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Intraperitoneal Hydrocortisone for Postoperative Pain and CRP after Cesarean Section: A Randomized Controlled Trial

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ABSTRACT: **Background**: Postoperative pain and acute surgical peritoneal injury following cesarean section (CS) induce substantial local nociception and systemic inflammatory surges. Intraperitoneal instillation of hydrocortisone—an endogenous mammalian glucocorticoid—exerts anti-inflammatory properties, but its incremental clinical utility within an already optimized modern multimodal analgesia (MMA) regimen remains undefined.

Methods: In a prospective, double-blind, parallel-group, randomized controlled trial (ClinicalTrials.gov Identifier: NCT07892547), 50 parturients undergoing elective CS under spinal anesthesia (12.5 mg hyperbaric bupivacaine 0.5% + 50 μg intrathecal morphine), bilateral ultrasound-guided transversus abdominis plane (TAP) blocks (50 mg levobupivacaine per side), and 1 g intravenous paracetamol were randomized 1:1 using computer-generated permuted blocks with sequentially numbered opaque sealed envelopes. Following uterine repair, subjects received either 100 mg hydrocortisone in 100 mL 0.9% NaCl (Group H, n=25) or 100 mL 0.9% NaCl placebo (Group P, n=25) instilled into the peritoneal cavity. Primary outcome was Visual Analog Scale (VAS) pain intensity at 6, 12, and 24 hours. Secondary outcomes included serum C-reactive protein (CRP) concentrations (baseline, 12h, 24h), dynamic changes (ΔVAS, ΔCRP), rescue fentanyl consumption, and safety parameters.

Results: All 50 randomized subjects completed the 24-hour protocol without dropout. VAS pain scores did not differ significantly between Group H and Group P at 6 hours (3.04±0.98 vs. 3.04±0.20 cm; p=0.324), 12 hours (2.80±0.41 vs. 3.00±0.87 cm; p=0.611), or 24 hours (3.20±0.82 vs. 3.48±1.50 cm; p=1.000). Serum CRP concentrations increased significantly over time in both cohorts (Friedman p<0.001), with no between-group differences at baseline (10.75±11.43 vs. 15.58±38.80 mg/L; p=0.682), 12 hours (20.14±22.74 vs. 22.95±25.67 mg/L; p=0.726), 24 hours (50.71±33.62 vs. 57.76±43.67 mg/L; p=0.900), or in net ΔCRP (39.96±31.28 vs. 42.18±33.21 mg/L; p=1.000). Supplemental fentanyl requirements (24% vs. 28%; p=1.000) and adverse event profiles were equivalent, with 0% pruritus and 0% hyperglycemia. In exploratory correlation analysis, dynamic pain change and inflammatory surge correlated positively in the placebo group (ΔVAS 6→24h vs. ΔCRP 12→24h: Spearman r=+0.465, p=0.019), but this association was uncoupled in the hydrocortisone group (r=-0.173, p=0.408).

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Conclusion: Intraperitoneal hydrocortisone 100 mg provided no incremental analgesic or anti-inflammatory benefit over placebo in parturients receiving comprehensive multimodal analgesia with bilateral TAP block, primarily attributable to an analgesic floor effect. Routine peritoneal corticosteroid instillation is not warranted when baseline regional analgesia is optimized.

1. INTRODUCTION

Cesarean section (CS) is the most widely performed major surgical intervention in contemporary obstetric care worldwide. Beyond somatic disruption of the abdominal wall layers, surgical delivery involves profound mechanical traction and surgical incision of the parietal and visceral peritoneum, eliciting intense visceral nociceptive transmission. This surgical tissue insult activates an immediate acute inflammatory cascade characterized by the synthesis and liberation of prostaglandins, bradykinin, tumor necrosis factor-alpha (TNF-α), and interleukin-6 (IL-6). Severe postoperative pain markedly impairs maternal ambulation, elevates deep vein thrombosis risk, impedes maternal-neonatal bonding, and undermines successful breastfeeding initiation.

