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Invasive Hemodynamic Monitoring and Arterial Blood Gas Exchange During Spinal vs General Anesthesia for Cesarean Delivery in Mongolian Parturient

Mungun Banzar[1,4], Enkhtsetseg Jamsranjav[2], Munkhtsetseg Janlav[3], Ganbold Lundeg[1]

[1]Department of Critical Care Medicine and Anesthesiology, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia;
[2]Department of Obstetrics and Gynecology, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia;
[3]Department of Biochemistry, School of Biomedicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia;
[4]Department of Anesthesiology, National Center for Maternal and Child Health, Ulaanbaatar, Mongolia.

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Corresponding Author:
Ganbold Lundeg (M.D., Ph.D., Prof)
Critical Care and Anesthesia Department, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia
E-mail: ganbold@mnums.edu.mn
ORCID: https://orcid.org/0000-0001-8470-7342

Munkhtsetseg Janlav (M.D., Ph.D., Prof)
Department of Biochemistry, School of Biomedicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia
ORCID: https://orcid.org/0000-0001-5948-3906
E-mail: jmtsetseg@gmail.com
Running title: Maternal brain injury in C-section delivery

Objective: This study investigated the accuracy and precision of continuous, invasive blood pressure obtained using the arterial line system in patients undergoing cesarean section with spinal and general anesthesia. **Methods:** A total of 150 parturient women who underwent C-sections from July 1, 2021, to Dec 30, 2023, were divided into two groups: the GA (general anesthesia) group (n=50) and the SA (spinal anesthesia) group (n=100). In this prospective observational study, we measured and compared the changes in hemodynamic fluctuation and arterial blood gas deviations under C-section with either spinal or general anesthesia.
Results: One hundred fifty patients were recruited for the study after exclusions, and data were analyzed for 150 patients. There were no significant differences in the time from anesthesia to incision, the operation duration, infused crystalloid volume, blood loss, and urine output. The most frequent complications were surgery hypotension, tachycardia, nausea, and headache in the SA group, and tachycardia, hypertension, in the GA group These complications may cause SA's impact on the sympathetic nerves, resulting in dilated blood vessels and reflex tachycardia. **Conclusion:** It has been suggested that the choice of anesthesia technique has a significant impact on hemodynamic stability during cesarean section.
Keywords: Invasive Arterial Blood Pressure, General Anesthesia, Spinal Anesthesia, Cesarean Section, Arterial Blood Gas

Introduction

Cesarean section is a standard surgical procedure in obstetrics, accounting for a significant proportion of all deliveries worldwide. Cesarean section is a fetal delivery through an open abdominal incision (laparotomy) and an incision in the uterus (hysterotomy).[1] According

to new research from the World Health Organization (WHO), the use of the Cesarean section (C-section) continues to rise globally, now accounting for more than 1 in 5 (21%) of all childbirths.[2] Based on the Center for Health Development study, the C-section rate in Mongolia has been increasing over the years, from 22.4% in 2012 to 27.9% in 2023.[3]

Anesthesiologists should choose between general or regional anesthesia for C-sections depending on the individual patient's condition and clinical situation. Spinal anesthesia (SA) is a type of anesthesia in which a local anesthetic is injected directly into the cerebrospinal fluid surrounding the spinal cord and nerve roots. SA is part of the modern practice of anesthesia because of its advantages, such as predictability, patient satisfaction, low complication rate, as well as pain control with low doses of the drug, which results in a minimal risk of maternal toxicity or fetal drug transfer.[4] However, the duration of SA is limited after a single spinal injection, without the ability to extend anesthesia for unforeseen circumstances.[5] On the other hand, general anesthesia (GA) offers rapid and reliable onset, control over the airway and ventilation, and potentially less hypotension. GA may be the most appropriate choice in some circumstances (e.g., profound fetal bradycardia, ruptured uterus, severe hemorrhage, severe placental abruption, umbilical cord prolapses, and preterm footling breech).[6] However, it has some side effects, including the aspiration of stomach contents, failed intubation, and respiratory problems for both mother and baby.[7]

