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Original Article ANESTHESIOLOGY & REANIMATION

Comparison of the effects of general and spinal anesthesia for cesarean delivery on maternal and fetal outcomes: A retrospective analysis of data

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ABSTRACT

OBJECTIVE: General or single-shut spinal anesthesia (SA) is applied for cesarean section and both methods of anesthesia have different effects on the mother and newborn. This retrospective study, in which 1-year data were analyzed, was aimed to examine the effects of general or SA on maternal and neonatal outcomes.

METHODS: Anesthesia technique, mother's age, gestational age, number of pregnancies, previous cesarean delivery number, maternal complications, and indications for cesarean delivery were analyzed in 883 cesarean deliveries. In addition, weight and Apgar scores of newborn and umbilical cord blood gas values were examined.

RESULTS: Neonatal intensive care need was higher in the general anesthesia (GA) group, Apgar scores were higher in the SA group, but neonatal mortality was similar. The umbilical cord Ph and lactate were lower; PCO_2 values were higher in the GA group. Neonatal weight, mother's age, gestational age, and Apgar scores were predictive for neonatal mortality, but anesthesia technique was not.

CONCLUSION: While umbilical cord blood gas values were less affected and the need for neonatal intensive care was lower with SA, we believe that both anesthesia methods can be used safely for mother and neonatal in cesarean anesthesia considering maternal and neonatal morbidity and mortality.

Keywords: Apgar score; cesarean section; general anesthesia; infant mortality; spinal anesthesia.

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When the fetus cannot be delivered naturally due to reasons related to the mother or the fetus, cesarean delivery is inevitable. One of anesthesia techniques, the regional anesthesia or general anesthesia (GA) methods is applied during the cesarean deliveries. Single-shot spinal anesthesia (SA) is more common technique for cesarean delivery among the regional anesthesia methods because the onset of anesthesia is faster and muscle relaxation is more suitable. Although both methods have advantages and disadvantages, the anesthesia method to be chosen may vary depending on maternal and fetal conditions. Because the time between the onset of anesthesia and the delivery of the baby was shorter in GA compared with SA according to previous studies [1]. It may gain importance in situations that need to be urgent. However, GA has disadvantages in pregnant women such as difficult intubation, aspiration risk of gastric contents, respiratory depression in newborns due

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to anesthetic agent transmission to the baby, and the risk of developing uterine atony due to inhalation anesthetic agents. On the other hand, regional anesthesia provides great advantages such as preventing the stress response to trauma, minimal respiratory depressant effect on the fetus, being awake for the mother, and being able to breastfeed in the early period [2].

This retrospective study reviewed the medical records of pregnant women performed cesarean delivery under GA or SA and compared the maternal and fetal outcomes based on morbidity and mortality of mother and neonatal, Apgar scores at 1th and 5th min, and umbilical blood gas values between both anesthesia groups.

Highlight key points

- Regional anesthesia or general anesthesia (GA) methods is applied during the cesarean deliveries.
- Which anesthesia method to be chosen may vary depending on maternal and fetal conditions.
- Anesthesia methods may effect on morbidity and mortality of mother and neonatal in cesarean deliveries.
- Both anesthesia methods can be used safely for mother and neonatal in cesarean anesthesia.

MATERIALS AND METHODS

In this study, data of the pregnant women who delivered with cesarean section between January 01, 2019 and December 31, 2019 at Goztepe Prof. Dr. Suleyman Yalcin City Hospital were analyzed. This study was performed in compliance with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Istanbul Medeniyet University, Goztepe Prof. Dr. Suleyman Yalcin City Hospital (Date December 25, 2019/No. 2019/0517) and an application was submitted to ClinicalTrials.gov (NCT05727449).

Anesthesia technique, mother's age, gestational age, number of pregnancies of the mother, presence of multiple pregnancies, previous cesarean delivery number, maternal complications (preeclampsia, placental abruption, and placenta previa), and indications for cesarean delivery (non-progressive labor, breech presentation, head and pelvis incompatibility, and large baby) were recorded. In addition, weight, height, head circumference of newborn, 1st and 5th min Apgar values of them, umbilical cord blood gas values (pH, PCO_2, HCO_3, Lactate, and base excess), neonatal complications (need for intensive care and mortality), and fetal congenital anomalies were recorded. All anesthesiologists induced anesthesia using the same anesthetic agents; patient monitoring, extubation criteria, and the same spinal technique were performed according to our institutional protocol.