Modern Enhanced Recovery After Cesarean (ERAC) pathways highlight multimodal analgesia (MMA) strategies designed to optimize pain relief while strictly minimizing perioperative opioid consumption. Glucocorticoids, particularly endogenous hydrocortisone (cortisol), serve as fundamental physiological hormones modulating immunometabolic balance and inflammatory dysregulation. Pharmacologically, hydrocortisone induces annexin-1 (lipocortin) synthesis, inhibiting phospholipase A2 and downstream cyclooxygenase-2 (COX-2) expression, which reduces tissue prostaglandin E2 and leukotriene synthesis. Furthermore, glucocorticoids transrepress nuclear factor-kappa B (NF-ϰB), directly dampening transcription of pro-inflammatory cytokines such as IL-6 and TNF-α.

Targeted intraperitoneal drug delivery provides substantial theoretical advantages by achieving high local bio-availability across extensively injured peritoneal mesothelial layers with minimal acute systemic exposure. Although intraperitoneal hydrocortisone has exhibited efficacy in laparoscopic gastrointestinal surgeries, its clinical role in open obstetric laparotomy—specifically within an advanced multimodal analgesia platform incorporating neuraxial opioids and bilateral transversus abdominis plane (TAP) blocks—has remained unestablished. Moreover, circulating C-reactive protein (CRP), an acute-phase reactant synthesized in the liver in direct response to systemic IL-6 secretion, represents an objective, reproducible biological marker to track surgical inflammatory magnitude. Hence, this double-blind, randomized controlled trial evaluated whether intraperitoneal hydrocortisone 100 mg reduces pain intensity (VAS) and blunts systemic inflammation (CRP) following elective CS with standardized multimodal analgesia.

2. MATERIALS AND METHODS

2.1 Trial Design and Ethical Oversight

This prospective, randomized, double-blind, placebo-controlled, parallel-group clinical trial (1:1 allocation ratio) was conducted at Dr. Soedirman Kebumen Regional Hospital between May and June 2026. The clinical protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine, Hasanuddin University (Registration No. 790/UN4.6.4.5.31/PP36/2026) and prospectively registered at ClinicalTrials.gov (Identifier: NCT07892547). All investigations adhered strictly to the ethical standards of the Declaration of Helsinki and ICH Good Clinical Practice guidelines. Written informed consent was obtained from all parturients prior to enrollment.

2.2 Participants and Eligibility Criteria

Eligible participants were adult parturients aged 18–40 years with single-term gestations scheduled for elective CS under spinal anesthesia, presenting with American Society of Anesthesiologists (ASA) physical status I or II. Exclusion criteria comprised: known allergy or hypersensitivity to glucocorticoids or local anesthetics; chronic corticosteroid use within the preceding 30 days; pre-gestational or gestational diabetes mellitus requiring medical therapy; pre-existing coagulopathy or ongoing anticoagulant therapy; signs of acute systemic or intra-abdominal infection; conversion to general anesthesia; major intraoperative complications (e.g., massive hemorrhage >1000 mL); and inability to comprehend the Visual Analog Scale (VAS).

2.3 Randomization and Allocation Concealment

Randomization was executed using a computer-generated random permuted block design with alternating block sizes of 4 and 6 to allocate 50 parturients in a 1:1 ratio to either the Hydrocortisone Group (Group H, n=25) or the Placebo Group (Group P, n=25). Allocation concealment was maintained using Sequentially Numbered Opaque Sealed Envelopes (SNOSE) managed by an independent hospital pharmacist who had no contact with study participants and was not involved in clinical care or assessment. The pharmacist prepared the investigational infusions in visually indistinguishable 100 mL normal saline (0.9% NaCl) infusion containers labeled solely with unique subject identification codes. The operating surgeons, scrub nurses, ward staff, attending anesthesiologists, outcome assessors, and patients remained strictly blinded to group assignments throughout the trial.

