

Impact of Regional Analgesia Techniques on Hemogram-Derived Inflammatory Indices in Patients Undergoing Cesarean Delivery Under Spinal Anesthesia: A Retrospective Cohort Study

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Abstract

Background: Regional anesthesia and interfascial plane blocks have been suggested to attenuate the perioperative inflammatory response. However, evidence regarding their effects on hemogram-derived inflammatory indices after cesarean delivery remains limited. This study evaluated the effects of different neuraxial anesthesia and postoperative analgesia strategies on early postoperative hematological parameters and inflammatory indices.

Methods: In this retrospective cohort study, 187 women undergoing cesarean delivery under neuraxial anesthesia were evaluated. Patients were grouped according to anesthetic and analgesic technique as spinal anesthesia alone (n=93), spinal anesthesia plus transversalis fascia plane block (TFPB) with dexamethasone (Dex+) (n=39), spinal anesthesia plus TFPB without dexamethasone (Dex-) (n=41), and combined spinal-epidural anesthesia (CSE) (n=14). Hematological parameters and inflammatory indices, including neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and systemic immune-inflammation index (SII), were calculated from preoperative and postoperative 6th-hour complete blood count measurements. Perioperative changes (Δ =preoperative-postoperative) and within-group changes were analyzed.

Results: Preoperative inflammatory indices were comparable among groups (all $p>0.05$). At the postoperative 6th hour, significant between-group differences were observed in WBC, neutrophil, lymphocyte, monocyte, eosinophil, NLR, PLR, and SII values (all $p<0.05$). Post hoc analyses demonstrated that these differences were primarily driven by the TFPB (Dex+) group, which showed significantly higher postoperative NLR, PLR, and SII values than the spinal anesthesia and TFPB (Dex-) groups (all adjusted $p\leq0.002$). Similar findings were observed in the analysis of perioperative changes, where Δ NLR, Δ PLR, and Δ SII differed significantly among groups (all $p<0.001$), with the greatest changes occurring in the TFPB (Dex+) group. Within-group analyses showed significant increases in NLR and SII in all groups (all $p\leq0.007$). In contrast, PLR increased significantly only in the TFPB (Dex+) group ($p<0.001$), while remaining unchanged in the spinal anesthesia, TFPB (Dex-), and CSE groups.

Conclusions: NLR and SII increased during the first six postoperative hours after cesarean delivery regardless of the neuraxial anesthesia or regional analgesia technique used. TFPB without dexamethasone and CSE were associated with inflammatory profiles comparable to spinal anesthesia alone. In contrast, the addition of dexamethasone to TFPB was associated with substantially greater changes in hemogram-derived inflammatory indices. Among the evaluated indices, PLR remained relatively stable in the absence of dexamethasone, suggesting that it may be less affected by early postoperative changes than NLR and SII.

Introduction

Cesarean delivery (CD) is a commonly performed operative procedure in obstetrics that triggers a systemic inflammatory response through both surgical trauma and anesthesia [1]. Although this response is part of normal postoperative healing, an exaggerated inflammatory reaction may be associated with unfavorable maternal and neonatal outcomes [2]. The magnitude of this response may vary according to surgical technique, anesthetic approach, and perioperative medications.

Although surgical practice may vary between centers and surgeons, cesarean delivery has become relatively standardized worldwide, most commonly through a Pfannenstiel incision [3]. In contrast, anesthesia and postoperative analgesia protocols show greater variability. While general and neuraxial anesthesia remain the main anesthetic approaches, postoperative analgesia may include intravenous or oral medications, local infiltration techniques, interfascial plane blocks, and neuraxial analgesic strategies [4]. Therefore, the analgesic plan may represent one of the modifiable components of the postoperative inflammatory response.

Regional anesthesia techniques have been hypothesized to attenuate this response by reducing nociceptive input, surgical stress, opioid requirement, and neuroendocrine activation [5–8]. This effect has been investigated in different surgical populations using interleukins and hemogram-derived inflammatory indices. However, most available data come from non-obstetric surgical settings, and evidence specific to cesarean delivery remains limited [9, 10]. Hemogram-derived markers, including the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), systemic immune-inflammation index (SII), and systemic inflammatory response index (SIRI), are simple and accessible indicators that can be calculated from routine complete blood count parameters [11, 12]. These indices may provide practical information regarding perioperative inflammatory changes after cesarean delivery.

Although several studies have evaluated postoperative changes in hemogram-derived inflammatory indices in relation to surgical stress, pain, and wound healing, data regarding the effects of different perioperative analgesic strategies on these parameters after cesarean delivery remain limited. In this study, we aimed to investigate the effects of different analgesic regimens on hemogram-derived inflammatory indices in women undergoing cesarean delivery under neuraxial anesthesia and to determine which parameters demonstrated significant early postoperative changes compared with baseline values.

Material and Methods

Study design and Ethics

This retrospective cohort study was conducted at Göztepe Medical Park Hospital, Bahçeşehir University Faculty of Medicine, after approval by the Bahçeşehir University Non-Interventional Clinical Research Ethics Committee (Decision No. 2026-13/01, dated 1 July 2026). The study included women who underwent cesarean delivery under neuraxial anesthesia between [start date] and [end date]. Because of the retrospective study design, the requirement for written informed consent was waived by the Ethics Committee. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and is reported in accordance with the STROBE Statement for observational studies.

Patient selection

Patients who underwent elective cesarean delivery under neuraxial anesthesia during the study period were screened retrospectively using the institutional electronic medical record system (COMED®, [manufacturer/city/country if known]).

