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PERIOPERATIVE INTRAVENOUS LIDOCAINE INFUSION IN SPINE SURGERY: A RANDOMISED, PROSPECTIVE, DOUBLE-BLIND, PLACEBO-CONTROLLED STUDY

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ABSTRACT

Background: Spine surgery is frequently followed by high-intensity pain and substantial opioid exposure during the first postoperative day. Intravenous lidocaine is being reconsidered as an opioid-sparing adjunct within multimodal analgesia and enhanced recovery pathways, with growing spine-specific evidence [1–6].
Methods: This single-centre, randomised, prospective, double-blind, placebo-controlled study was conducted at Yashoda Hospital, Secunderabad (June 2017 to June 2018). Forty adults (ASA I–II) scheduled for elective spine surgery were randomised to receive either perioperative intravenous lidocaine infusion (2 mg/kg/h; Group I, n=20) or equal-volume 0.9% normal saline (Group II, n=20). General anaesthesia and postoperative rescue analgesia were standardised. Pain was measured using a 0–10 visual analogue scale (VAS) at 0, 1, 2, 4, 8, 12 and 24 hours. Secondary outcomes included intraoperative fentanyl consumption, total fentanyl requirement over 24 hours, number of rescue fentanyl boluses, postoperative nausea and vomiting (PONV) scores, Ramsay sedation scores, patient satisfaction score and adverse events.
Results: Baseline characteristics were comparable between groups. Intraoperative fentanyl requirement was lower in Group I (133.00±22.73 µg) than Group II (232.00±35.33 µg; p=0.00). Total fentanyl requirement over 24 hours was also reduced (208.50±40.68 µg vs 365.00±71.77 µg; p=0.00). VAS scores were lower in Group I at every postoperative time point from 1 to 24 hours (all p<0.001), with similar baseline (0 hour) scores. PONV and sedation scores were lower during the first 12 hours (all p<0.001) and were similar at 24 hours. Group I required fewer rescue boluses (p=0.005) and had a lower (better) satisfaction score (p=0.000). No toxicity symptoms or clinically important haemodynamic events were noted.
Conclusion: Perioperative intravenous lidocaine infusion at 2 mg/kg/h reduced opioid requirement and improved early recovery-relevant outcomes after spine surgery in this cohort, without safety concerns. The results support its role as a practical component of opioid-sparing multimodal and ERAS-aligned perioperative care.

Keywords: *intravenous lidocaine; spine surgery; multimodal analgesia; opioid-sparing; postoperative pain; enhanced recovery.*

INTRODUCTION

Spine surgery is among the elective procedures most consistently associated with moderate to severe postoperative pain. Paraspinal muscle dissection, periosteal irritation, bony work and instrumentation produce sustained nociceptive input, and patients often report both background pain at rest and pronounced movement-evoked pain during turning, coughing and early mobilisation. Inadequate pain control in the first postoperative day can delay mobilisation, reduce participation in physiotherapy, impair sleep and exacerbate anxiety, ultimately lowering patient-reported quality of recovery and satisfaction [1-6].

For decades, opioids have been the default strategy to manage this burden. While opioids remain indispensable for rescue analgesia, relying on them as the primary analgesic has predictable disadvantages: nausea and vomiting, sedation, dizziness, constipation and ileus, urinary retention, pruritus and respiratory depression. In spine surgery, these effects are not mere inconveniences—they can directly oppose the goals of early mobilisation, early oral intake and safe discharge. Moreover, early high-dose opioid exposure may contribute to prolonged use in a subset of patients, especially those with preoperative pain and long symptom durations [7-10].

Accordingly, modern perioperative care is shifting toward multimodal, opioid-sparing analgesia. The principle is to combine agents and techniques with different mechanisms—so the opioid dose can be reduced while maintaining adequate analgesia. Contemporary spine pathways commonly use scheduled paracetamol, selective use of NSAIDs where appropriate, local wound infiltration, and carefully chosen systemic adjuncts such as ketamine or dexmedetomidine in selected patients. Alongside these pharmacologic components, standardised perioperative pathways such as enhanced recovery after surgery (ERAS) incorporate goal-directed fluids, early feeding and structured mobilisation to improve outcomes [1, 5, 7].