2.4 Anesthetic Protocol and Multimodal Analgesia

All subjects received standard oral premedication with ranitidine 50 mg and ondansetron 4 mg intravenously 30 minutes pre-procedure. In the operating room, standard non-invasive monitors were established. Spinal anesthesia was performed at the L3–L4 interspace with the patient in the sitting position, utilizing a 27-gauge Whitacre needle to administer 12.5 mg hyperbaric bupivacaine 0.5% combined with 50 μg preservative-free intrathecal morphine. Following infant delivery and umbilical cord clamping, all patients received 1 g intravenous paracetamol infused over 15 minutes.

Following complete delivery of the placenta and anatomical closure of the uterine incision, but immediately prior to closing the parietal peritoneum, the surgeon instilled the concealed 100 mL trial solution evenly throughout the peritoneal cavity (subdiaphragmatic spaces, lateral paracolic gutters, and anterior/posterior uterine surfaces). Group H received 100 mg hydrocortisone sodium succinate dissolved in 100 mL 0.9% NaCl, whereas Group P received 100 mL plain 0.9% NaCl. Immediately after skin closure, ultrasound-guided bilateral transversus abdominis plane (TAP) blocks were administered to every patient by the attending anesthesiologist using a linear ultrasound probe, injecting 20 mL levobupivacaine 0.25% (50 mg) per side between the internal oblique and transversus abdominis fascial layers.

Postoperatively, patients were monitored in the post-anesthesia care unit and obstetrics ward. Supplemental rescue analgesia consisting of intravenous fentanyl 50 μg was administered on demand whenever the VAS pain score was ≥5 cm, with a minimum lockout interval of 15 minutes.

2.5 Blood Sampling and Laboratory Measurements

Venous blood samples (3 mL) were drawn from the antecubital vein at three standardized intervals: baseline (preoperatively, prior to spinal puncture), 12 hours postoperatively, and 24 hours postoperatively. Samples were collected into non-anticoagulant serum-separator tubes, allowed to clot at room temperature for 30 minutes, and centrifuged at 3,000 rpm for 10 minutes. Serum was separated immediately and analyzed by an independent clinical pathology laboratory technician unaware of patient groupings. Quantitative serum CRP determination was performed using particle-enhanced immunoturbidimetry (Cobas c501 analyzer, Roche Diagnostics) with a detection limit of 0.1 mg/L and an upper normal reference threshold of <5.0 mg/L.

2.6 Study Outcomes and Adverse Event Monitoring

The primary clinical outcome was postoperative pain intensity at rest measured on a 10-cm horizontal Visual Analog Scale (VAS: 0 = no pain, 10 = worst imaginable pain) at 6, 12, and 24 hours postoperatively. Secondary outcomes included: serum CRP levels at baseline, 12, and 24 hours; net inflammatory elevation (ΔCRP = CRP 24h – CRP baseline); total rescue fentanyl requests and time to first rescue dose; and perioperative adverse effects. Postoperative nausea and vomiting (PONV) was recorded using a four-point scale. Pruritus, wound infections, and capillary blood glucose concentrations (measured at 6 and 24 hours) were documented. Hyperglycemia was defined a priori as blood glucose >180 mg/dL.

2.7 Statistical Analysis

Sample size was calculated based on detecting a clinically meaningful difference of 2.0 cm on the VAS pain scale with an anticipated standard deviation of 2.5 cm, derived from previous intraperitoneal corticosteroid trials. Assuming a two-tailed alpha of 0.05 and a statistical power of 80% (1-beta), 24.5 subjects per arm were required, which was rounded to 25 patients per group (total N=50).