Patients were included if complete preoperative and postoperative complete blood count data were available. Preoperative complete blood count was defined as the last available blood sample obtained within 24 hours

before surgery. Postoperative complete blood count was defined as the routine blood sample obtained at the 6th hour after completion of surgery. If more than one preoperative complete blood count was available, the sample closest to the time of surgery was used. Patients without either preoperative or postoperative 6th-hour complete blood count data were excluded.

Additional exclusion criteria included preeclampsia, eclampsia, HELLP syndrome, active infection, chronic inflammatory disease, autoimmune disease, hematological disease, malignancy, immunosuppressive treatment, and documented systemic or topical corticosteroid use within the preceding three weeks. Patients who required perioperative corticosteroid administration for clinical indications other than the study analgesic protocol were also excluded. Emergency cesarean deliveries, multiple pregnancies, conversion to general anesthesia, and patients with incomplete perioperative records were excluded from the analysis.

Data Collection

Demographic, obstetric, anesthetic, and laboratory data were retrieved retrospectively from the institutional electronic medical record system. Collected demographic and clinical variables included age, height, weight, body mass index, number of pregnancies, and number of deliveries. Perioperative anesthesia and analgesia records were reviewed to determine the neuraxial anesthesia technique and use of transversalis fascia plane block with or without dexamethasone.

Hematological parameters obtained from complete blood count analyses included white blood cell count, hemoglobin, hematocrit, mean corpuscular volume, platelet count, monocyte count, basophil count, eosinophil count, neutrophil count, lymphocyte count, plateletcrit, mean platelet volume, and platelet distribution width. Preoperative and postoperative inflammatory indices, including neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and systemic immune-inflammation index, were calculated from these parameters.

Perioperative anesthesia, analgesia management, and grouping

All cesarean deliveries were performed under neuraxial anesthesia in the sitting position. Spinal anesthesia was administered at the L3–L4 or L4–L5 intervertebral level using a 26-gauge spinal needle. Hyperbaric bupivacaine 12 mg combined with fentanyl 20 µg was used for intrathecal injection, with minor dose adjustments according to patient height and body weight when considered necessary by the attending anesthesiologist.

Intraoperative and postoperative analgesic management was otherwise standardized among the groups. At the end of surgery, all patients received intravenous paracetamol 1 g and a single dose of a nonsteroidal anti-inflammatory drug. Scheduled postoperative analgesia consisted of repeated paracetamol and nonsteroidal anti-inflammatory drug administration at the postoperative 8th and 12th hours, respectively.

Patients were categorized into four groups according to the neuraxial anesthesia and postoperative regional analgesia technique recorded in the medical records:

1. **Spinal anesthesia group:** patients who received spinal anesthesia alone without additional regional analgesia.
2. **Spinal anesthesia + TFPB (Dex+) group:** patients who received spinal anesthesia combined with bilateral ultrasound-guided transversalis fascia plane block at the end of surgery. In this group, 30 mL of 0.20% bupivacaine plus 4 mg dexamethasone was administered on each side.
3. **Spinal anesthesia + TFPB (Dex-) group:** patients who received spinal anesthesia combined with bilateral ultrasound-guided transversalis fascia plane block at the end of surgery. In this group, 30 mL of 0.20% bupivacaine without dexamethasone was administered on each side.
4. **Combined spinal–epidural anesthesia (CSE) group:** patients who received combined spinal–epidural anesthesia without additional transversalis fascia plane block.

Apart from the neuraxial technique and the use of TFPB with or without dexamethasone, perioperative anesthetic and analgesic management was similar among the groups.

Outcomes

The primary outcomes of the study were postoperative 6th-hour neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and systemic immune-inflammation index (SII) values and their perioperative changes according to anesthesia and analgesia groups. NLR was calculated as the absolute neutrophil count divided by the absolute lymphocyte count, whereas PLR was calculated as the platelet count divided by the absolute lymphocyte count. SII was calculated using the formula $\text{platelet count} \times \text{neutrophil count} / \text{lymphocyte count}$.

Secondary outcomes included preoperative and postoperative complete blood count parameters and changes (Δ values) in hematological and inflammatory indices. Δ values were calculated as preoperative values minus postoperative 6th-hour values.

Statistics

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro–Wilk test together with visual inspection of histograms and Q–Q plots. Since the study had a retrospective design, no a priori sample size calculation was performed, and all eligible patients during the study period were included in the analysis.

Continuous variables were presented as median [interquartile range] and minimum–maximum values. Comparisons among the four study groups were performed using the Kruskal–Wallis test. When a statistically significant overall difference was detected, pairwise post hoc comparisons were performed using Dunn–Bonferroni correction.

Within-group comparisons between preoperative and postoperative 6th-hour values were performed using the Wilcoxon signed-rank test. Changes (Δ values) in hematological parameters and inflammatory indices were

calculated as preoperative values minus postoperative 6th-hour values and compared among the groups using the Kruskal–Wallis test followed by Dunn–Bonferroni post hoc analysis when appropriate.

A two-sided p-value < 0.05 was considered statistically significant. Violin plot visualizations were prepared using the Numiqo online statistical visualization platform.

Results

A total of 187 patients were included in the analysis: 93 in the spinal anesthesia group, 39 in the spinal anesthesia + TFPB (Dex+) group, 41 in the spinal anesthesia + TFPB (Dex–) group, and 14 in the CSE group. Age differed significantly among the groups (Kruskal–Wallis, $p = 0.024$), mainly due to lower age in the spinal anesthesia + TFPB (Dex–) group. The number of pregnancies also differed significantly among the groups ($p = 0.001$), mainly due to a lower number in the spinal anesthesia + TFPB (Dex+) group compared with the Dex– group (adjusted $p < 0.001$). There were no statistically significant differences among the groups in terms of height, weight, body mass index, or number of deliveries (all $p > 0.05$). The demographic and clinical characteristics of the study population are presented in Table 1.