Side effects of anesthesia often cause sudden onset of hypotension, so peripheral venous dilatation and increased venous capacitance due to the sympathetic blockade, along with inferior vena cava compression by the gravid uterus, cause a decrease in cardiac output as well as a reduction in cardiac preload, hence a hemodynamic compromise.[8] Combining a phenylephrine infusion and rapid crystalloid hydration is the first method that reliably prevents hypotension. In addition, it is known that the hemodynamic effects of an oxytocin bolus after delivery include increased cardiac output and pressure of the pulmonary artery, hypotension, systemic vasodilation, and tachycardia, depending on the dose and rate of administration.[9,10]

Due to its crucial role in the hemodynamic stability of the mother, the choice of anesthesia technique can have a significant impact on hemodynamic stability during cesarean section. It should be noted that the hemodynamic changes observed during cesarean section are also multifactorial and influenced by various factors such as patient position, underlying medical conditions, fluid management, and anesthetic technique. Tihtonen, et al. evaluated maternal hemodynamics and observed a 47% increase in cardiac index and a 39% decrease in systemic vascular resistance index at the point of delivery under SA.[11] Another study also revealed the reduction of total peripheral resistance and increased cardiac output at the time of delivery of the fetus and placenta under SA.[12] A retrospective cohort study by Sung, et al. showed significantly higher postoperative hemodynamic parameters in the GA compared to SA (SBP: 136.8 ± 16.7 vs. 119.3 ± 12.7 mmHg, heart rate: 93.2 ± 16.8 vs. 71.0 ± 12.7 beats/min, respectively, $P < 0.001$).[13]

Although the hemodynamic changes after various anesthesia could be well tolerated in healthy patients, the deep fluctuation of hemodynamic changes will lead to very detrimental consequences for the obstetric population due to coexisting comorbidities, such as preeclampsia and cardiac diseases. Thus, anesthesia providers need to monitor and manage hemodynamic parameters carefully during cesarean sections, and advanced monitoring via A-line allows the optimization of hemodynamic conditions and decreases morbidity and mortality. This study compares maternal hemodynamic fluctuation and arterial blood gas changes during caesarian delivery under general and spinal anesthesia in a healthy parturient in Mongolia.

The increasing experience in advanced hemodynamic management will probably permit a decrease in the morbidity and mortality of obstetric patients in the future.

Material and Methods

Study Design

The study was a prospective, observational, single-center, controlled study. The parturient women who undergo C-sections in Obstetrics and Gynecology Hospital of The National Center of the Maternal and Child Health of Mongolia from July 2021 to Dec 2023 enrolled in this study according to the inclusion and exclusion criteria. We recruited 153 participants, 101 for general anesthesia (GA) and 52 for spinal anesthesia (SE). The group was given GA, defined as the GA (general anesthesia) group, and the group was given spinal anesthesia as the SE (spinal anesthesia). The primary endpoint was invasive hemodynamic monitoring beat-to-beat via arterial line during C-section with either spinal or general anesthesia. The secondary outcomes were maternal

arterial blood gas values, surgery and anesthesia, neonatal outcomes, and maternal postoperative numeric pain rating scale (NPRS) compared in two groups.

All the women were placed on a 20G catheter in the indwelling radial arterial catheter as standard practice after the positive modified Allen's test[14-16] and connected the catheter to the fluid-filled tubing of the monitoring system "PHILIPS" for continuous monitoring of a patient's blood pressure for hemodynamic changes while lying in the supine position with leftward tilt, and at the following 7 times points: before undergoing a C-section (measurement T0), 3 minutes after receiving anesthesia (measurement T1), 6 minutes after receiving anesthesia (measurement T2), 9 minutes after receiving anesthesia (measurement T3), immediately after delivery of the newborn (measurement T4), after oxytocin injection (measurement T5), the end of surgery (measurement T6).

Inclusion Criteria

The inclusion criteria are as follows: (1) aged between 18-40, (2) American Society of Anesthesiologists physical status I or II, (3) term gestation at 37 weeks, (4) patients whose hemoglobin >100 g/L, (5) women who had uncomplicated singleton pregnancies who were indicated to undergo elective cesarean section due to previous Caesarean delivery, history of primary infertility or more.

Exclusion Criteria

Exclusion criteria were as follows: (1) height less than 150 cm (2) body mass index (BMI) ≥ 30 kg/m2 (3) included parturient women with severe internal, surgical, or obstetric comorbidities, (4) preeclampsia (5) patients who were given analgesic and sedative drugs before surgery (6) patients with severe mental illness (7) requirement for emergency cesarean section for delivery, (8) classification as ASA status ≥ III (9) patients who refused to participate in the study (10) patients who were allergic to anesthetics (11) patients who had contraindications to general anesthesia/ or spinal anesthesia.

