

Effect of anesthesia type on outcome measures in cesarean section in the presence of fetal macrosomia

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SUMMARY

OBJECTIVE: The aim of this study was to compare the effects of general and spinal anesthesia on maternal and neonatal outcomes during cesarean section in pregnancies with macrosomia.

METHODS: This retrospective cohort study included 1043 patients who delivered by cesarean section between May 2018 and December 2021 and had a baby born with a birth weight of 4000 g or greater. Maternal and neonatal outcomes were compared according to the type of anesthesia performed in the spinal anesthesia group (n=903; 86.6%) and general anesthesia group (n=140; 13.4%). The Apgar score was categorized into <7 and ≥7.

RESULTS: Neonates with an Apgar score of <7 at the first minute (11.4 vs. 0.4%; p<0.001) and the fifth minute (2.9 vs. 0.3%; p=0.004) were significantly higher in the general anesthesia group. The preoperative and postoperative hematocrit difference was significantly lower in patients who received spinal anesthesia than those who received general anesthesia [2 (1.1–3.1) vs. 4.05 (2.8–5.35); p<0.001]. The number of patients transfused was higher in the general anesthesia group (9.3 vs. 2.7%; p<0.001). In the regression model, general anesthesia, birth weight, and emergency conditions were significant independent factors related to the preoperative and postoperative hematocrit decrease (p<0.001, p=0.005, and p=0.034, respectively).

CONCLUSIONS: Apgar scores of <7 at the first and fifth minutes are higher in macrosomic neonates who received general anesthesia than in neonates who received spinal anesthesia. Performing cesarean section under general anesthesia in mothers of macrosomic neonates results in a greater decrease in hematocrit value and a greater need for blood transfusion than under spinal anesthesia.

KEYWORDS: Cesarean section. Fetal macrosomia. General anesthesia. Pregnancy outcomes. Spinal anesthesia.

INTRODUCTION

Macrosomia is defined as birth weight (BW) of 4000 g or higher, regardless of the gestational age, and accounts for 8% of all births. Although not a disease in the strict sense, it is of clinical importance because of the potential risks to mother and neonate and the difficulties in delivery planning. The feared complications of macrosomia are shoulder dystocia, clavicular fracture, brachial plexus injury, and maternal third- and fourth-degree perineal lacerations, which most commonly occur with vaginal delivery¹.

The goal of obstetric anesthesia is to ensure the safety and well-being of the mother, deliver a healthy baby, and provide appropriate surgical conditions. The choice of anesthesia type depends on factors such as the urgency of the cesarean section (CS), patient's current systemic problems, experiences of the anesthesiologist and surgeon, and size of a hospital². Although general anesthesia (GA) has rapid application in emergencies, regional anesthesia is the most commonly used and widely accepted method for elective CS, even for emergencies without

contraindications. Spinal anesthesia (SA) prevents the possibility of aspiration pneumonia, failed tracheal intubation, maternal and neonatal respiratory complications, and maternal awareness when CS is performed under GA and allows for early maternal-neonatal bonding and improved postpartum pain management³.

Cesarean section, which appears to reduce the risk of birth trauma in macrosomic fetuses compared with vaginal delivery and is performed more frequently than in nonmacrosomic fetuses, does not eliminate all the risks associated with maternal and neonatal morbidity despite improved anesthetic techniques¹. Previous studies that compared maternal and neonatal outcomes between GA and SA for CS reported controversial results regarding neonatal well-being^{4,5}. Pre-postoperative hematocrit reduction was reported to be greater in those receiving GA due to the uterine-relaxing effects of inhalation anesthetics^{6,7}. Although fetal macrosomia is a proven obstetric risk factor for postpartum hemorrhage due to uterine overdistension and uterine atony associated with prolonged labor⁸, there is limited

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evidence regarding the effects of anesthetic technique on CS procedures performed in the presence of fetal macrosomia.