Table 1
Demographic and Clinical Characteristics by Anesthesia Type

Variable	Spinal anesthesia (n = 93)	Spinal + TFPB (Dex+) (n = 39)	Spinal + TFPB (Dex–) (n = 41)	CSE (n = 14)	p-value
Age (years)	32 [29–35]; 19–45	32 [29–35]; 26–41	29 [26–34]; 23–39	31 [29–36.5]; 27–44	0.024
Height (cm)	164 [160–167]; 150–183	164 [159.5–168]; 155–180	164 [161–166]; 157–174	164.5 [162.25–168]; 154–172	0.915
Weight (kg)	72 [67–79]; 51–117	76 [64–84.5]; 50–106	75 [69–80]; 56–98	71 [63.75–79]; 55–92	0.492
BMI (kg/m ²)	27.25 [24.62–29.24]; 18.42–40.77	28.04 [23.6–31.21]; 20.03–37.11	28.01 [26.35–29.03]; 21.88–37.65	26.25 [23.41–28.87]; 21.86–32.21	0.547
Number of pregnancies	1 [1–2]; 1–7	1 [1–1]; 1–3	2 [1–3]; 1–5	1 [1–2]; 1–5	0.001
Number of deliveries	1 [1–1]; 0–3	1 [1–1]; 0–2	1 [1–2]; 0–3	1 [1–1.75]; 1–2	0.101
Values are presented as median [interquartile range] and minimum–maximum. Abbreviations: TFPB: Transversalis Fascia Plane Block, Dex: Dexamethasone, CSE: Combined spinal–epidural anesthesia ,					

Preoperative hematological parameters and inflammatory indices were largely comparable among the groups. No statistically significant differences were observed in WBC, hemoglobin, hematocrit, platelet count, monocyte, basophil, eosinophil, neutrophil, PCT, MPV, PDW, lymphocyte count, NLR, PLR, or SII values (all $p > 0.05$). Only MCV differed significantly among the groups ($p = 0.001$), with lower values observed in the spinal + TFPB (Dex–) group. These findings are presented in Table 2.

Table 2
Preoperative Hematological Parameters by Anesthesia Type

Variable	Spinal (n = 93)	Spinal + TFPB (Dex+) (n = 39)	Spinal + TFPB (Dex-) (n = 41)	CSE (n = 14)	p-value
WBC	9.72 [8.36–11.07]; 6.29–17.28	10.02 [8.02–11.11]; 4.54–13.59	9.76 [8.14–11.12]; 5.46–14.90	9.09 [8.17–11.93]; 6.52–15.20	0.947
Hemoglobin	12.0 [11.2–13.1]; 9.0–14.7	12.4 [11.85–12.9]; 7.8–14.3	11.6 [11.0–12.5]; 9.19–14.2	12.15 [11.65–12.38]; 10.7–13.7	0.083
Hematocrit	36.7 [33.5–39.0]; 28.1–43.6	37.1 [35.6–38.55]; 25.7–42.4	35.4 [33.1–36.9]; 29.0–42.0	36.4 [35.42–37.33]; 33.4–40.3	0.056
MCV	89.6 [87.1–92.5]; 66.1–104.4	88.9 [85.05–92.15]; 77.4–97.5	*84.3 [82.1–90.5]; 31.2–98.8	89.5 [88.53–92.78]; 79.7–96.1	0.001
Platelet	202 [168–271]; 122–487	210 [177.5–251.5]; 142–345	206 [171–263]; 134–402	195.5 [190.25–242.25]; 122–422	0.983
Monocyte	0.66 [0.51–0.80]; 0.38–1.10	0.64 [0.55–0.75]; 0.31–1.16	0.64 [0.57–0.79]; 0.25–1.22	0.66 [0.51–0.76]; 0.33–1.06	0.994
Basophil	0.03 [0.02–0.04]; 0–0.12	0.03 [0.02–0.04]; 0.01–0.07	0.03 [0.02–0.05]; 0.01–0.40	0.04 [0.02–0.05]; 0.01–0.09	0.931
Eosinophil	0.06 [0.04–0.11]; 0–0.48	0.07 [0.04–0.13]; 0.02–0.37	0.06 [0.03–0.13]; 0.01–0.37	0.08 [0.05–0.14]; 0.03–0.20	0.519
Neutrophil	6.99 [5.91–8.24]; 3.56–13.39	7.15 [5.96–8.16]; 2.41–10.40	7.07 [5.72–8.24]; 4.01–10.50	6.34 [5.48–8.82]; 3.77–11.63	0.992
PCT	0.23 [0.19–0.28]; 0.13–1.47	0.23 [0.20–0.26]; 0.16–0.30	0.23 [0.20–0.27]; 0.12–0.37	0.23 [0.21–0.26]; 0.15–0.44	0.971
MPV	10.9 [10.3–11.7]; 9.0–14.8	10.6 [10.0–11.4]; 8.3–13.8	10.8 [10.1–11.6]; 8.8–13.0	10.6 [10.33–11.48]; 10.1–12.7	0.560
PDW	13.1 [11.6–15.0]; 8.9–21.39	12.6 [11.3–14.8]; 9.3–17.5	13.3 [10.95–14.8]; 8.6–19.1	12.75 [11.7–15.9]; 10.8–18.7	0.893
Lymphocyte	1.89 [1.55–2.17]; 0.87–2.95	1.76 [1.50–2.12]; 1.11–2.80	1.76 [1.45–2.09]; 0.94–3.37	2.01 [1.77–2.30]; 1.45–2.88	0.170
NLR	3.92 [3.17–4.67]; 1.57–7.55	3.83 [3.12–4.51]; 1.67–6.33	4.01 [3.16–5.01]; 2.31–7.50	3.32 [2.84–4.15]; 1.81–5.11	0.469
PLR	121.16 [94.91–149.73]; 53.88–238.73	114.36 [91.05–144.62]; 62.22–199.17	118.75 [106.45–149.34]; 42.11–243.64	101.63 [86.70–118.74]; 75.60–181.12	0.358
SII	787.25 [590.68–1089.48]; 254.06–2069.75	798.65 [620.65–934.32]; 445.18–1570.12	854.01 [657.23–1169.72]; 410.73–2441.24	622.23 [492.75–1119.14]; 353.44–1780.37	0.571