Measure Blood Pressure Using an Arterial Line: First, the arterial pressure transducer was leveled and zeroed at the intersection of the anterior axillary line and the 5th intercostal space. Then, investigators purged the system of any air bubble with the dedicated inflated flush system set at 300 mmHg. Secondly, invasive systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean blood pressure (MBP) were measured using a radial artery catheter (20G Surflo® (Terumo China Holding Co., Ltd) connected to a disposable pressure transducer (Package transducer Edwards; VAMP Plus system; Edwards Lifesciences, Irvine, CA, USA) and measured with a Philips MP60 IntelliVue monitor (Philips Medical System; Best, The Netherlands). Finally, the SBP, DBP, and MBP values were measured and recorded.

Methods of Anesthesia

Preoperative medications: Ranitidine 150 mg orally (H2-blocker) and metoclopramide 10 mg intravenously. Women in both groups were kept in the 15-degree left lateral tilt position till delivery to protect against supine hypotension syndrome.

Patients in the GA. Patients were oxygenated with 100% oxygen via face mask for 3 minutes before induction. General anesthesia was performed with propofol 2mg/kg (manufacturer: Guangdong Jiabo Pharmaceutical Co., Ltd.; specification: 20 ml/200 mg), 2 μg/kg of fentanyl (manufacturer: Flagship Biotech International, India; specification: 2.5 ml/25 mg), succinylcholine 2 mg/kg followed by tracheal intubation, mechanical ventilation. After intubation, the patients were injected intravenously with 0.5 mg/kg of atracurium besylate and 2.0 of fentanil (manufacturer: IVCO, Mongolia, specification: 0.005%-2 ml). Simultaneously pumping propofol at 2.5 mg/kg per hour and fentanil at 0.05 mg/kg per minute. An observer collected all intraoperative data. Hypoxia was defined as SpO2 <95%.

The SE Group: For spinal anesthesia, a 25 gauge spinal needle is used to access the spinal space at the L2–L3 or L3–L4 interspace level. Upon return of cerebrospinal fluid, 0.5%-10 mg heavy bupivacaine (manufacturer: Troikaa, Pharmaceuticals Ltd, India specification: 4 ml/20 mg) and fentanyl were injected. The sensory block level was adjusted to approximately T5–T6. Hypotension was defined as a greater than 20% decrease in SAP below the baseline value and was treated with intravenous ephedrine. In addition, oxygen at approximately 5 l/min was given via face mask during the C-section. All patients received an intravenous injection of 5 units of Oxytocin (manufacturer: HBM Pharma, Slovakia, specifications: 1 ml/5 mg) and 15 units intravenously drip immediately after delivery of the placenta.

Follow-up/Measurements.

Preoperative. Eligible patients were approached and provided written informed consent before surgery. Preoperative assessment evaluation for both groups included a detailed histo-