Spine-specific ERAS pathways have expanded quickly in recent years. Across spine subspecialities, systematic reviews indicate that ERAS implementation can reduce length of stay and opioid consumption without increasing complications, although the magnitude of benefit varies by procedure type and protocol maturity [8–11]. Within these pathways, opioid-sparing anaesthetic and analgesic components remain an area of active development because they can influence both symptom burden and recovery milestones.

Intravenous lidocaine has re-emerged as a candidate adjunct for this role. Although traditionally viewed as a local anaesthetic and antiarrhythmic agent, lidocaine administered intravenously at sub-anaesthetic concentrations appears to exert analgesic and antihyperalgesic effects that extend beyond peripheral nerve blockade. Proposed mechanisms include attenuation of ectopic neuronal firing, reduction of central sensitisation, and modulation of inflammatory signalling and neuroimmune activation triggered by tissue injury. Recent reviews also describe lidocaine's ability to influence perioperative inflammatory mediators, which may be relevant to spine surgery where muscle trauma and bony manipulation contribute to a measurable inflammatory response [12,13].

Safety is central to its perioperative use. Lidocaine has a narrow therapeutic window, and local anaesthetic systemic toxicity is a recognised risk if dosing is not weight-based, contraindications are overlooked, or concurrent local anaesthetic exposure is not considered. A 2021 international consensus statement recommended protocolised administration, contraindication screening and institutional governance to support safe implementation [1]. In parallel, anaesthesia recommendations for complex spine surgery highlight that adjuncts should be chosen with attention to patient selection, monitoring and recovery goals [2].

Evidence in spine surgery has grown in the last few years. Spine-focused systematic reviews report that intravenous lidocaine can reduce opioid requirement and improve early pain scores, although dosing regimens and infusion durations differ across trials [3,4]. Randomised studies in thoracolumbar and lumbar procedures further suggest improvements in recovery indices, including pain and, in some settings, gastrointestinal recovery [14–16]. Taken together, these data justify further evaluation of perioperative intravenous lidocaine in routine spine practice.
The present randomised, prospective, double-blind, placebo-controlled study was designed to evaluate whether perioperative intravenous lidocaine infusion, used as an adjunct to general anaesthesia in elective spine surgery, improves postoperative pain and opioid consumption in the first 24 hours. Secondary objectives were to assess effects on rescue analgesia, PONV, sedation and patient satisfaction, while monitoring for adverse events.

MATERIALS AND METHODS

STUDY DESIGN AND SETTING

A single-centre, randomised, prospective, double-blind, placebo-controlled study was carried out at Yashoda Hospital, Secunderabad, Telangana, India, from June 2017 to June 2018.

PARTICIPANTS

Adult patients undergoing elective spine surgery under general anaesthesia were screened after written informed consent. Inclusion criteria were age 18–60 years and ASA physical status I or II. Exclusion criteria included known allergy to lidocaine, significant hepatic or renal dysfunction, seizure disorder, clinically significant cardiac conduction abnormality or arrhythmia, pregnancy or lactation, chronic opioid use, and any condition judged by the attending anaesthesiologist to increase risk or confound outcome assessment.

RANDOMISATION AND BLINDING

Participants were randomised in a 1:1 ratio to Group I (lidocaine infusion) or Group II (placebo infusion). Allocation concealment was maintained using sealed envelopes. The infusion was prepared by an anaesthesia provider not involved

in intraoperative management or postoperative assessments. Patients, surgeons, anaesthesiologists, nursing staff and outcome assessors remained blinded to group assignment until analysis.

ANAESTHETIC PROTOCOL

Standard monitoring (ECG, non-invasive blood pressure, pulse oximetry, capnography and temperature) was applied. After preoxygenation, anaesthesia was induced with intravenous fentanyl 2 µg/kg and propofol 2 mg/kg. A bolus of 2% lidocaine 1.5 mg/kg was administered at induction as per the thesis protocol, followed by vecuronium 0.1 mg/kg to facilitate tracheal intubation. Anaesthesia was maintained with oxygen:nitrous oxide (40:60), propofol infusion (150 µg/kg/min), vecuronium infusion (1–2 µg/kg/min) and fentanyl infusion (1 µg/kg/h), titrated to haemodynamic responses. At the end of surgery, neuromuscular blockade was reversed with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg.