Values are presented as median [interquartile range] and minimum–maximum. Abbreviations: TFPB, transversalis fascia plane block; Dex, dexamethasone; CSE, combined spinal–epidural anesthesia; WBC, white blood cell; MCV, mean corpuscular volume; PCT, plateletcrit; MPV, mean platelet volume; PDW, platelet distribution width; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; SII, systemic immune-inflammation index.

At the postoperative 6th hour, platelet count, basophil count, PCT, MPV, and PDW values were comparable among the groups (all $p > 0.05$). In contrast, WBC, hemoglobin, hematocrit, MCV, monocyte, eosinophil, neutrophil, lymphocyte, NLR, PLR, and SII differed significantly among the groups (all $p < 0.05$). Post hoc Dunn–Bonferroni analyses demonstrated that these differences were primarily driven by the spinal anesthesia + TFPB (Dex+) group. Specifically, this group showed higher WBC, neutrophil, NLR, PLR, and SII values compared with the spinal and spinal + TFPB (Dex–) groups (all adjusted $p \leq 0.002$), while lymphocyte, monocyte, and eosinophil counts were significantly lower (all adjusted $p \leq 0.003$). In contrast, comparisons between the spinal, spinal + TFPB (Dex–), and CSE groups did not reveal consistent significant differences. Although MCV differed in the overall analysis ($p = 0.037$), no significant pairwise differences were observed after Bonferroni correction. These findings are presented in Table 3.

Table 3
Postoperative 6th-hour Hematological Parameters by Anesthesia Type

Variable	Spinal (n = 93)	Spinal + TFPB (Dex+) (n = 39)	Spinal + TFPB (Dex-) (n = 41)	CSE (n = 14)	p-value
WBC	13.47 [11.45–15.94]; 8.12–23.14	16.51 [13.36–19.68]; 6.40–26.72	12.14 [9.17–15.34]; 6.58–22.40	13.72 [11.95–14.91]; 8.87–27.25	< 0.001
Hemoglobin	11.1 [10.1–11.9]; 7.7–14.7	11.5 [10.9–12.05]; 9.4–14.0	10.19 [9.4–10.8]; 7.8–12.1	10.7 [10.3–11.63]; 7.5–13.2	< 0.001
Hematocrit	33.0 [30.9–35.5]; 23.4–43.4	34.5 [32.9–36.6]; 28.8–41.6	30.7 [28.6–32.4]; 24.7–35.4	33.25 [31.43–34.55]; 24.1–41.3	< 0.001
MCV	89.9 [87.0–92.3]; 64.5–104.3	88.5 [83.9–90.1]; 79.2–96.2	87.4 [82.1–90.6]; 57.9–97.8	89.85 [88.33–92.68]; 78.0–94.7	0.037
Platelet	188 [156–236]; 91–366	191 [172–232.5]; 122–322	190 [146–228]; 106–387	185 [176.25–220.5]; 95–319	0.525
Monocyte	0.82 [0.66–1.04]; 0.18–1.51	0.44 [0.35–0.56]; 0.20–0.96	0.81 [0.67–1.04]; 0.35–1.41	0.74 [0.65–0.91]; 0.47–1.39	0.031
Basophil	0.03 [0.02–0.04]; 0.01–0.12	0.02 [0.01–0.04]; 0.01–0.10	0.02 [0.02–0.04]; 0.01–0.08	0.03 [0.02–0.04]; 0.01–0.09	0.153
Eosinophil	0.02 [0.01–0.04]; 0–0.60	0.00 [0–0.01]; 0–0.20	0.03 [0.02–0.05]; 0–0.17	0.03 [0.01–0.06]; 0–0.11	< 0.001
Neutrophil	11.07 [9.13–13.08]; 5.41–19.40	14.75 [11.98–18.13]; 4.25–24.68	9.85 [7.48–12.48]; 4.83–18.85	11.01 [9.66–12.44]; 6.17–25.23	< 0.001
PCT	0.21 [0.18–0.25]; 0.10–1.40	0.22 [0.19–0.24]; 0.14–0.34	0.20 [0.16–0.23]; 0.10–0.40	0.20 [0.18–0.24]; 0.12–0.34	0.327
MPV	11.1 [10.3–11.7]; 8.6–14.8	10.7 [10.35–11.3]; 9.2–12.8	10.95 [10.17–11.5]; 8.19–13.4	10.75 [10.43–11.48]; 10.0–13.3	0.633
PDW	13.2 [11.4–15.0]; 8.5–22.9	12.85 [11.75–14.18]; 9.3–17.3	12.85 [11.28–14.15]; 7.6–20.3	12.35 [11.48–14.58]; 10.9–18.5	0.821
Lymphocyte	1.67 [1.37–1.87]; 0.66–2.92	0.90 [0.73–1.17]; 0.24–1.95	1.55 [1.34–1.90]; 0.82–2.99	1.69 [1.38–1.96]; 1.17–2.98	0.021
NLR	7.06 [5.07–8.74]; 2.61–15.08	16.32 [12.41–21.82]; 3.22–47.94	6.57 [5.11–7.96]; 2.98–11.52	6.28 [5.24–7.91]; 3.12–21.56	< 0.001
PLR	114.21 [92.86–153.37]; 52.94–262.82	230.86 [164.66–311.19]; 77.95–795.83	117.27 [97.47–152.94]; 35.45–217.42	105.17 [90.02–134.16]; 69.85–200.85	< 0.001
SII	1240.91 [950.45–1867.75]; 435.73–3495	3477.96 [2462.85–4644.09]; 663.26–8868.67	1162.82 [837.17–1621.15]; 394.35–3228.62	1119.28 [932.65–1505.79]; 551.56–5067.56	< 0.001