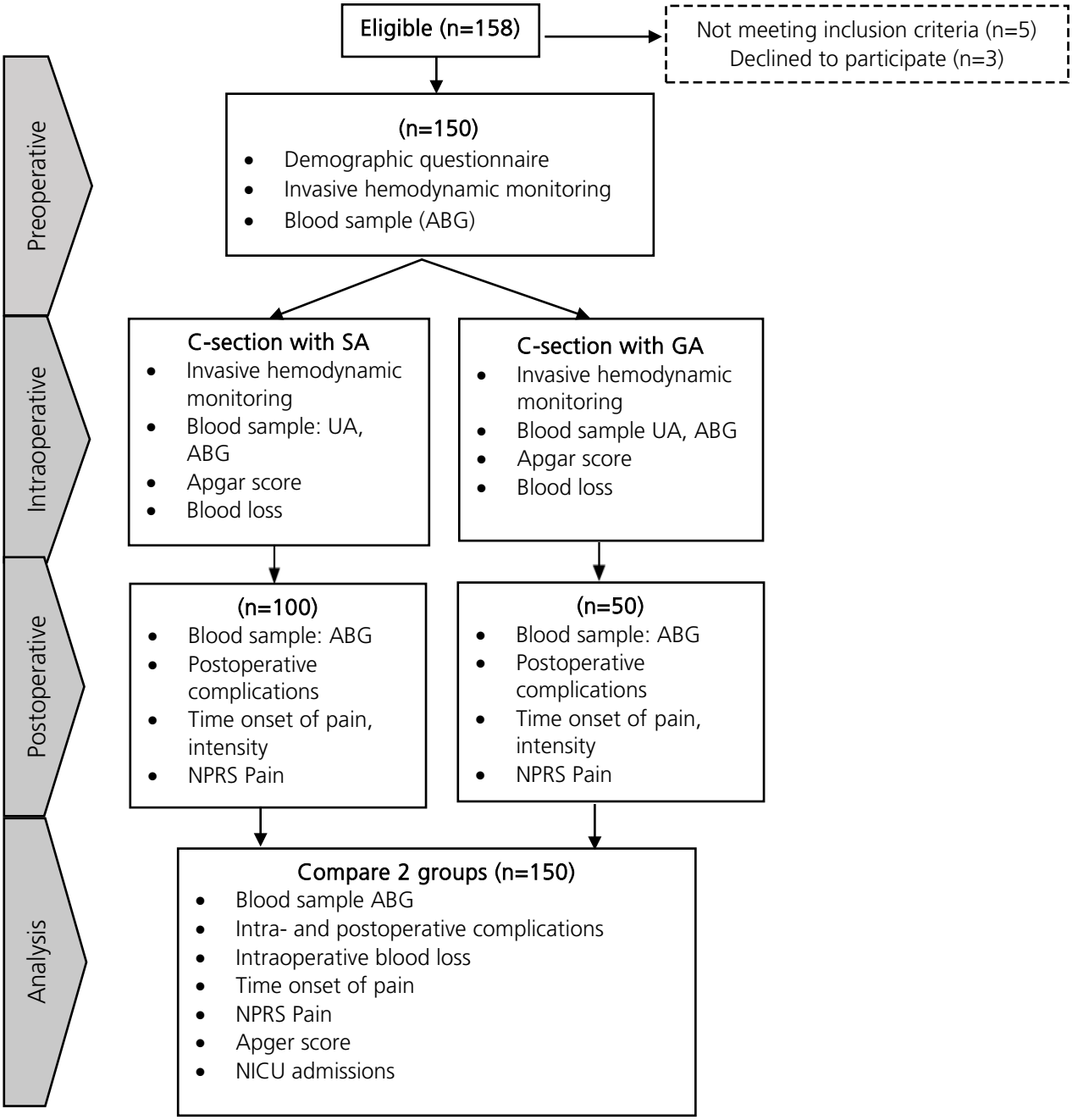

Figure 1. Flowchart detailing the study. GA: General anesthesia, SA: Spinal anesthesia, ABG: Arterial blood gas, UA: Umbilical artery, NPRS: Numeric pain rating scale, NICU: Neonatal intensive care

ry, physical examination, and investigations (hemoglobin level, platelet count, random blood glucose, serum creatinine, total protein, albumin, liver function tests, prothrombin time (PT) and international normalized ratio (INR), creatinine).

Before anesthesia, radial arterial cannulation was performed for all patients using 20G Surflo® (Terumo China Holding Co., Ltd.) under local anesthesia (2% lidocaine) and monitored arterial blood pressure. Electrocardiogram measurements, invasive blood pressure (IBP) readings, including systolic, diastolic, and mean blood pressures (SBP, DBP, MBP), and pulse oxygen saturation (SpO2) were obtained.

MAP = (systolic blood pressure + 2 × diastolic blood pres-

sure)/3; the HR and SpO2 were measured by the fingertip photoelectric sensor (manufactured: Guangzhou Sichuang Hongyi Electronic Technology Co., Ltd.)

Transoperative. Seven times during surgery, invasive blood pressure (IBP) readings, including systolic, diastolic, and mean blood pressures (SBP, DBP, MBP) and pulse oxygen saturation (SpO2), were recorded.

In both groups, the time from anesthesia induction to delivery, total operative time, intraoperative blood loss, urine output, and complications during surgery were recorded. All vital signs were recorded.