STUDY INTERVENTION

After positioning, the blinded study infusion was started using a syringe pump. Group I received 2% lidocaine infusion at 2 mg/kg/h. Group II received an equal volume of 0.9% normal saline. The infusion was continued until discharge from the post-anaesthesia care unit (PACU) or for a maximum of 8 hours, whichever occurred earlier.

POSTOPERATIVE ANALGESIA AND RESCUE PROTOCOL

Pain was assessed using a 0–10 visual analogue scale (VAS). If VAS exceeded 4, rescue fentanyl 50 µg was administered and could be repeated if required. Total fentanyl consumption over the first 24 hours and number of rescue boluses were recorded.

OUTCOMES

Primary outcome was postoperative VAS score measured at 0, 1, 2, 4, 8, 12 and 24 hours. Secondary outcomes were intraoperative fentanyl consumption, total fentanyl requirement over 24 hours, number of rescue fentanyl boluses, PONV score (0=no nausea, 1=nausea, 2=retching, 3=vomiting), Ramsay sedation score, and satisfaction score at discharge. The satisfaction scale used in the thesis rated satisfaction numerically, with lower scores indicating better satisfaction. Adverse events were recorded with specific attention to hypotension, bradycardia, arrhythmias, respiratory depression and symptoms suggestive of local anaesthetic systemic toxicity.

STATISTICAL ANALYSIS

Continuous variables were expressed as mean±SD and compared using independent samples t-test. Categorical variables were compared using chi-square or Fisher's exact test as appropriate. A p value <0.05 was considered statistically significant.

ETHICAL CONSIDERATIONS

The study was conducted after institutional approval and written informed consent from all participants.

RESULTS

PARTICIPANT FLOW AND BASELINE CHARACTERISTICS

Forty patients were randomised (20 per group), and all completed follow-up through 24 hours. Baseline demographic and clinical parameters were similar between groups (Table 1).

Table 1: Baseline demographic and clinical characteristics (n=20 per group)

Variable	Group I (Lidocaine)	Group II (Placebo)	p value
Age (years)	53.40 ± 8.91	55.35 ± 11.82	0.55
Sex (coded)	1.45 ± 0.51	1.50 ± 0.51	0.095
Weight (kg)	66.15 ± 3.20	61.70 ± 8.40	0.17
Height (cm)	161.85 ± 5.32	161.85 ± 5.32	1.00
ASA grade (coded)	1.75 ± 0.44	1.60 ± 0.50	0.32

Note: *Sex and ASA grade were recorded as numerical codes in the thesis dataset; values are summarised as mean ± SD.*

OPIOID REQUIREMENT

Group I required less fentanyl intraoperatively (133.00±22.73 µg) than Group II (232.00±35.33 µg; p=0.00). Total fentanyl requirement over 24 hours was also lower in Group I (208.50±40.68 µg) compared with Group II (365.00±71.77 µg; p=0.00) (Tables 2–3; Figure 1). Group I required fewer rescue boluses (p=0.005) (Table 4).

Table 2: Intraoperative fentanyl consumption

Outcome	Group I (mean ± SD)	Group II (mean ± SD)	p value
Fentanyl (µg)	133.00 ± 22.73	232.00 ± 35.33	0.00

Note: *Totals reflect intraoperative fentanyl requirement.*

Table 3: Total fentanyl requirement in the first 24 hours

Outcome	Group I (mean ± SD)	Group II (mean ± SD)	p value
Total fentanyl (µg)	208.50 ± 40.68	365.00 ± 71.77	0.00

Note: *Includes intraoperative and postoperative fentanyl administered up to 24 hours.*