In this study, we aimed to compare the effects of SA and GA on maternal and fetal outcomes and determine which anesthesia type is safer during CS surgeries for the mother and neonate with a BW of 4000 g or greater.

METHODS

After approval by the Local Ethics Committee (2011-KAEK-25 2022/01-02), a retrospective cohort study was performed by reviewing the medical records of 1102 cesarean deliveries with a baby BW of 4000 g or greater between May 2018 and December 2021. A total of 5 (0.5%) intrauterine fetal deaths, 4 (0.4%) fetal anomalies, 4 (0.4%) placental abnormalities, 37 (3.3%) combined spinal-epidural anesthesia, and 9 (0.8%) SA to GA conversions were excluded from the study. A total of 1043 subjects who met the inclusion criteria were divided into the SA group (n=903; 86.6%) and GA group (n=140; 13.4%) and then compared.

In the urgency of CS classification by Lucas et al., category 1 CS is defined as immediate threat to life of woman or fetus, category 2 CS is defined as maternal and fetal compromise, which is not immediately life-threatening, category 3 CS is defined as requiring early delivery but not maternal or fetal compromise, and category 4 CS is defined as the time that suits the mother and maternity team⁹. In this study, categories 1 and 2 were grouped as emergency CS, while categories 3 and 4 were grouped as elective CS.

Preoperative hematocrit values were obtained from the complete blood count (CBC) within 1 week before surgery for elective CS and immediately before surgery in emergency CS.

In our clinic, which is a tertiary referral hospital, anesthetic procedures are performed by an experienced anesthesia team according to the same protocol. After preloading, single-shot SA was administered with a 25-gauge spinal needle, at the level of lumbar vertebrae 3-4 or 4-5 interspinously. About 8–10 mg of 0.5% hyperbaric bupivacaine combined with 20 µg fentanyl was injected intrathecally to achieve adequate sensorial block (T4-T5) and then the surgery was initiated. If hypotension occurred, the intravenous (IV) fluid infusion rate was increased, and if hypotension persisted, 5–10 mg IV ephedrine was administered.

After preoxygenation, GA was induced with 2–2.5 mg/kg propofol and 0.6–1 mg/kg rocuronium. After endotracheal intubation, GA was maintained with 50% oxygen in air until delivery of the neonate. After delivery, IV administration of 2 µg/kg fentanyl and 0.15 mg/kg rocuronium was initiated, and

1% sevoflurane in 50% oxygen was continued to be administered. At the end of the surgery, the residual neuromuscular block was resolved with 2–4 mg/kg sugammadex.

Cesarean section was performed in the same manner and with a standard technique in all cases. After the delivery of the neonate, 5 IU of oxytocin was routinely infused to induce uterine contractions. A pediatrician evaluated the neonates for Apgar, BW, and the need for neonatal resuscitation. The criteria for blood transfusion are strictly applied to patients with symptoms of anemia and non-massive bleeding is defined as a hemoglobin value of <7 g/dL¹⁰.

A CBC was performed 12 h after surgery to determine the hematocrit levels. If the patient had received a transfusion of blood products, then the CBC was referred to before discharge to determine the mean difference in hematocrit values. The length of hospital stay was calculated as days from the 24th hour after CS.

Data were analyzed using the IBM SPSS Statistics 18[©] Copyright SPSS Inc. 1989, 2010 software. The fit of continuous variables to normal distribution was examined using the Kolmogorov-Smirnov test. Nominal variables were expressed as frequencies and percentages (%), whereas continuous variables were expressed as mean, standard deviation (SD), or median and interquartile range (IQR) for the non-normally distributed variables.

In the analysis of categorical variables, Pearson's chi-square test was used. Mann-Whitney U test was applied when the assumptions of the parametric test were not met while comparing the means of two groups, and Student's t-test was used when provided. In addition, the variables and confounding factors that might affect the preoperative and postoperative hematocrit difference according to the literature were analyzed using a linear regression model^{1,6,8}. The level of statistical significance was assumed to be 0.05.