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Data distribution was assessed for normality using the Shapiro-Wilk test. Continuous demographic and clinical variables were expressed as Mean ± Standard Deviation (SD) or Median [Interquartile Range, IQR]. Between-group comparisons were analyzed using independent sample t-tests for normally distributed continuous data or the Mann-Whitney U test for non-normally distributed data. Effect sizes were computed as rank-biserial correlations (r). Longitudinal repeated measures across time points within each group were analyzed using the non-parametric Friedman test, followed by post-hoc pairwise comparisons via the Wilcoxon signed-rank test. Categorical data were compared using the Chi-square test or Fisher's exact test. Dynamic correlations between change in pain (ΔVAS) and change in systemic inflammation (ΔCRP) were examined using Spearman rank-order correlation. All statistical evaluations were two-tailed, with $p < 0.05$ considered statistically significant, and were conducted using SPSS version 26.0 (IBM Corp., Armonk, NY).

3. RESULTS AND DISCUSSION

3.1 Patient Baseline Demographics and Clinical Characteristics

A total of 50 parturients were enrolled, randomized, and allocated to either Group H (n=25) or Group P (n=25). All 50 participants completed the full 24-hour postoperative evaluation without dropouts, conversion to general anesthesia, or protocol violations. Baseline demographic and surgical characteristics—including maternal age, BMI, gestational duration of surgery, parity, and ASA physical status—were homogeneous between groups (all $p > 0.05$; Table 1).

Table 1. Baseline demographic and clinical characteristics of subjects

Characteristic	**Group H (Hydrocortisone, n=25)**	**Group P (Placebo, n=25)**	**p-value**
Age (years), Median [IQR] (Min–Max)	29.0 [26.0–31.0] (18–40)	29.0 [26.0–37.0] (18–40)	0.496*
Body Mass Index (kg/m²), Mean ± SD (Min–Max)	29.36 ± 6.90 (20.3–44.4)	29.72 ± 4.50 (21.1–39.1)	0.816†
Duration of Surgery (min)**, Median [IQR] (Min–Max)	60.0 [50.0–80.0] (40–120)	75.0 [60.0–80.0] (40–120)	0.249*
Parity, n (%)			0.768‡
- Primipara	10 (40.0%)	8 (32.0%)	
- Multipara	15 (60.0%)	17 (68.0%)	
ASA Physical Status, n (%)			0.470‡
- ASA I	2 (8.0%)	0 (0.0%)	
- ASA II	23 (92.0%)	25 (100.0%)	

***Mann-Whitney U test; †Independent sample t-test; ‡Chi-square / Fisher's exact test. IQR = Interquartile Range**

3.2 Primary Outcome: Postoperative Pain Intensity (VAS)

Postoperative pain intensity scores on the Visual Analog Scale demonstrated no statistically significant differences between Group H and Group P at any measured postoperative interval (Table 2). At 6 hours, mean VAS scores were identical (3.04 ± 0.98 cm in Group H vs. 3.04 ± 0.20 cm in Group P, $p = 0.324$, $r = 0.110$). At 12 hours, VAS was 2.80 ± 0.41 cm vs. 3.00 ± 0.87 cm ($p = 0.611$, $r = 0.064$), and at 24 hours, VAS was 3.20 ± 0.82 cm vs. 3.48 ± 1.50 cm ($p = 1.000$, $r = 0.002$). Longitudinal

repeated-measures evaluation using the Friedman test indicated that pain levels remained remarkably stable across 24 hours in both cohorts (Group H: $\chi^2 = 3.562, p = 0.168$; Group P: $\chi^2 = 0.744, p = 0.689$).