Postoperative. For 2 hours after the postoperative stage, the patients were monitored in the recovery room. Complications after C-section within 2 hours were recorded in both groups, including postoperative nausea, vomiting, headache, and chills, and pain-related outcomes were recorded. All patients were assessed using the Numeric pain rating scale (NPRS), which indicated the severity of postoperative pain on a scale of scores between 0 = no pain and 10 = worst pain ever. The time onset and intensity of pain were recorded.

Neonatal Parameters

The pediatricians examined the neonatal condition. The Apgar scores 1, 5 minutes, and neonatal intensive care unit (NICU) admission were assigned and documented. The newborn's physical conditions in both groups were evaluated by referring to the Apgar scoring, with a total score of 10 points. A score of 7–10 was considered normal; 4 to 6, mild neonatal asphyxia; and three and below, severe neonatal asphyxia.

After the delivery of the baby from the uterus, the umbilical cord (~10–12 cm) was clamped on both sides, then by cutting the cord between the clamp away from the placenta side and the newborn baby. The placenta was delivered shortly after baby delivery, and 1–3 ml of blood for ABG was taken from the umbilical artery between two clamped sides immediately after placenta delivery.

Laboratories Outcome

Arterial Blood Gas Analysis

The blood gas analysis was performed from umbilical cord blood immediately drawn after childbirth. A portion of the blood was immediately injected into a blood gas/electrolyte analyzing system (COBAS B-221, ROSHE) for pH, pCO2, pO2, Hb, Hct, O2Hb, COHb, Ca2+, K+, Na+,CI-, SO2, BB, BE, HCO3, Osm measured and compared between the 2 groups, and the remaining blood sample was used for the S100β study assay.

Statistical Analysis

Continuous variables are shown as means (standard deviation) and compared using an unpaired t-test. Categorical variables are shown as numbers and percentages and were compared using X2 and Fisher's exact tests for association. A critical P-value of < 0.05 was used. SPSS version 24 software (SPSS Inc., Chicago, IL, USA) was used for statistical analyses.

Ethical Statement

This study was approved by the Ethics Committee of The National Center of the Maternal and Child Health of Mongolia, Ethics Committee of Mongolian National University of Medical Sciences (2021/03-07). Written informed consent was obtained from patients scheduled for C-sections under spinal or general anesthesia.

Results

Patient recruitment and flow are presented in Fig 1. After exclusions, fifty patients were recruited for the study; data were analyzed for 150 patients. Table 1 shows the demographic characteristics of the study participants. The mean maternity age between SA and GA groups was 30+/-5 and 31+/-5, respectively. A total of 30 (19.6%) patients were from urban, while 123 (79.4%) patients were from rural areas. Regarding the birth history, 29 mothers (18.3%) had 1-2 births, while 20.9% had more than 4 times of birth. Twenty-three mothers had a previous history of C-sections.

Anesthesia and surgery outcomes are presented in Table 2. The fentanyl dose in the GA group was 231.7 +/-58.8 mcg and 14.3+/-2.2 mcg in the SA group ($P< 0.001$). There were no significant differences in the time from anesthesia to incision, the operation duration, infused crystalloid volume, blood loss, and urine output.

Table 1. Demographic outcomes.