GA and SA techniques were explained to the pregnant women who were taken to the operating room with a cesarean delivery indication, and if there was no contraindication for the techniques, anesthesia was applied with the technique preferred by the pregnant woman. GA was preferred in the presence of contraindications of SA such as the use of anticoagulants, increased intracranial pressure or infection in the spinal area, while SA was preferred in the presence of contraindications of GA such as lung infection, predicted difficult intubation, or full stomach patient. Standard monitoring (ECG, SpO_2, and non-invasive blood pressure measurement) was applied during cesarean delivery. After preoxygenation using 100% oxygen delivered over 3–5 min, propofol 2–2.5 mg/kg and rocuronium 0.6 mg/kg were administered for induction of GA. Rapid sequential intubation was performed, then sevoflurane was administered for maintenance of anesthesia after delivering of fetus. At the end of the cesarean, the residual neuromuscular block was reversed with atropine 0.2 mg/kg and neostigmine 0.3 mg/kg and patients were extubated when they were fully awake.

For performing SA, 0.5% hyperbaric bupivacaine 10–12.5 mg was administered intrathecal with a Quincke-type needle from the L3–5 or L4–5 interval with a midline approach in the sitting position. The cesarean was performed when the sensory block was an adequate level (T4–T5). If hypotension (More than 20% decrease from the baseline blood pressure value or a decrease in the mean arterial pressure below 65) was observed in the patient, incremental dose of ephedrine 5 mg was administered. When the peripheral oxygen saturation of the patients was detected below 94%, O_2 support was applied through nasal cannula. All patients were placed in the supine position with 10–15° to the left to prevent aortocaval compression. After the delivery, mothers were sedated with intravenous midazolam if she wanted. Cesarean surgery was performed through a standard lower-segment transverse uterine incision.

Apgar scores of 1st and 5th min and clinical status of newborn were evaluated for further care. The umbilical cord blood sample was taken after clamping the two segments of the umbilical cord after delivery. Apgar scores of 1st and 5th min and the values of pH, pO_2, pCO_2, lactate, and base deficit records were evaluated.

Statistical Analysis

For evaluating the findings obtained in the study, IBM SPSS Statistics 22 (IBM SPSS, Turkiye) program was used for statistical analysis. While evaluating the study data, in addition to descriptive statistical methods (mean, standard deviation, and frequency), independent sample t-test was used for the comparison of normally distributed parameters between two groups, and Mann–Whitney U-test was used for comparisons between two groups of parameters that did not show normal distribution. Chi-square test was used to compare categorical variables. Univariate logistic regression test was used to determine the predictors of neonatal mortality. Significance was evaluated at the $p<0.05$ level.

RESULTS

Between January 01, 2019, and December 31, 2019, a total of 1747 deliveries took place in the hospital and 883 pregnant women were delivered by cesarean section. After unsuccessful SA, 21 pregnant women who had cesarean delivery were anesthetized by GA and these pregnant women were excluded from the study. GA was applied to 701 of 862 pregnant women, and SA was applied to 161 of them, and the data of these patients were compared.

In this study, 41.5% of the pregnant women who underwent GA were performed cesarean section with the indication of repeated cesarean section, 17.8% had fetal distress, 5.7% had non-progressive labor, and 5.4% had multiple pregnancies as well as large baby, breech presentation. Cesarean section was performed due to presentation, detachment, preeclampsia, articular, placental anomalies, cephalopelvic incompatibility, and maternal desire. While 14.5% of the pregnancies were in the 1st gravity, 25.7% in the 2nd gravity, 23.7% in the 3rd gravity, and 13.4% in the 4th gravity, 24.3% of the pregnancies were their first deliveries. About 33.8% had 2nd birth and 24.4% had 3rd birth. While the 1st min Apgar results of newborns were calculated as 45.3%, 8, 18.3% were calculated as 9, and 16.1% as 7. While the 5th min Apgar scores of newborns were estimated as 48.5%, 9, 25% were calculated as 10, and 9.6% as 9.6%. While 19.2% of newborn babies were followed in the intensive care unit, 1.4% died.

Again, in this study, 42.2% of the pregnant women who performed SA underwent cesarean section with a repeat cesarean indication, 20.5% had fetal distress, 3.7% had non-progressed labor, 5% had multiple pregnancies, and 8.1% had cesarean section. Cesarean section was performed for other reasons such as breech presentation, detachment, preeclampsia, articular, placental anomalies, head-pelvis incompatibility, and maternal desire. About 27% of pregnancies were 1st gravity, 34.6% 2nd gravity, and 20.8% 3rd gravity, 30.7% of pregnancies were first deliveries. About 46.4% had 2nd birth and 14.4% had 3rd birth. The 1st min Apgar scores of newborns were calculated as 25.7% and 9%, it was calculated as 8 in 54.5% and 7 in 10.3%, while the 5th min Apgar scores of newborns were calculated as 45.6% 10 and 45.6% as 9. In this study, 8.4% of the newborn babies were followed in the intensive care unit, 1.9% died.