Values are presented as median [interquartile range] and minimum–maximum. Abbreviations: TFPB, transversalis fascia plane block; Dex, dexamethasone; CSE, combined spinal–epidural anesthesia; WBC, white

blood cell; MCV, mean corpuscular volume; PCT, plateletcrit; MPV, mean platelet volume; PDW, platelet distribution width; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; SII, systemic immune-inflammation index.

Table 4

Changes in Hematological Parameters From Preoperative to Postoperative 6th Hour by Anesthesia Type

Variable	Spinal anesthesia (n = 93)	Spinal + TFPB (Dex+) (n = 39)	Spinal + TFPB (Dex-) (n = 41)	CSE (n = 14)	p-value
ΔWBC	-4.08 [-5.78--2.48]; -11.39--2.19	-7.10 [-8.75--5.01]; -13.90--0.89	-2.83 [-4.40--1.03]; -8.63--2.57	-3.89 [-5.66--2.19]; -12.05--0.30	< 0.001
ΔHemoglobin	1.00 [0.40--1.52]; -2.20--3.40	0.70 [0.20--1.25]; -2.90--3.40	1.40 [0.80--1.90]; -18.40--3.80	1.00 [0.55--1.95]; -0.80--3.20	0.005
ΔHematocrit	3.00 [0.90--4.90]; -6.30--12.09	2.00 [0.70--3.45]; -8.50--10.70	4.39 [2.40--6.00]; 0.29--11.09	3.25 [1.50--5.93]; -1.00--9.30	0.002
ΔMCV	0.00 [-1.00--0.90]; -10.10--11.90	0.80 [-0.15--1.55]; -4.50--3.60	-0.60 [-2.20--0.80]; -59.90--11.10	0.30 [-0.57--1.20]; -2.50--1.70	0.128
ΔPlatelet	23 [7--38]; -62--157	7 [-5--23]; -43--139	30 [14--42]; -48--77	21.5 [10.25--36]; 0--103	0.004
ΔMonocyte	-0.18 [-0.29--0.09]; -0.70--0.29	0.22 [0.09--0.29]; -0.38--0.57	-0.21 [-0.30--0.06]; -0.95--0.29	-0.17 [-0.25--0.06]; -0.45--0.30	< 0.001
ΔBasophil	0.00 [-0.01--0.01]; -0.08--0.04	0.01 [0.00--0.02]; -0.05--0.04	0.00 [0.00--0.01]; -0.02--0.37	0.00 [0.00--0.02]; -0.01--0.03	0.328
ΔEosinophil	0.04 [0.01--0.07]; -0.48--0.43	0.07 [0.03--0.13]; -0.10--0.37	0.03 [0.01--0.08]; -0.05--0.30	0.06 [0.03--0.10]; -0.02--0.17	0.003
ΔNeutrophil	-4.19 [-6.01--2.33]; -11.87--3.27	-8.44 [-10.32--6.02]; -15.79--1.02	-2.88 [-4.65--1.19]; -9.70--1.90	-3.94 [-6.26--2.60]; -13.60--0.70	< 0.001
ΔPCT	0.03 [0.01--0.05]; -0.06--1.16	0.01 [-0.01--0.03]; -0.04--0.08	0.03 [0.01--0.05]; -0.14--0.09	0.03 [0.02--0.03]; 0--0.10	0.001
ΔMPV	0.00 [-0.30--0.30]; -1.30--2.50	-0.10 [-0.35--0.10]; -2.00--1.20	0.00 [-0.19--0.40]; -12.60--1.10	-0.10 [-0.20--0.00]; -0.80--0.80	0.117
ΔPDW	0.00 [-0.70--0.90]; -3.10--12.20	0.00 [-0.60--0.45]; -1.70--11.20	0.40 [-0.20--1.10]; -20.30--3.20	-0.20 [-0.60--1.00]; -0.90--5.30	0.316
ΔLymphocyte	0.24 [-0.03--0.47]; -0.86--1.06	0.82 [0.67--1.15]; -0.44--1.72	0.21 [0.01--0.40]; -0.89--1.26	0.29 [0.17--0.52]; -0.65--1.11	< 0.001
ΔNLR	-3.32 [-4.58--1.92]; -10.81--3.66	-13.22 [-17.58--8.62]; -43.95--0.76	-2.38 [-3.65--0.80]; -6.22--0.94	-3.24 [-4.02--1.88]; -16.46--0.68	< 0.001