Variables	Study groups			P-value
	SA N = 101 Mean ± SD	GA N = 52 Mean ± SD	Total N = 153 Mean ± SD	
Maternal Age	30.1 ± 5.3	31.3 ± 5.0	31.4 ± 5.4	0.503
Weight (kg)	70 ± 10	70 ± 18	70 ± 15	0.203
Height (sm)	160 ± 3	156 ± 18	158 ± 13	0.519
	N (%)	N (%)	N (%)	
Location				
Urban	16 (53.3)	14 (46.7)	30 (19.6)	0.606
Rural	85 (66.7)	38 (53.3)	123 (79.4)	
Marital status				
Yes	30 (29.7)	30 (57.6)	60 (39.2)	0.350
Education status				
<High school degree	3 (10)	2 (6.7)	5 (8.3)	
High school graduate	7 (23.3)	12 (40.0)	19 (31.7)	
≥Bachelor's degree	20 (66.7)	16 (53.3)	36 (60.0)	
Housing situation				
Social housing	14 (46.7)	12 (40.0)	26 (43.3)	
Ger	10 (33.3)	14 (46.7)	24 (40.0)	
Others	6 (20.0)	4 (13.3)	10 (16.7)	
Working conditions				
Normal	28 (93.3)	29 (96.7)	57 (97.0)	
Abnormal	1 (3.3)	-	1 (1.7)	
Health risk	1 (3.3)	1 (3.3)	2 (2.3)	
Abdominal surgery				
Yes	13 (12.9)	13 (25.0)	26 (17.0)	0.908
No	98 (87.1)	39 (75.0)	127 (83.0)	
Blood types				
O	14 (46.7)	12 (40.0)	26 (43.3)	
A	5 (16.7)	6 (20.0)	11 (18.3)	
B	10 (33.3)	10 (33.3)	20 (33.3)	
AB	1 (3.3)	2 (6.7)	3 (5.0)	
COVID19 infection				
Yes	19 (18.8)	24 (46.2)	43 (28.1)	0.152
No	82 (81.2)	28 (43.8)	110 (71.9)	
COVID19 vaccine				
Yes	30 (29.7)	28 (53.8)	58 (37.9)	0.150
No	71 (69.3)	24 (55.2)	95 (62.1)	
Allergy				
Yes	3(0.03)	2 (3.8)	5 (3.3)	0.640
No	98 (99.7)	50 (96.2)	148 (96.7)	
Gestation age at 1st prenatal visit				
≤ 8 weeks	20 (66.7)	17 (56.7)	37 (61.7)	0.583
>8 weeks	10 (33.3)	13 (43.3)	23 (38.3)	
Gestational age, weeks				
37-38	8 (26.7)	5 (16.7)	13 (21.7)	0.633
38-39	10 (33.3)	12 (40.0)	22 (36.7)	
> 39	12 (40.0)	13 (43.3)	25 (41.7)	
Previous births				
1-2 births	15 (36.6)	13 (25.0)	28 (18.3)	0.372
> 4 births	15 (36.6)	17 (32.7)	32 (20.9)	
Previous C-section				
Yes	18 (17.8)	18 (34.6)	36 (23.5)	1.000
No	83 (82.2)	34 (65.4)	117 (76.5)	

SA = Spinal Anesthesia; GA = General Anesthesia

Table 2. Anesthesia and surgery outcomes (N=60)

Variables	Study Groups			P-value
	SA Mean ± SD	GA Mean ± SD	Total Mean ± SD	
Surgery time (min)	50 ± 8	52 ± 10	51 ± 9	0.471
Fentanyl dose (mcgr)	14.3 ± 2.2	231.7 ± 58.8	123.0 ± 117.1	0.000
Oxytocini dose (iu)	22 ± 4	23 ± 3	22 ± 3	
Isotonic solution (ml)	1563 ± 237	1562 ± 236	1563 ± 234	0.972
Urine output (ml)	155 ± 95	195 ± 93	175 ± 95	0.105
Blood loss (ml)	432 ± 72	456 ± 83	444 ± 78	0.232
Previous anesthesia	N (%)	N (%)	N (%)	
General	2 (11.8)	5 (21.7)	7 (17.5)	0.091
Spinal	13 (76.5)	18 (78.3)	31 (77.5)	

SA = Spinal Anesthesia; GA = General Anesthesia

Table 3. Pain and complications outcomes (N=60)

Variables	Study Groups			P-value
	SA N (%)	GA N (%)	Total N (%)	
Time onset of pain				
≤ 60 min	1 (3.3)	13 (43.3)	14 (23.3)	0.471
61-119 min	16 (53.3)	14 (46.7)	30 (50.0)	0.000
>179 min	13 (43.3)	2 (6.7)	15 (25.0)	
NPRS				
1-3 score	8 (26.7)	5 (16.7)	13 (21.7)	0.604
4-7 score	16 (53.3)	17 (56.7)	33 (55.0)	
8-10 score	6 (20.0)	8 (26.7)	14 (23.3)	
Complications during surgery				
Hypotension	5 (16.7)	1 (3.3)	6 (10.0)	
Hypertension	-	12 (40.0)	12 (20.0)	
Bradycardia	-	2 (6.7)	2 (3.3)	
Tachycardia	5 (16.7)	11 (36.7)	16 (26.7)	
Nausea	15 (50.0)	-	15 (25.0)	
Headache	2 (6.7)	-	2 (3.3)	
Complications after surgery				
Nausea	11 (36.7)	9 (30.0)	20 (33.3)	
Vomiting	2 (6.7)	1 (3.3)	3 (5.0)	
Headache	5 (16.7)	1 (3.3)	6 (10.0)	
Shivering	4 (13.3)	3 (10)	7 (11.7)	
Weakness	1 (3.3)	6 (20)	7 (11.7)	
Shortness of breath	4 (13.3)	2 (6.7)	6 (10.0)	
Uncomplicated				

SA = Spinal Anesthesia; GA = General Anesthesia

Table 3 shows the time onset of pain and complications during surgery between the two study groups. The most frequent complications were surgery hypotension, tachycardia, nausea, and headache in the SA group, and tachycardia, hypertension was in the GA group.