RESULTS

Of the 1043 patients who underwent elective or emergency CS during the study period, 903 (86.6%) received SA and 140 (13.4%) received GA. The rate of emergency CS was 58.9% in the SA group and 73.6% in the GA group (p=0.001). Preoperative hematocrit values were similar in both groups (34.98±3.06 vs. 34.73±3.60; p=0.396), but postoperative hematocrit values were lower (32.74±3.20 vs. 30.58±3.82; p<0.001) and the mean hematocrit difference was higher [4.05 (2.8–5.35) vs. 2 (1.1–3.1); p<0.001] in patients in the GA group. The general characteristics of the groups are summarized in Table 1.

In the distribution of CS indications, a suspected macrosomic fetus was more frequent in the SA group, while fetal distress and umbilical cord prolapse were observed in the GA group ($p<0.001$).

Neonates with an Apgar score of <7 at the first minute (11.4 vs. 0.4%; $p<0.001$) and the fifth minute (2.9 vs. 0.3%; $p=0.004$) were significantly higher in the GA group. Approximately 7.3% of neonates in the SA group and 15.0% of neonates in the GA group were admitted to the neonatal intensive care unit (NICU) ($p=0.002$) (Table 2).

There were no differences in intraoperative and postoperative complications between the groups ($p=0.983$ and $p=0.205$, respectively). Approximately 2.7% of the patients in the SA group required transfusions, while this rate was higher in the GA group at 9.3% ($p<0.001$). The length of hospital stay was significantly longer in the GA group than in the SA group [2 (2–3) vs. 3 (2–3); $p=0.002$] (Table 2).

Analysis of cases by emergency ($n=637$) or elective ($n=408$) surgery showed that the mean hematocrit difference [2.4 (-3.40–13.60) vs. 2.0 (0.10–8.10); $p=0.001$] was significantly higher in

the emergency CS cases. While the need for NICU admission (9.1 vs. 7.1%; $p=0.248$) did not differ by type of CS surgery, Apgar scores of <7 at the first minute (2.5 vs. 0.7%; $p=0.035$), on the one hand, were higher in emergency CS cases, with no difference in Apgar scores at the fifth minute (0.09 vs. 0.02%; $p=0.177$). On the other hand, those who received SA for both elective and emergency CSs had a higher Apgar score of ≥ 7 at the first minute (99.7 vs. 96.4%, $p<0.001$).

A regression model was created for the variables and confounding factors that might affect the preoperative and postoperative hematocrit difference according to the literature^{1,6,8}. The use of GA caused an increase in hematocrit difference by 1.102 units ($p<0.001$), elective surgery caused a decrease in hematocrit difference by -0.124 units ($p=0.034$), and an increase in BW by 1 unit caused an increase in hematocrit difference by 0.0834 units ($p=0.009$). GA, BW, and emergency CS were found to be significant independent risk factors for a decrease in hematocrit. Anesthesia type was the parameter that best explained the variation in pre-postoperative hematocrit difference in the model ($t=13,204$) (Table 3).

Table 1. General characteristics according to the type of anesthetic technique applied.