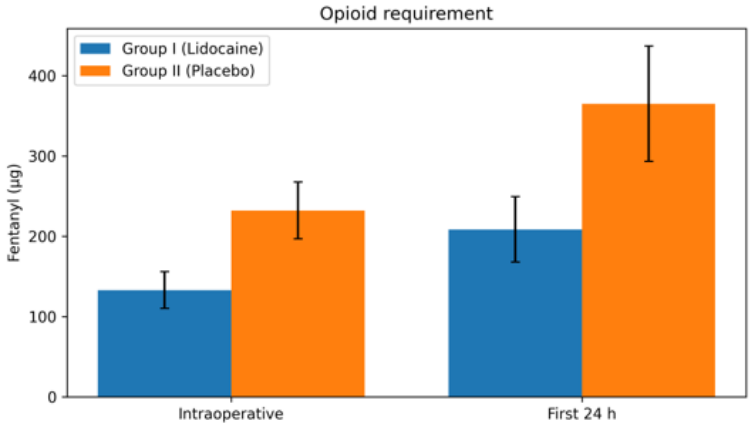

Figure 1: *Intraoperative fentanyl consumption and total fentanyl requirement in the first 24 hours (mean ± SD). Error bars represent SD.*

Table 4: ***Rescue fentanyl boluses during the first 24 hours***

Outcome	Group I (mean ± SD)	Group II (mean ± SD)	p value
Rescue boluses (n)	1.60 ± 0.75	2.42 ± 0.96	0.005

Note: *Rescue fentanyl 50 µg was administered when VAS > 4*

PAIN SCORES

Baseline VAS (0 hour) was comparable between groups (p=4.222). From 1 hour onwards, VAS was lower in Group I at each time point up to 24 hours (all p<0.001) (Table 5; Figure 2).

Table 5: Postoperative pain scores (VAS 0–10) over 24 hours

Time	Group I (mean ± SD)	Group II (mean ± SD)	p value
0 h	2.55 ± 3.75	1.14 ± 0.55	4.222
1 h	2.85 ± 4.10	0.81 ± 0.72	5.154
2 h	3.60 ± 4.15	0.94 ± 0.67	2.129
4 h	2.50 ± 4.05	0.83 ± 0.89	5.715
8 h	2.90 ± 4.95	1.21 ± 1.00	5.845
12 h	2.00 ± 4.35	0.00 ± 0.99	10.636
24 h	1.60 ± 4.10	0.50 ± 0.97	10.251

Note: VAS: 0=no pain and 10=worst imaginable pain.

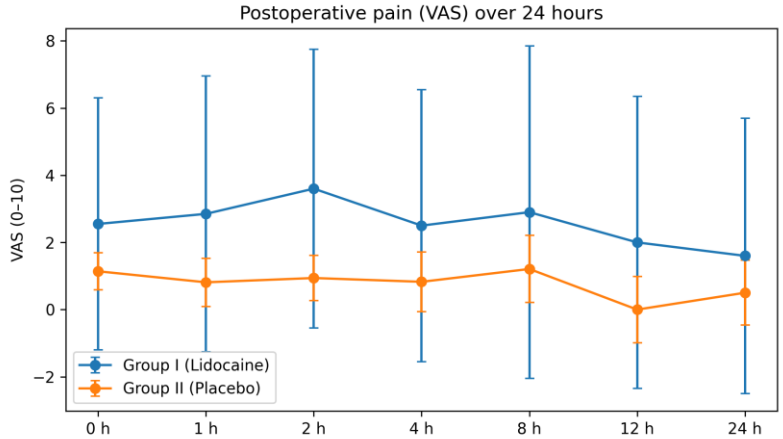

Figure 2: *Postoperative VAS pain scores at 0, 1, 2, 4, 8, 12 and 24 hours (mean ± SD). Error bars represent SD. Exact p values are shown in Table 5.*

PONV and sedation

Baseline PONV and sedation scores (0 hour) were comparable between groups. PONV scores were lower in Group I at 1, 2, 4, 8 and 12 hours (all p<0.001), with no difference at 24 hours (p=2.179) (Table 6; Figure 3). Ramsay sedation scores were lower at 1–12 hours (all p<0.001) and were similar at 24 hours (p=2.629) (Table 7; Figure 4).