These complications may cause the impact of SA on the sympathetic nerves, resulting in dilated blood vessels and reflex tachycardia. Autonomic nervous imbalance induced by SA, ephedrine, and oxytocin may cause intraoperative tachycardia during C-section and continue after surgery. Postoperative adverse reactions and complications such as nausea, headache, shivering, and weakness were found in both groups.

The incidence of postoperative nausea, headache, and shivering were significantly higher in the SA group than in the GA group (P< 0.05) The total incidence of postoperative adverse reactions in the GA group was considerably lower (P< 0.05) We detected that the time of onset of pain was significantly shorter in GA group, 13 (43.3%) patients felt pain after surgery within ≤ 60 min. However, no two groups had significant differences in pain intensity, NPRScore, the wound healing process, or length of stay in the hospital).

Table 4 shows the neonatal parameters. No significant differences were found in Apgar scores and neonatal asphyxia rates between the two groups (all P> 0.05).

Table 4. Neonatal outcomes (N=60)

ABG values	Study Groups			P-value
	SA Mean ± SD	GA Mean ± SD	Total Mean ± SD	
pH	7.31 ± 0.04	7.28 ± 0.04	7.30 ± 0.04	0.009
pCO2 (mmHg)	41.3 ± 9.6	44.3 ± 5.9	42.8 ± 8.0	0.157
PO2 (mmHg)	45.5 ± 27.3	51.0 ± 31.2	48.2 ± 29.2	0.476
Hb (g/L)	142.2 ± 37.0	150.9 ± 14.2	146.5 ± 28.1	0.237
Hct (%)	43.8 ± 8.6	44.8 ± 3.8	44.3 ± 6.6	0.588
O2Hb (%)	70.1 ± 14.6	76.1 ± 16.9	73.1 ± 15.9	0.146
HHb (%)	25.0 ± 14.6	21.5 ± 16.7	23.2 ± 15.6	0.385
Met Hb (%)	0.8 ± 0.1	0.9 ± 0.2	0.8 ± 0.1	0.389
Ca2+ (mmol/L)	1.34 ± 0.15	1.47 ± 0.12	1.41± 0.15	0.000
K+ (mmol/L)	5.91 ± 1.93	5.70 ± 1.55	5.80 ± 1.74	0.643
Na+ (mmol/L)	133.5 ± 6.7	136.3 ± 1.8	134.9 ± 5.0	0.029
Cl- (mmol/L)	103.2 ± 2.1	103.8 ± 1.9	103.5 ± 2.0	0.263
SO2 (%)	72.6 ± 16.1	78.0 ± 17.2	75.3 ± 16.7	0.216
BB (mmol/L)	42.1 ± 2.2	42.1 ± 1.8	42.1 ± 2.0	0.923
BE (mmol/L)	-5.8 ± 2.2	-5.9 ± 1.6	-5.9 ± 1.9	0.864
ctCO2	18.0 ± 2.3	18.5 ± 1.5	18.3 ± 2.0	0.341
HCO3-	20.1 ± 2.4	20.7 ± 1.7	20.4 ± 2.1	0.263
Osm (mOsm/kg)	269 ± 5.0	272 ± 3.0	271 ± 4.0	0.004
Hospital length (d)	4.1 ± 0.0	3.6 ± 0.5	4.4 ± 1.2	0.012
Apgar score	N (%)	N (%)	N (%)	
4-6 score	7 (24.1)	5 (16.7)	12 (20.3)	0.476
7< score	22 (75.9)	25 (83.3)	47 (79.7)	

SA = Spinal Anesthesia; GA = General Anesthesia

Blood gas readings of the umbilical artery (UA) show that pH and Ca 2+ levels were lower in the GA group (P<0.001). Further, the osmolarity was significantly different in the two groups (269 ± 5.0 for the SA group vs 272 ± 3.0 for the GA group). The SA group had 4.1 ± 0.0 days of hospitalization, while the GA group had a slightly shorter hospital length (3.6 ± 0.5 days).