Variable	Spinal anesthesia (n = 93)	Spinal + TFPB (Dex+) (n = 39)	Spinal + TFPB (Dex-) (n = 41)	CSE (n = 14)	p-value
ΔPLR	2.33 [-18.88– 19.55]; -122.29– 65.60	-97.66 [-158.43–-63.34]; -676.23–41.49	6.65 [-15.90– 19.55]; -68.08– 90.32	-5.24 [-25.10– 5.96]; -88.57– 74.07	< 0.001
ΔSII	-444.88 [-792.22–-230.06]; -2294.44–552.33	-2724.37 [-3751.34–-1733.03]; -8247.35–-22.40	-328.50 [-570.84– 13.39]; -1908.47– 429.16	-528.72 [-736.38–-187.17]; -3761.74–651.02	< 0.001

Values are presented as median [interquartile range] and minimum–maximum. p-values were calculated using the Kruskal–Wallis test. Abbreviations: TFPB, transversalis fascia plane block; Dex, dexamethasone; CSE, combined spinal–epidural anesthesia; Δ, preoperative–postoperative change.

Changes (Δ) in hematological parameters were calculated as preoperative values minus postoperative 6th-hour values (Δ = preoperative – postoperative). Changes in hematological parameters differed significantly among the groups for ΔWBC, Δhemoglobin, Δhematocrit, Δplatelet, Δmonocyte, Δeosinophil, Δneutrophil, ΔPCT, Δlymphocyte, ΔNLR, ΔPLR, and ΔSII (all $p \leq 0.005$), whereas no significant differences were observed for ΔMCV, Δbasophil, ΔMPV, and ΔPDW (all $p > 0.05$) (Table 4, Fig. 1).

Post hoc Dunn–Bonferroni analyses demonstrated that these differences were predominantly driven by the spinal anesthesia + TFPB (Dex+) group. Specifically, the Dex+ group showed significantly greater changes in ΔWBC, Δneutrophil, ΔNLR, ΔPLR, and ΔSII compared with all other groups (all adjusted $p < 0.001$). Similarly, Δmonocyte and Δlymphocyte values were significantly higher in the Dex+ group than in the other groups (all adjusted $p \leq 0.001$). In addition, Δeosinophil and Δplatelet also differed significantly, primarily due to differences between the Dex + and Dex– groups (adjusted $p < 0.05$).

In contrast, no consistent significant differences were observed between the spinal, spinal + TFPB (Dex–), and CSE groups across most parameters, indicating that the addition of TFPB without dexamethasone did not significantly alter the magnitude of postoperative hematological changes.

Violin plots showing the distribution of changes (Δ) in inflammatory parameters across anesthesia groups. The spinal anesthesia + TFPB (Dex+) group demonstrates a markedly greater shift across all parameters, whereas the spinal anesthesia, spinal anesthesia + TFPB (Dex–), and CSE groups show largely overlapping distributions. A relatively attenuated shift is observed in the spinal anesthesia + TFPB (Dex–) group, particularly for SII.

To further evaluate the temporal pattern of inflammatory indices, within-group preoperative and postoperative 6th-hour comparisons were performed. NLR increased significantly from the preoperative period to the postoperative 6th hour in all groups (all $p < 0.001$). SII also increased significantly in all groups, including the spinal anesthesia, spinal anesthesia + TFPB (Dex+), spinal anesthesia + TFPB (Dex–), and CSE groups ($p < 0.001$, $p < 0.001$, $p < 0.001$, and $p = 0.007$, respectively). In contrast, PLR increased significantly only in the

spinal anesthesia + TFPB (Dex+) group ($p < 0.001$), while no significant preoperative–postoperative change was observed in the spinal anesthesia, spinal anesthesia + TFPB (Dex–), or CSE groups (Table 5).

Table 5
Within-Group Comparisons of Preoperative and Postoperative Inflammatory Indices

Parameter	Spinal anesthesia	Spinal + TFPB (Dex+)	Spinal + TFPB (Dex–)	CSE
NLR	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$
PLR	$p = 0.905$	$p < 0.001$	$p = 0.322$	$p = 0.358$
SII	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p = 0.007$

P-values were calculated using the Wilcoxon signed-rank test for paired comparisons between preoperative and postoperative 6th-hour measurements within each group. Abbreviations: TFPB, transversalis fascia plane block; Dex, dexamethasone; CSE, combined spinal–epidural anesthesia; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; SII, systemic immune-inflammation index.

Discussion

In this retrospective cohort study, we evaluated perioperative changes in hematological parameters and hemogram-derived inflammatory indices according to different neuraxial anesthesia and postoperative analgesia strategies in women undergoing cesarean delivery. Baseline hematological parameters and inflammatory indices were largely comparable among the study groups, except for MCV. At the postoperative sixth hour, significant between-group differences emerged in several hematological and inflammatory parameters. These differences were mainly driven by the TFPB with dexamethasone group, which showed higher WBC and neutrophil counts, lower lymphocyte, monocyte, and eosinophil counts, and consequently higher NLR, PLR, and SII values than the other groups. A similar pattern was observed in the analysis of perioperative changes, with the greatest shifts in inflammatory indices occurring in the TFPB with dexamethasone group. In contrast, patients receiving spinal anesthesia alone, TFPB without dexamethasone, or CSE showed largely comparable postoperative inflammatory profiles. In within-group analyses, NLR and SII increased significantly from baseline in all groups, whereas PLR increased only in the TFPB with dexamethasone group. Overall, these findings indicate that cesarean delivery was associated with an early postoperative inflammatory response in all groups, that this response was most pronounced when dexamethasone was added to TFPB, and that PLR remained comparatively stable in the absence of dexamethasone.