Table 6: ***PONV scores (0–3) over 24 hours***

Time	Group I (mean ± SD)	Group II (mean ± SD)	p value
0 h	0.00 ± 0.20	0.00 ± 0.41	2.179
1 h	0.00 ± 0.60	0.00 ± 1.04	2.565
2 h	0.00 ± 1.00	0.00 ± 1.33	3.343
4 h	0.00 ± 0.80	0.00 ± 1.00	3.559
8 h	0.00 ± 0.40	0.00 ± 0.50	3.559
12 h	0.00 ± 0.35	0.00 ± 0.67	2.333
24 h	0.00 ± 0.50	0.00 ± 0.86	2.179

Note: PONV score: 0=no nausea; 1=nausea; 2=retching; 3=vomiting.

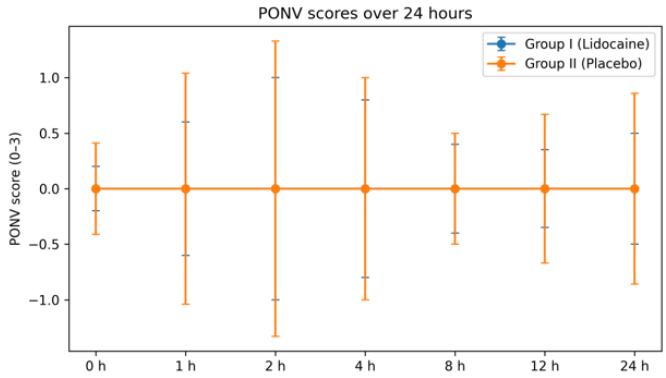

Figure 3: *Postoperative nausea and vomiting scores (mean ± SD) over 24 hours. Error bars represent SD. Group comparisons are in Table 5.*

Table 7: Ramsay sedation scores over 24 hours

Time	Group I (mean ± SD)	Group II (mean ± SD)	p value
0 h	2.25 ± 2.10	0.44 ± 0.71	0.794
1 h	2.05 ± 2.80	0.22 ± 0.41	7.177
2 h	2.00 ± 3.15	0.00 ± 0.74	6.902
4 h	2.00 ± 2.55	0.00 ± 0.68	3.584
8 h	2.00 ± 2.20	0.00 ± 0.61	1.453
12 h	2.00 ± 2.50	0.00 ± 0.60	3.684
24 h	2.00 ± 2.40	0.00 ± 0.68	2.629

Note: *Assessed at standard postoperative time points; lower scores indicate lighter sedation.*

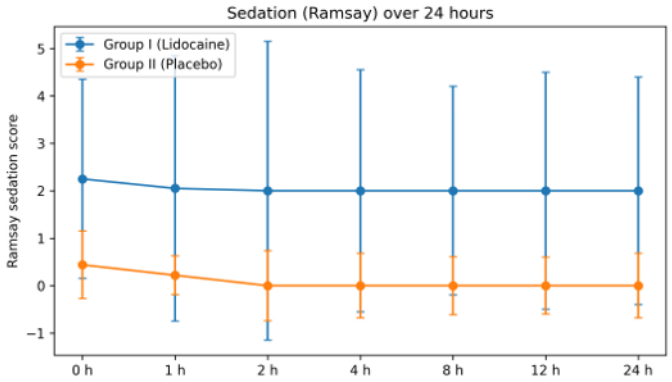

Figure 4: *Ramsay sedation scores (mean ± SD) over 24 hours. Error bars represent SD. Group comparisons are in Table 7.*

SATISFACTION AND SAFETY

Group I had a lower (better) satisfaction score than Group II (1.65±0.74 vs 3.42±1.01; p=0.000) (Table 8; Figure 5). No participant developed symptoms suggestive of local anaesthetic systemic toxicity or clinically significant haemodynamic instability.

