, and when they stabilized to a certain value, the recording was made. Pathological circumstances, including neonatal sepsis, hypovolemia, and left-to-right shunting congenital heart ailments commonly develop in preterm neonates in the transitional phase and may have a negative effect on microvascular blood flow and cardiovascular coherence in the primary neonatal period [12].

PVI is a beneficial technique due to its advantages, including noninvasiveness, a simple-to-place sensor, and continuous bedside measurement [13]. PVI evaluates rates of nonpulsatile (AC) to pulsatile blood flow (DC) in the capillary bed [7]. A recent article stated that PVI correlates well with cardiac preload indices [14]. It is also a predictor of the dynamic changes in PI that occur in the course of respiratory periods [15].

The most common and undesirable side effect of spinal anesthesia, which is the preferred method of anesthesia in elective cesarean sections, is maternal hypotension. Uterine blood flow reduction, fetal acidosis, neonatal depression, and maternal nausea and vomiting may occur due to hypotension resulting from sympathetic blockade [16]. In our study, a decrease of more than 30% in the basal value or a decrease below 90 mmHg was considered hypotension. When hypotension developed, IV (Intravenous) fluid replacement and IV ephedrine [10 mg] were administered.

It may cause hypotension, sweating, dizziness, nausea, pulmonary aspiration and cardiac arrest in pregnant women after spinal anesthesia. [17]. Hypotension, which can be seen in 80–90% of cesarean sections in which spinal anesthesia is applied, can have harmful effects on the mother and newborn. Despite research and discussions over the last 10 years, hypotension continues to be the most common side effect associated with sympathetic blockade in this type of surgery [4]. Both phenylephrine and ephedrine are employed to control maternal blood pressure during spinal anesthesia in such surgeries. Since there is no phenylephrine in our country, only ephedrine is used. The latter is the preferred vasopressor for maintaining uteroplacental blood flow in obstetric anesthesia and can be used prophylactically or as an IV bolus or IV infusion in case of hypotension [4]. IV bolus ephedrine was administered to our patients who developed hypotension.

Apgar scoring is frequently used to immediately assess the clinical condition of neonates [18]. The scoring, which is carried out at the 1st, 5th, and (infrequently) 10th minute following birth, analyzes the neonate's cardiac rhythm, respiration, muscle tone, reflex reply, and skin color [19]. Maternal hypotension due to regional anesthesia can influence uteroplacental blood flow, leading to fetal acidosis, asphyxia, and lower Apgar scores [20]. It is preferable to prevent hypotension, which is dangerous for the mother and more so to the child, rather than allowing it to affect the fetus. Blood pressure is commonly ensured in the

face of vasodilation, which is induced due to elements other than central neural blockage, via a reflexive rise in cardiac output. However, when spinal-provoked venodilation is present, venous return is decreased to the extent that cardiac output cannot rise and is commonly decreased. The outcome is serious hypotension with lower uteroplacental perfusion and Apgar scores [21]. In their study examining the effect of Mon at al regional anesthesia on newborn Apgar scores, it was determined that the rate of fetal acidosis was higher in the regional anesthesia group, especially in the ephedrine group [22]. In our study, no statistical difference was observed in Apgar scores and PI values between the two groups. Maternal SBP (systolic blood pressure) of 80 mmHg for 5 minutes generally leads to hypoxic fetal bradycardia [23].

In our clinic, starting from the preoperative period in cesarean section surgeries, a preliminary fluid loading with crystalloid and colloid fluids is conducted, and the surgery is performed with spinal anesthesia. When perioperative hypotension occurs, a 10 mg ephedrine IV is administered in repeated doses. In terms of vasopressors, ephedrine (a mixed α- and β-agonist) was formerly proposed as the preferred agent in obstetrics, but there is currently increasing proof that it has the tendency to reduce fetal pH and base surplus [6]. Now, phenylephrine is considered to have a high impact, low placental transmission, and less tendency to suppress fetal pH [24].

Despite its promising results, our study has some limitations, including the lack of long-term PI and PVI monitoring, not checking the blood gas values of the newborns, and the limited number of participants.

Conclusion

In our opinion, similar results for PI, PVI, and Apgar scores between the two groups were caused by preoperative fluid replacement, as well as rapid intervention in maternal hypotension and circulation through uteroplacental autoregulation. We concluded that the adverse effects of maternal hypotension on newborns can be prevented with adequate fluid replacement and appropriate vasoconstrictive treatment.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Funding: *None*

Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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How to cite this article:

Erdinç Koca. *The effect of perioperative hypotension on perfusion index in infants in cesarean delivery with spinal anesthesia. Ann Clin Anal Med 2022; DOI: 10.4328/ACAM.21216*