Table 2. Comparison of Visual Analog Scale (VAS) pain scores across time points

Time Interval	Group H (Mean ± SD)	Min–Max	Group P (Mean ± SD)	Min–Max	p-value*	Effect Size (r)
VAS 6 hours	3.04 ± 0.98	2–7	3.04 ± 0.20	3–4	0.324	0.110
VAS 12 hours	2.80 ± 0.41	2–3	3.00 ± 0.87	2–6	0.611	0.064
VAS 24 hours	3.20 ± 0.82	2–5	3.48 ± 1.50	2–7	1.000	0.002
Within-group longitudinal variation	χ^2 = 3.562, p = 0.168†		χ^2 = 0.744, p = 0.689†			

***Between-group Mann-Whitney U test; †Within-group Friedman test. r = rank-biserial correlation.**

3.3 Secondary Outcomes: Serum CRP Kinetics, Rescue Analgesia, and Safety

Preoperative baseline serum CRP concentrations were comparable between Group H and Group P (10.75 ± 11.43 vs. 15.58 ± 38.80 mg/L, p = 0.682, Table 3). Serum CRP concentrations exhibited a marked, progressive increase over time in both cohorts (Friedman test: Group H $\chi^2 = 40.796, p < 0.001$; Group P $\chi^2 = 38.371, p < 0.001$). Post-hoc pairwise Wilcoxon tests confirmed significant elevation from baseline to 12 hours (p = 0.014 in Group H, p = 0.012 in Group P) and from 12 to 24 hours (both p < 0.001). However, between-group comparisons revealed no significant differences in serum CRP concentrations at 12 hours (20.14 ± 22.74 vs. 22.95 ± 25.67 mg/L, p = 0.726) or at 24 hours (50.71 ± 33.62 vs. 57.76 ± 43.67 mg/L, p = 0.900). Similarly, net dynamic elevation (ΔCRP from baseline to 24 hours) did not differ between the hydrocortisone and placebo cohorts (39.96 ± 31.28 vs. 42.18 ± 33.21 mg/L, p = 1.000, r = 0.000).

Table 3. Comparison of serum C-reactive protein (CRP) levels

Parameter	Group H Mean ± SD (Median)	Group P Mean ± SD (Median)	p-value*	Effect Size (r)
Preoperative CRP (mg/L)	10.75 ± 11.43 (5.00)	15.58 ± 38.80 (5.00)	0.682	-0.067
CRP at 12 hours (mg/L)	20.14 ± 22.74 (11.10)	22.95 ± 25.67 (14.20)	0.726	0.059
CRP at 24 hours (mg/L)	50.71 ± 33.62 (47.00)	57.76 ± 43.67 (41.10)	0.900	0.022

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Parameter	Group H Mean ± SD (Median)	Group P Mean ± SD (Median)	p-value*	Effect Size (r)
ΔCRP (Baseline to 24h)	39.96 ± 31.28 (35.10)	42.18 ± 33.21 (34.40)	1.000	0.000
Within-group variation	χ^2 = 40.796, p < 0.001†	χ^2 = 38.371, p < 0.001†		

***Between-group Mann-Whitney U test; †Within-group Friedman test.**

Rescue analgesia demands were remarkably low across both study groups (Table 4). The mean number of supplemental rescue fentanyl doses was 0.24 ± 0.44 in Group H compared to 0.40 ± 0.71 in Group P (p = 0.595). Complete avoidance of rescue analgesia was achieved in 76.0% (19/25) of Group H and 72.0% (18/25) of Group P (p = 1.000). In parturients requiring rescue, the mean time to first analgesic request did not differ significantly (13.33 ± 4.18 vs. 16.43 ± 2.23 hours, p = 0.189).

The safety evaluation demonstrated excellent clinical tolerability (Table 4). The incidence of PONV was 20.0% in Group H versus 36.0% in Group P (p = 0.345). Pruritus was 0% in both cohorts. Capillary random blood glucose levels at 6 hours (84.72 ± 17.09 vs. 77.60 ± 17.64 mg/dL, p = 0.084) and at 24 hours (77.52 ± 16.41 vs. 79.96 ± 19.50 mg/dL, p = 0.704) were entirely within normal limits, with no instances of transient hyperglycemia (>180 mg/dL). No surgical site infections or delayed wound healing complications occurred.