Our initial assumption was that adding a fascial plane block to spinal anesthesia, or using CSE, might attenuate the early postoperative inflammatory response after cesarean delivery. This assumption was based on the concept that regional analgesia may reduce nociceptive input, surgical stress, opioid requirement, and neuroendocrine activation, and thereby limit the postoperative increase in hemogram-derived inflammatory indices [13, 14]. However, our findings did not support this assumption in the early postoperative period. In the post hoc analyses, patients who received spinal anesthesia alone, spinal anesthesia combined with TFPB without dexamethasone, and CSE showed largely similar postoperative inflammatory profiles. NLR and SII increased in these groups as part of the expected response to surgery and delivery, and the addition of TFPB

without dexamethasone or the use of CSE did not appear to suppress this increase. This finding differs from some reports in other surgical settings, including major orthopedic surgery, where regional analgesia techniques have been associated with a smaller postoperative increase in inflammatory indices [5, 15, 16]. In contrast, when dexamethasone was added to TFPB, the increase in inflammatory indices was more pronounced rather than attenuated. This pattern is most likely related to the early systemic absorption of dexamethasone from the fascial plane and its known hematological effects, particularly neutrophilia and lymphocyte suppression, rather than to a true aggravation of the surgical inflammatory response. Therefore, in the context of cesarean delivery under neuraxial anesthesia, our findings suggest that additional regional analgesic techniques did not measurably blunt the early inflammatory response within the first six postoperative hours, while dexamethasone substantially modified the hemogram-derived indices.

The timing of blood sampling may also be important when interpreting these findings. Many studies evaluating postoperative inflammatory indices have focused on later time points, particularly the first postoperative day or beyond [5, 6, 13]. In contrast, our analysis was based on the sixth postoperative hour, which represents a very early phase of the postoperative response. It is possible that a longer follow-up period might have shown different patterns, including a delayed modulatory effect of fascial plane blocks on inflammatory indices [13, 17]. However, later measurements after cesarean delivery may also be influenced by several additional variables, such as early mobilization, breastfeeding, oral intake, sleep, postoperative pain experience, and differences in subsequent analgesic requirement. In our clinical practice, complete blood count is routinely obtained at the sixth postoperative hour, and this provided a standardized early time point before many of these postoperative factors could substantially influence the inflammatory profile. Therefore, although the sixth-hour measurement may not capture the full evolution of the inflammatory response, it offers a clinically relevant and relatively less confounded early window for evaluating hemogram-derived indices after cesarean delivery [18].

Evidence specifically evaluating the effects of perineural dexamethasone on hemogram-derived inflammatory indices remains limited. In a recent study [19], patients receiving supraclavicular brachial plexus block with or without perineural dexamethasone were compared, and no significant differences in NLR or PLR were observed at the 24th postoperative hour. Although the surgical population, block type, dexamethasone dosing strategy, and patient characteristics differed substantially from those in the present study, the findings are nevertheless interesting when interpreted together. In our cohort, the most pronounced differences were observed at the sixth postoperative hour, whereas the aforementioned study reported similar inflammatory indices at 24 hours. One possible explanation is that the hematological effects of dexamethasone may be more prominent during the early postoperative period and become less apparent over time. However, because our study did not include later measurements, this hypothesis cannot be confirmed. Future studies incorporating serial measurements at multiple postoperative time points may help clarify the temporal effects of perineural dexamethasone on hemogram-derived inflammatory indices.

Hemogram-derived inflammatory indices have been investigated as potential predictors of several postoperative outcomes after cesarean delivery, including surgical site infection, post-dural puncture headache, postoperative pain, and analgesic requirements. Similar approaches have also been reported in other perioperative settings, where indices such as NLR and PLR have been associated with outcomes ranging from recovery characteristics to motor block duration after spinal anesthesia. However, these parameters are

influenced by numerous factors, including obesity, chronic stress, metabolic disorders, and other patient-related variables. Therefore, statistically significant associations should not automatically be interpreted as evidence of a direct causal relationship. Another important consideration is that many of these studies rely on preoperative blood samples or measurements obtained at least 24 hours after surgery. In routine clinical practice, however, an appropriately timed preoperative complete blood count may not always be available. In our cohort, PLR remained largely unchanged during the first six postoperative hours in all groups except those receiving dexamethasone. This observation suggests that, when perioperative analgesic strategies are comparable, early postoperative PLR values may resemble preoperative measurements more closely than NLR or SII. If confirmed by future studies, this finding may provide an opportunity to include patients without standardized preoperative blood sampling in studies evaluating PLR-based associations after cesarean delivery.

This study has some limitations. First, the retrospective and single-center design should be considered when interpreting the findings. Therefore, the results should not be interpreted as showing a direct causal effect of any analgesic technique on postoperative inflammation. Second, hemogram-derived indices were evaluated only at the sixth postoperative hour. This was a standardized and routinely available time point in our clinical practice; however, it does not show how these parameters changed later in the postoperative period. A longer follow-up might have shown whether the effects of fascial plane blocks became more apparent over time or whether the dexamethasone-related changes decreased after the early postoperative period. Third, postoperative pain scores, opioid consumption, mobilization status, breastfeeding time, and other recovery-related variables were not included in the analysis. For this reason, we could not directly evaluate the relationship between analgesic efficacy and inflammatory indices. Fourth, inflammation was assessed only using hemogram-derived parameters. More specific markers such as CRP, IL-6, IL-10, or other cytokines were not measured. Finally, although the marked changes in the dexamethasone group are compatible with the known hematological effects of corticosteroids, serum dexamethasone levels were not measured. Therefore, systemic absorption from the fascial plane could not be directly demonstrated.