There was no statistical difference between the GA and SA groups in the causes of repeated cesarean section, fetal distress, breech presentation, multiple pregnancy, non-progressive pregnancy, preeclampsia, articular, cephalopelvic incompatibility, and maternal desire. While the indication of large baby and baby with anomaly was higher in the SA group ($p=0.04$), placenta previa ($p=0.013$) was higher in the GA group ($p=0.011$) (Table 1).

Maternal age, gestational age, neonatal weight, neonatal height, and neonatal head circumference were statistically similar in both groups ($p>0.05$). When Apgar scores were evaluated, 1st min Apgar ($p<0.001$) and 5th min Apgar ($p=0.001$) scores were statistically higher in the SA group than in the GA group. The umbilical cord Ph values were lower ($p<0.001$), PCO_2 values were higher ($p>0.001$), and lactate values were lower ($p=0.002$) in the GA group and HCO_3 and BE values were similar between groups ($p>0.05$). While the number of babies followed in the neonatal intensive care unit was higher in the GA group ($p=0.003$), neonatal mortality was similar in both groups ($p=0.733$) (Table 2).

Neonatal head circumference, neonatal height, neonatal weight, mother's age, gestational age, and 1st and 5th min Apgar scores are predictive test results for neonatal mortality. The applied anesthesia technique has no predictive effect on neonatal mortality (Univariate logistic regression test).

DISCUSSION

In this study, which retrospectively analyzed the data of pregnant patients who had a cesarean section, we found higher Apgar scores in the newborns of the pregnant women who underwent SA. In addition, the umbilical cord blood Ph values of the newborns were lower who were administered GA and the PCO_2 values were higher.

Table 1. Demographic data of pregnant women and neonates

	Group GA n=701	%	Group SA n=171	%	p
Over weight newborn	28	4	13	8.1	0.867
Fetal distress	125	17.8	30	20.5	0.431
Breech arrival	34	4.9	8.0	3.7	0.530
Placenta detachment	9	1.3	0	0.6	0.698
Multiple pregnancy	38	5.4	8	5.0	0.817
Non-advancing traway	40	5.7	6	3.7	0.293
Preeclampsia/hellp	33	4.7	8	5.0	0.889
Placenta previa	28	4	1	0.6	0.011
Head pelvis incompatibility	33	4.7	6	3.7	0.580
First C/S	410	58.5	93	57.8	NS
Duplicate C/S	291	41.5	68	42.2	NS

Mann–Whitney U-test. GA: General anesthesia; SA: Spinal anesthesia.

Table 2. Maternal and neonatal characteristics and umbilical artery blood gas values

	Group GA n=701 Mean±SD	Median (min–max)	Group SA n=171 Mean±SD	Median (min–max)	p
Maternal age	30.00	18–47	30.00	19–44	0.683
Gestation period (day)	268	161–294	270.00	132–295	0.161
Newborn weight (mg)	3130–00	430–4170	3265.00	1422–4890	0.056
Newborn size (cm)	49.00	25–55	49.00	38–54	0.642
Head circumference (cm)	34.00	18–46	35	20–38	0.205
Congenital anomaly	6	0.9	6	3.7	0.013
Apgar 1^{th} min (mean±SD)	7.92±1.11		7.37±1.63		<0.001*
Apgar 5^{th} min	9.31±0.84		9.06±1.03		0.004≠*
pH	7.32	6.9–7.55	7.35	7.12–7.45	<0.001*
pCO_2 (mmHg)	51.45	23.40–93.40	46.9	28.00–78.00	<0.001*
HCO_3	23.30	10.0–46.0	23.00	13.8–39.0	0.969
Lactate	1.90	0.4–9.9	2.76	16.1–39	0.002*
BE	0.70	□11.4–□16.1	1.00	□8.6–□7.4	0.430
Newborn ICU	118	19.2	11	8.4	0.003*
Newborn mortality	11	1.6	3	1.90	0.733

*: p<0.005, ≠: Mann–Whitney U-test. GA: General anesthesia; SA: Spinal anesthesia; SD: Standard deviation; pCO_2: Partial carbon dioxide pressure 2; HCO_3: Bicarbonate; BE: Base excess; ICU: Intensive care unit.