Table 4. Rescue analgesia requirements and safety profile

Parameter	Group H (n=25)	Group P (n=25)	p-value
Rescue Analgesia Frequency (doses), Mean ± SD	0.24 ± 0.44	0.40 ± 0.71	0.595*
Parturients Requiring Zero Rescue, n (%)	19 (76.0%)	18 (72.0%)	1.000†
Time to First Rescue Request (hours), Mean ± SD	13.33 ± 4.18	16.43 ± 2.23	0.189*
Nausea / Vomiting, n (%)	5 (20.0%)	9 (36.0%)	0.345†
Pruritus, n (%)	0 (0.0%)	0 (0.0%)	1.000†
Hyperglycemia (RBG > 180 mg/dL), n (%)	0 (0.0%)	0 (0.0%)	1.000†
RBG at 6 hours (mg/dL), Mean ± SD	84.72 ± 17.09	77.60 ± 17.64	0.084*
RBG at 24 hours (mg/dL), Mean ± SD	77.52 ± 16.41	79.96 ± 19.50	0.704*

***Mann-Whitney U test; †Fisher's exact test. RBG = Random Blood Glucose.**

3.4 Exploratory Correlation Analysis: Pain and Systemic Inflammation

In the overall study cohort (n=50), static Spearman correlation between VAS at 24 hours and serum CRP at 24 hours was weak and non-significant ($r = 0.159$, $p = 0.271$). However, subgroup stratification revealed that within the placebo cohort, a moderate, statistically significant positive correlation existed between VAS at 24 hours and CRP at 24 hours ($r = +0.497$, $p = 0.011$), whereas this correlation was absent in the hydrocortisone group ($r = -0.363$, $p = 0.074$).

Similarly, evaluation of dynamic rates of change demonstrated that in the placebo arm, dynamic pain elevation ΔVAS 6-24 hours) was positively correlated with acute systemic inflammatory surge ΔCRP 12-24 hours; Spearman $r = +0.465$, $p = 0.019$). Conversely, this relationship was uncoupled in the hydrocortisone group ($r = -0.173$, $p = 0.408$). While biologically intriguing, these subgroup findings must be interpreted cautiously as exploratory associations that warrant verification in trials with larger sample sizes.

3.5 Discussion

This randomized, double-blind, placebo-controlled trial demonstrates that the addition of 100 mg intraperitoneal hydrocortisone following uterine closure does not provide significant additional pain relief or attenuate acute systemic inflammatory responses compared with placebo in women undergoing elective cesarean section managed with an optimized multimodal analgesia regimen.

The lack of demonstrable analgesic difference is primarily explained by a pronounced **analgesic floor effect**. In earlier clinical trials evaluating intraperitoneal corticosteroids (e.g., in laparoscopic cholecystectomy), the intervention demonstrated significant pain reduction because patients were treated with single-agent intravenous analgesics or systemic opioids alone, leaving substantial room for local anti-inflammatory analgesia to manifest. In marked contrast, our baseline protocol integrated three synergistic analgesic components: (1) 50 μg intrathecal morphine, providing prolonged central spinal receptor blockade; (2) 1 g intravenous paracetamol, inhibiting central prostaglandin synthesis; and (3) bilateral ultrasound-guided TAP blocks, achieving somatic sensory denervation across the anterior abdominal wall (T7–L1).

Because the dominant somatic component of surgical pain was already interrupted by the bilateral TAP blocks, mean VAS scores across both groups were compressed into a very narrow band of mild pain (~3 cm) throughout the 24-hour observation period, accompanied by narrow standard deviations. Over 70% of parturients in both cohorts required zero supplemental rescue analgesia. When baseline multimodal analgesia achieves such profound pain suppression, an adjunctive local corticosteroid wash encounters an insurmountable ceiling (or floor) of efficacy, preventing the demonstration of any incremental clinical benefit.