Conclusion

In this cohort, the first six postoperative hours after cesarean delivery were associated with clear changes in hemogram-derived inflammatory indices. NLR and SII increased significantly regardless of the anesthesia or analgesia strategy used, whereas PLR remained largely stable except in patients who received dexamethasone-added TFPB. Additional regional analgesic techniques, including TFPB without dexamethasone and CSE, were not associated with meaningful differences in early postoperative hemogram-derived inflammatory indices when compared with spinal anesthesia alone. In contrast, the addition of dexamethasone was associated with substantially greater changes in these parameters. These results should be interpreted as early postoperative findings and may help guide future studies evaluating the timing and clinical use of hemogram-derived indices after cesarean delivery.

Declarations

Ethics approval and consent to participate: This retrospective cohort study was approved by the Bahçeşehir University Non-Interventional Clinical Research Ethics Committee (Decision No. 2026-13/01; approved 1 July

2026). Because of the retrospective study design, the requirement for individual written informed consent was waived by the Ethics Committee. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Consent for publication: Not applicable.

Competing interests: The authors declare that they have no competing interests.

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Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Authors' contributions: ZA and ST conceived and designed the study. ZA, OU, AK and EEA collected the data. IEY contributed to data collection and literature review. SA and IA contributed to anesthesia data collection and interpretation. ST performed the statistical analysis. ZA drafted the manuscript. ST supervised the study. All authors critically revised the manuscript and read and approved the final version.

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Figures

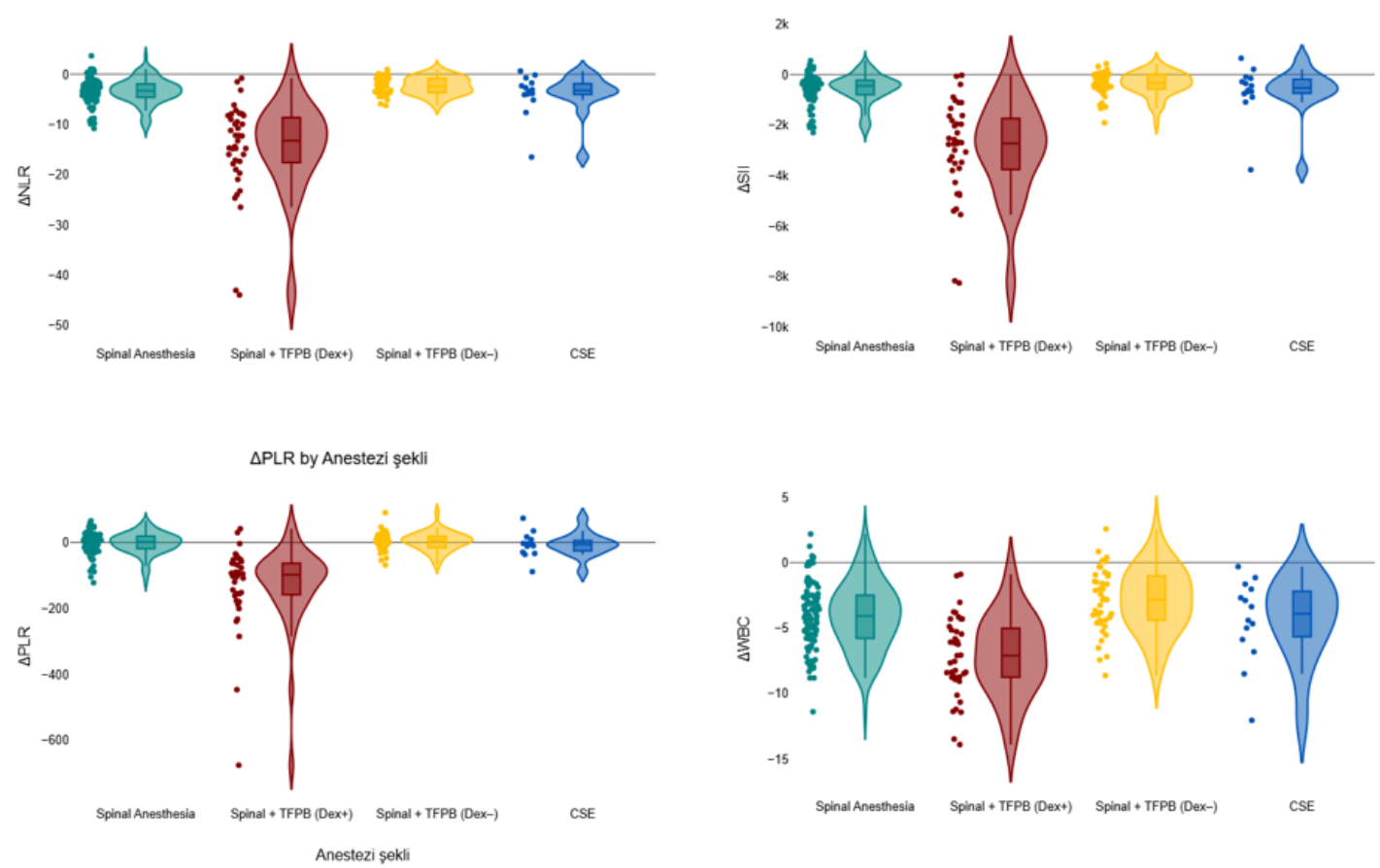


Figure 1

Violin plots showing changes in the platelet-to-lymphocyte ratio (ΔPLR), systemic immune-inflammation index (ΔSI), and white blood cell count (ΔWBC) according to anesthesia technique. Each dot represents an individual patient. The violin plots illustrate the distribution of the data, while the embedded boxplots indicate the median and interquartile range. Δ values represent the difference between preoperative and postoperative measurements.