	Spinal anesthesia (n=903)	General anesthesia (n=140)	Total (n=1043)	p
Maternal age (years)	29 (16–45)	30 (18–46)	29 (16–46)	0.024 μ
Gestational age (weeks)	39 (35–42)	39 (34–43)	39 (34–43)	0.590 μ
BMI (kg/m ²)	35.10 (27.80–44.30)	35.00 (27.80–44.30)	35 (27.80–44.30)	0.568 μ
Parity number	2 (1–11)	2 (1–8)	2 (1–11)	0.007 μ
Previous cesarean number	1 (1–5)	1 (1–5)	1 (1–5)	0.327 μ
Birth weight (g)	4190 (4000–5530)	4250 (4000–5520)	4200 (4000–5530)	0.045 μ
Maternal DM	23 (2.5)	11 (7.9)	34 (3.3)	0.002 ^x
Maternal GDM	46 (5.1)	7 (5.0)	53 (5.1)	0.999 ^x
Pre-op Hct	34.98 \pm 3.06	34.73 \pm 3.60	34.94 \pm 3.13	0.396 ^t
Post-op Hct	32.74 \pm 3.20	30.58 \pm 3.82	32.45 \pm 3.37	$<0.001\mu$
Hct difference (pre-postoperative Hct)	2 (1.1–3.1)	4.05 (2.8–5.35)	2.2 (1.2–3.4)	$<0.001\mu$
Infant gender				
Female	294 (32.6)	37 (26.4)	331 (31.7)	0.147 ^x
Male	609 (67.4)	103 (73.6)	712 (68.3)	
Type of cesarean section				
Emergency	532 (58.9)	103 (73.6)	635 (60.9)	0.001 ^x
Elective	371 (41.1)	37 (26.4)	408 (39.1)	

BMI: body mass index; DM: diabetes mellitus; GDM: gestational diabetes mellitus; Hct: hematocrit. Results are given as mean \pm SD, median (IQR), or n (% column). μ Mann-Whitney U test; ^tStudent's t-test; ^xPearson's χ^2 test. Bold indicates significant values.

Table 2. Neonatal and maternal outcomes by type of anesthesia.

	Spinal anesthesia (n=903)	General anesthesia (n=140)	Total (n=1043)	p
Apgar first minute				
<7	4 (0.4)	16 (11.4)	20 (1.9)	<0.001*
≥7	899 (99.6)	124 (88.6)	1023 (98.1)	
Apgar fifth minute				
<7	3 (0.3)	4 (2.9)	7 (0.7)	0.004*
≥7	900 (99.7)	136 (97.1)	1036 (99.3)	
NICU admission	66 (7.3)	21 (15.0)	87 (8.3)	0.002*
Intraoperative complications				
No	894 (99.0)	138 (98.6)	1032 (98.9)	0.642*
Yes	9 (1.0)	2 (1.4)	11 (1.1)	
Uterine rupture	1	1		
Bladder laceration	2	1		
Uterine atony	5	0		
Bowel laceration	1	0		
Postoperative wound infection				
No	897 (99.3)	137 (97.9)	1034 (99.1)	0.078*
Yes	6 (0.7)	3 (2.1)	9 (0.9)	
Blood transfusion requirement				
No	879 (97.3)	127 (90.7)	1006 (96.5)	<0.001*
Yes	24 (2.7)	13 (9.3)	37 (3.5)	
Pre-postop hematocrit difference	2.23±1.43	4.15±2.18	2.49±1.68	<0.001 μ
Length of hospital stay (day)	2 (1-15)	3 (1-14)	2 (1-15)	0.002 μ

NICU: neonatal intensive care unit. Results are given as median (IQR), or n (% column). μ Mann-Whitney U test; *Pearson; χ^2 test. Bold indicates significant values.

Table 3. Regression model for factors affecting pre-postoperative hematocrit difference.

Predictor	Estimate	SE	95% confidence interval	t	p	Stand. estimate
			Lower Upper			
Intercept ^a	-4.04754	2.04259	-8.05562 - -0.0395	-1.982	0.048	
Birth weight	0.55511	0.19549	0.17151-0.9387	2.840	0.005	0.08340
Maternal age (years)	0.01087	0.00807	-0.00496-0.0267	1.348	0.178	0.03849
Gestational age (weeks)	0.02312	0.04206	-0.05941-0.1056	0.550	0.583	0.01580
BMI (kg/m ²)	0.0040	0.01610	-0.02756-0.0356	0.250	0.802	0.00727
Type of anesthesia GA-SA	1.85994	0.14086	1.58353-2.1364	13.204	<0.001	1.10263
Preoperative Hct	0.07551	0.01519	0.04571-0.1053	4.972	<0.001	0.14046
Type of CS Elective-Emergency	-0,20968	0.09883	-0.40362 - -0.015	-2.122	0.034	-0.12431

GA: general anesthesia; SA: spinal anesthesia; Hct: hematocrit. Model coefficients: pre-postoperative hematocrit difference. ^aReference level. Bold indicates significant values.