However, in the other hand, the umbilical cord blood lactate values of the newborns of those who underwent SA were found to be higher. In addition, neonatal weight, mother's age, gestational age, and Apgar scores are predictive for neonatal mortality; the applied anesthesia technique has no predictive effect on neonatal mortality.

Cesarean delivery rates have increased over time, considering the health of both the mother and the fetus.

Although GA as an anesthetic technique provides rapid induction and better cardiovascular and respiratory stability, anesthetic drugs that cross the placental barrier may cause fetal depression. In addition, while the risk of aspiration is increased in a pregnant woman who is considered to have a full stomach, intubation may be difficult due to the changing anatomy of the pregnant woman [3]. It has been suggested that GA may be more appropriate to apply to the patient to shorten the time between the onset of anesthesia and the delivery of the fetus in cesarean deliveries [4]. Sympathetic blockade and hypotension developing during SA may adversely affect the newborn by decreasing uteroplacental perfusion. Furthermore, cerebrospinal fluid leakage from lumbar puncture causes complications such as headache and nausea [5, 6]. An ideal anesthesia method has been determined for cesarean delivery, and the decision is made according to the mother's request, obstetric reasons, and the experience of the anesthesiologist. In our clinic, the preferred method for cesarean delivery was more as GA on the specified dates.

The incidence of hypotension in cesarean delivery with SA has been reported as 25–75% and sympathetic system blockade and cardiac output decrease during SA have been shown as the cause of this hypotension [7, 8]. Chen et al., [4] found that mean arterial pressures at the beginning of the cesarean section and delivery of the baby were lower in pregnant patients who underwent SA. Furthermore, different causes have been put forward for hypotension during SA such as the level of SA and some neonatal factors. Shitemaw et al. [9] found the correlations with newborn weight (>4 kg), SA level (>T6), the length between SA application and skin incision, and anesthesiologist experience for occurrence of hypotension. The enlargement of the veins in the epidural space during pregnancy and the pressure of uterus on the inferior vena cava have let to increase in cerebrospinal fluid pressure in the lumbosacral area, and it has been claimed that local anesthetic agents, therefore, cause higher levels of anesthesia by displacing toward the cephalad [10]. There have been some methods for prevention of hypotension in SA. Fluid replacement treatment before SA performing with crystalloid or colloid and perioperative vasopressor application has been studied in the studies. Although there are studies showing that pre-operative fluid administration does not prevent the development of hypotension, the effects of these treatments are still discussed [11–13]. Perioperative fluid treatment has been frequently preferred in our clinic experience. Ephedrine as a choice of vasopressor has been administered in the case of sustained hypotension.

The importance of hypotension in SA for fetus is that it may lead to fetal asphyxia due to decreased uteroplacental blood flow and it can be seen in the umbilical cord blood gas analysis [14]. Studies have reported that neonatal acidosis, hypoxia, and low Apgar scores may be observed due to acute uteroplacental flow reduction after SA [15, 16]. Perioperative blood pressure values were not available in this study. However, Apgar score and umbilical cord blood gas values, which are thought to be affected by decreased uteroplacental blood flow, were evaluated for this purpose.

Apgar is simple test performed at 1th min for determination how well the baby tolerated the birthing process and 5th min for determination how well the baby is doing outside [17]. For newborn outcome, Apgar score and umbilical cord blood gas analysis are examined and newborn further care is decided as the results of them. Apgar score is below 3 in severe neonatal asphyxia, between 4 and 6 values in moderate neonatal asphyxia. Some studies have shown that Apgar results are similar in general and SA in elective cesarean deliveries [18]. In the study of Chen et al. [4], pregnant patients with GA or SA were compared in terms of Apgar scores of 1st and 5th min and found similar scores in both technique of anesthesia. Other studies have shown that GA reduces Apgar scores in neonates and reported that SA is safer in terms of neonatal outcomes [19]. In the prospective study of Saygı et al. [20], the Apgar results of neonates were found to be higher in cesarean deliveries with SA, while neonatal intensive care admissions were found to be the same in both anesthesia methods. In this study, Apgar scores of babies delivered by cesarean section using SA were higher than those delivered by GA at both the 1st and the 5th min and this made us think that SA has a more positive effect on infant wellbeing.