Furthermore, intraperitoneal hydrocortisone did not alter systemic CRP kinetics. While topical instillation achieves high local serosal drug concentrations, open cesarean delivery involves extensive tissue trauma, including rectus sheath incision, myometrial division, and substantial vascular shear. These extensive extra-peritoneal surgical injuries trigger massive systemic IL-6 release that stimulates hepatic acute-phase reactant synthesis unhindered by a localized single dose of peritoneal hydrocortisone. Interestingly, while systemic inflammation correlated with pain intensity in the placebo group at 24 hours, this link was detached in the hydrocortisone cohort. This suggests that local hydrocortisone may have blunted local peritoneal hyperalgesia even though numerical VAS scores remained clamped by the multimodal floor effect.

Regarding clinical safety, single-dose intraperitoneal hydrocortisone exhibited an impeccable safety profile. Glucocorticoids administered perioperatively carry theoretical risks of transient hyperglycemia and impaired wound healing. In our cohort, serial blood glucose concentrations remained normal across all patients, and zero instances of surgical site infection, wound dehiscence, or opioid-related pruritus occurred.

Scientific Significance of Neutral Findings: Publication of rigorously designed neutral or negative randomized trials is vital to medical science. In modern obstetric practice, unnecessary polypharmacy escalates healthcare costs and adds needless procedural complexity. Our findings offer clear, evidence-based guidance: in centers where multimodal post-cesarean protocols routinely incorporate neuraxial morphine and regional abdominal wall blocks (such as bilateral TAP blocks), the routine addition of intraperitoneal corticosteroids does not provide measurable clinical benefit and should not be recommended.

Limitations: This investigation was conducted at a single academic medical center with an observation period limited to 24 hours. Consequently, long-term maternal recovery outcomes—such as chronic post-surgical pain or maternal satisfaction at 6

weeks—could not be assessed. Additionally, local peritoneal washings and tissue concentrations of pro-inflammatory cytokines (IL-6, TNF-α) were not measured. Future multicenter investigations may evaluate whether intraperitoneal corticosteroids provide valuable analgesia in resource-constrained environments where ultrasound-guided peripheral regional blocks are unavailable.

4. CONCLUSION

Intraperitoneal administration of hydrocortisone 100 mg following uterine closure did not confer incremental analgesic benefit or attenuate systemic CRP elevation compared to placebo in parturients undergoing elective cesarean section managed with an optimized multimodal analgesia regimen incorporating bilateral TAP blocks. The observed lack of additional efficacy is primarily attributable to an analgesic floor effect. Consequently, routine intraperitoneal corticosteroid instillation is not warranted when comprehensive regional analgesia is utilized.

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AUTHOR CONTRIBUTIONS

Raditsya Mada Gautama: Conceptualization, Methodology, Clinical Investigation, Formal Analysis, Writing—Original Draft.

Charles Wijaya Tan: Conceptualization, Supervision, Formal Analysis, Writing—Review & Editing.

Alamsyah Ambo Ala Husain: Methodology, Supervision, Data Curation, Writing—Review & Editing.

Andi Muhammad Takdir Musba: Clinical Methodology, Resources, Validation, Writing—Review & Editing.

Syafruddin Gaus: Supervision, Project Administration, Writing—Review & Editing.

Madonna Damayanthie Datu: Investigation, Data Verification, Visualization, Writing—Review & Editing.

CONFLICT OF INTEREST

The authors declare that there are no financial, personal, or professional conflicts of interest associated with this study.

ETHICS STATEMENT

This study was performed in accordance with the Declaration of Helsinki and approved by the Health Research Ethics Committee of Hasanuddin University (Approval No. 790/UN4.6.4.5.31/PP36/2026). Written informed consent was obtained from all individual participants prior to enrollment.

DATA AVAILABILITY STATEMENT

The de-identified clinical datasets generated and analyzed during the current study are available from the corresponding author upon reasonable academic request.

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