DISCUSSION

Our results show that GA is associated with Apgar scores of <7 at the first and fifth minutes, increased NICU admission rates, higher pre-postoperative hematocrit difference, increased number of transfused patients, and increased length of hospital stay in CS procedures with macrosomia. GA, BW, and emergency conditions were independent risk factors for decreased hematocrit pre- and postoperatively.

Afolabi et al. reported that Apgar scores were significantly lower at the first and fifth minutes in emergency CS cases who received GA compared with SA⁴. Another study found that despite faster delivery in neonates born under category 1 CS according to the Lucas classification⁹, an Apgar score of <7 at the fifth minute and NICU hospitalization were significantly higher in the GA group compared with the SA group¹¹.

Al-Husban et al. evaluated both elective and emergency CS procedures and concluded that the Apgar scores were higher in emergency category cases who received SA than those who received GA, with no significant difference in the elective category¹². In contrast, Mancuso et al⁵. and Saygi et al⁷. reported that SA had a better effect on Apgar scores in elective CS than GA.

On the one hand, our study found that neonates exposed to GA were more likely to have Apgar scores of <7 at the first and fifth minutes and more likely to be admitted to the NICU than those exposed to SA. When the same neonates were evaluated according to whether they were delivered as an emergency or electively, Apgar scores of <7 at the first minute were higher in emergency CS cases. On the other hand, neonatal morbidity was not classified according to the indication for CS. Therefore, our results suggest that most GA-related adverse neonatal outcomes may be influenced by the emergency nature of the procedure and the indication of the CS surgery.

In this study, we focused on neonates with macrosomia and found that postoperative hematocrit values were lower and the pre-postoperative hematocrit difference was greater in the GA group than in the SA group. The need for blood transfusion was also higher in the GA group than in the SA group. Sung et al.⁶ found that the mean difference between preoperative and postoperative hematocrit levels was greater

in the GA group. However, in agreement with the results of Heesen et al.¹³, the proportion of transfused patients did not differ between the groups.

Our results are consistent with the study by Aksoy et al., who examined elective cesarean deliveries in uncomplicated term pregnancies and concluded that SA was associated with lower blood loss during CS than GA. Blood transfusions were required in 4 (2%) patients in the GA group and 2 (1%) patients in the SA group, although whether this difference was statistically significant was not stated¹⁴. In our regression model, GA, BW, and emergency conditions were independent factors associated with the decrease in hematocrit values. In emergency CS cases, the mean hematocrit difference increased, but the need for blood transfusion did not increase. It can be concluded that in CS procedures performed in the presence of a fetus with macrosomia, GA is associated with a clinically significant reduction in the hematocrit level.

The main limitation of this study was its retrospective design. The focus on macrosomic fetuses and the large sample size are the strengths of our study. The fact that the same surgical team managed the patients and infants were cared for in the same center also contributes to the strengths of the study.

CONCLUSIONS

The incidence of fetal macrosomia is steadily increasing and poses potential obstetric and fetal risks at birth. In CS procedures performed in the presence of a fetus with macrosomia, Apgar scores of <7 at the first and fifth minutes and NICU hospitalization were significantly higher in the GA group than in the SA group. GA was associated with a greater decrease in hematocrit values during CS and a greater need for blood transfusions.

AUTHORS' CONTRIBUTIONS

FNT: Conceptualization, Data curation, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing. **NK:** Conceptualization, Data curation, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing.

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