Discussion

Cesarean section is a common surgical procedure in obstetrics, accounting for approximately 21% of childbirth. According to statistics by the Center for Health Development Mongolia, the C-section rate has been increasing over the years, reaching 22.4% in 2012 and 27.9% in 2023.[3,4]

Obstetric anesthesia is a type of anesthesiology for pain management, and it is of great importance to the cesarian section. Nowadays, there are two types of anesthesia widely used worldwide for C-sections depending on the individual patient's condition and clinical situation: general and regional anesthesia. Spinal anesthesia is a regional anesthesia where the local anesthetic is injected directly into the cerebrospinal fluid. It has been demonstrated that spinal anesthesia showed increased patient satisfaction, low complication rate, as well as minimal drug risk of maternal toxicity or fetal drug transfer. However, this procedure has some limitations, such as short duration due to its impossibility of the extension of anesthesia and some side effects resulting in the onset of hypotension. On the other hand, general anesthesia offers rapid and reliable onset, control over the airway and ventilation, and potentially less hypotension. General anesthesia is widely provided in situations such as ruptured uterus, severe hemorrhage, severe placental abruption, umbilical cord prolapses, and preterm footling breech. It has been suggested that the choice of anesthesia technique has a significant impact on hemodynamic stability during cesarean section. Numerous studies analyzed the advantages and disadvantages of these two anesthetic methods of cesarean section.[14-17] In an arm-based, random-effects frequentist network meta-analysis by Kim. et al, there were significant differences in Apgar score ≤6 at 1 min between spinal versus general anesthesia (odds ratio 0.27, 95% confidence interval [CI] 0.13 to 0.55: moderate quality evidence) and Apgar scores at 1- and 5-min, favoring spinal anesthesia. Umbilical venous pH associated with epidural anesthesia was significantly higher than general anesthesia (mean difference 0.010, 95% CI 0.001 to 0.020: moderate quality evidence) or spinal anesthesia. Spinal anesthesia was ranked best for Apgar score ≤6 at 1-min (SUCRA=89.8), Apgar score at 1-min (SUCRA=80.4) and 5-min (SUCRA=90.5). Epidural anesthesia was ranked highest for umbilical venous pH (SUCRA=87.4) and neonatal score (SUCRA=79.3). The general anesthesia group was significantly higher in postoperative patient satisfaction than the SE group (P<0.05).[18] On the other hand, as described by Chen. et al, there are. Re no significant differences between the general anesthesia group (n=56) and spinal and epidural anesthesia group (n=56) in total operative time, Apgar score, neonatal asphyxia rate, umbilical arterial and venous cord blood gas values, intraoperative blood loss, and time interval from skin incision to delivery (all P> 0.05). The incidence of nausea, vomiting, and chills in the general anesthesia group was significantly lower than those in the spinal anesthesia group (all P< 0.05).[19] This was consistent with our results, where we did not observe significant differences between the two groups' Apgar scores and neonatal asphyxia rates (all P> 0.05). Also, postoperative nausea, headache, and shivering were significantly higher in our study's SA group than in the GA group (P< 0.05). Further, Afolabi, et al. showed that, compared with GA, women having either an epidural anesthesia or spinal anesthesia had a lower estimated maternal blood loss (epidural versus GA: standardized mean difference (SMD) -0.32 mL; 95% CI -0.56 to -0.07; two trials, 256 women; spinal versus GA anesthesia: SMD -0.59 mL; 95% CI -0.83 to 0.35; two trials, 279 women).[20] However, in our study, there were no significant differences in the time from anesthesia to incision, the operation duration, infused crystalloid volume, blood loss, and urine output.

There are several limitations to this study. Firstly, this study includes a small sample size, which cannot represent all expectant pregnant populations. The small size and short follow-up may cause errors in the results. Secondly, the study had a narrow scope, focusing only on pregnant women from a single center of the capital city of Mongolia, which may limit the applicability of the findings to a broader context or population. Although the research comparing general versus spinal anesthesia is well studied during the C-section, the new era comes between both types of anesthesia, medications, and techniques and needs further research.

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