Neonatal acidemia developing during delivery is closely associated with neonatal morbidity and mortality. Therefore, umbilical cord blood gas values are a useful and reliable analysis in determining neonatal risks [21]. Malin et al. [16] demonstrated that low pH measured from the umbilical cord artery associated with neonatal mortality and also hypoxic ischemic encephalopathy, intraventricular hemorrhage, periventricular leukomalacia, and cerebral palsy were seen mostly with this low pH. Fahey and King., demonstrated that low pH in the um-

bilical cord blood artery has prone to perinatal asphyxia [22]. Especially pH of <7.00 and a base deficit of ≥12 mmol/L in umbilical cord blood sampling have been seen mostly in neonatal with cerebral palsy [23]. The study of Heller et al. [24] suggested the association of arterial cord pH and neonatal mortality. Some studies have claimed that neonatal complications have been associated with metabolic acidosis rather than respiratory acidosis. The exact correlation was found between umbilical cord pH and mortality, especially in newborns <32 weeks old or babies with a birth weight <2000 g [25, 26].

In the prospective study of Chen et al., [4] there was no difference which was observed between the groups in terms of both hemodynamic values and umbilical cord blood gas values between GA and SA. In the prospective study of Ozden Omaygenc et al. [17], Apgar 1st and 5th min results were lower in the GA group, and transient tachypnea of the newborn (TTN) requiring follow-up in the neonatal intensive care unit was observed more frequently. In the same study, while there was no difference in PCO_2 in umbilical blood gas, pH was measured lower. Yousefshahi et al. [27] reported that Apgar scores, umbilical cord blood gas values, perioperative hemodynamics, and the amount of perioperative fluid administered were not changed with ephedrine administration to patients who developed hypotension due to SA. In a retrospective study by Kireçci et al. [28], the effects of SA and GA on newborns in the early period were compared. While the Apgar 1st, 5th and 10th min values were similar between the groups, low pH values and high pCO_2 values were measured in umbilical blood gas sampling in GA group. In this study, the pH values of the babies who were delivered by cesarean section by applying GA were found to be lower and the PCO_2 values to be higher. For this reason, we believe that the babies of pregnant women who underwent GA are prone to respiratory acidosis as a result of respiratory depression due to the anesthetic drugs used. We think that the reason for the high lactate values in the SA group may be the decrease in the placental blood flow of the baby due to the hypotension that developed in the mother during SA.

In the study of Keleş et al. [2], patients who underwent GA and SA were compared in terms of the development of TTN in 1447 pregnant women retrospectively. As a result of this study, while 1st and 5th min Apgar values, umbilical cord pH and pCO_2 values were found to be similar, TTN was diagnosed in 5.3% of the pregnant women who received GA and 7.6% of the pregnant women who underwent SA. They explained this data that the long time between SA application and skin incision determined in the study increases the incidence of TTN. The time between SA and skin incision could not be reached among the data analyzed retrospectively in our study.

In a study aiming to establish a predictive model of mortality in high risk newborns and examining 220 births, it was shown that weight, gestational age, Apgar scores, resuscitation needs, and the presence of congenital anomalies are associated with newborn mortality [29]. In a cohort study of examining 4,503,197 singleton births including 19,301 infant deaths during the 9-year study period, it was shown that infant factors with a major effect on the infant mortality rate are birth weight and gestational age [30]. In a study investigating optimal fetal and neonatal risk assessment tools, a total of 502,648 pregnancies were examined and found that birth weight was the most important predictor for infant mortality [31]. According to the data obtained from 438 hospitals over 5 years, a strong correlation was found between the 1st min and 5th min Apgar scores and infant mortality [32].

In this study, a correlation was found with infant mortality in neonatal weight, mother's age, mother's gestational age, 1st and 5th min Apgar scores, and consistent with the literature. However, no study could be found on the effect of the anesthesia technique applied on infant mortality. In our study, anesthesia technique applied in cesarean section did not affect infant mortality.

This retrospective study had some limitations. Since the hemodynamic data of pregnant women were not available, the effect of maternal hemodynamic measurements on the newborn could not be evaluated. In addition, there was a difference in the number of cases of the groups, since the GA method was preferred more in the time period when the data were analyzed. We think that this may affect the statistical analysis. Neonatal morbidity was examined considering the neonatal intensive care hospitalization; a detailed examination of its cause could not be performed due to lack of data. Therefore, TTN, which is important in neonatal morbidity, could not be evaluated in detail.

Conclusion

Apgar scores showing neonatal outcome were found to be higher in newborns of pregnant women who underwent cesarean section, while umbilical cord blood gas

values were less affected and the need for neonatal intensive care was lower by applying SA. However, considering maternal and neonatal morbidity and mortality, we believe that both anesthesia methods can be used safely for mother and neonatal in cesarean anesthesia.

Ethics Committee Approval: The Istanbul Medeniyet University, Goztepe Prof. Dr. Suleyman Yalcin City Hospital Clinical Research Ethics Committee granted approval for this study (date: 25.12.2019, number: 2019/0517).

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