Table 8: Patient satisfaction score at discharge

Outcome	Group I (mean ± SD)	Group II (mean ± SD)	p value
Satisfaction score	1.65 ± 0.74	3.42 ± 1.01	0.000

Note: *Lower score indicates better satisfaction as per the thesis satisfaction scale.*

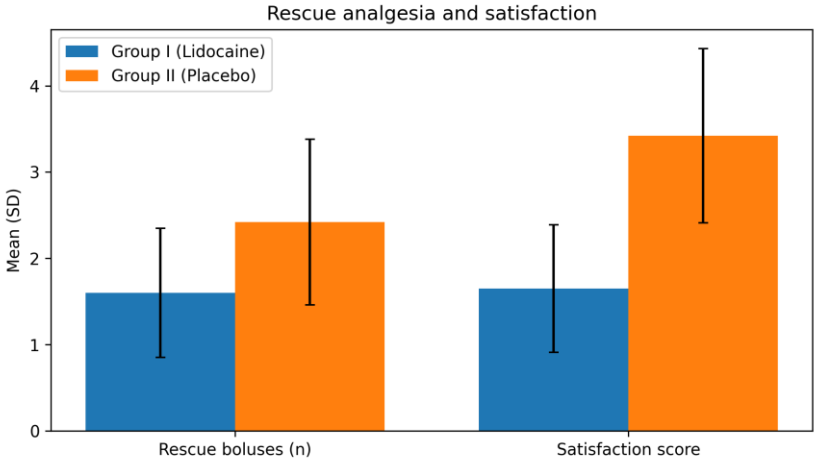

Figure 5: *Rescue fentanyl boluses and satisfaction scores at discharge (mean ± SD). Error bars represent SD.*

DISCUSSION

In this randomised, double-blind study, perioperative intravenous lidocaine infusion was associated with lower opioid requirement and improved postoperative analgesia after elective spine surgery. The reduction in fentanyl consumption was present intraoperatively and persisted across the first postoperative day, and the analgesic advantage was reflected in consistently lower VAS scores from 1 hour onwards. Importantly, improvements were also seen in recovery-relevant endpoints—PONV, sedation and satisfaction—providing converging evidence that the opioid-sparing effect translated into day-one clinical benefit.

The direction and pattern of benefit align with recent spine-focused evidence. Meta-analyses of randomised trials in spine procedures report reduced opioid consumption and lower early pain scores with intravenous lidocaine, although infusion regimens and durations vary and contribute to heterogeneity [3,4]. Our data show a sustained pain advantage over 24 hours, despite the infusion being discontinued within the early postoperative period, which supports the concept of an antihyperalgesic effect rather than a purely short-lived analgesic effect.

Reductions in PONV and lighter early sedation are clinically meaningful. Both outcomes are strongly opioid-linked and are common reasons for delayed mobilisation and delayed oral intake. In modern spine ERAS pathways, opioid minimisation is repeatedly emphasised as a practical route to fewer opioid-related adverse effects and faster functional recovery [8–11]. In the present cohort, PONV and sedation scores were lower through the first 12 hours, which is typically the time window when patients attempt early mobilisation and begin oral intake.

Several mechanisms may explain these findings. Lidocaine's systemic effects appear to involve modulation of central sensitisation and inflammatory signalling, which can reduce postoperative hyperalgesia. Recent meta-analyses suggest that intravenous lidocaine can blunt perioperative inflammatory responses in surgical patients [12], and contemporary reviews propose plausible links between these biological effects and clinically meaningful recovery endpoints [13]. Although inflammatory markers were not measured here, the consistent improvements across pain, opioid requirement and opioid-related symptoms are compatible with this mechanistic framework.

Safety considerations remain non-negotiable. Consensus guidance recommends weight-based dosing, careful patient selection and institutional protocols to minimise the risk of toxicity [1]. No toxicity symptoms or serious haemodynamic events were observed in this cohort, which supports the feasibility of protocolised use in appropriately selected patients. However, the sample size is not adequate to exclude rare adverse events; therefore, implementation should continue to follow consensus recommendations, with clear monitoring and escalation pathways.

This study has limitations. It was conducted at a single centre with a modest sample size, and outcomes beyond 24 hours—such as time to mobilisation, length of stay, and persistent opioid use—were not assessed. The anaesthetic regimen included opioid infusions, and practice may differ across institutions. Nevertheless, the study provides internally consistent benefit across multiple endpoints (pain scores, opioid consumption, rescue boluses, PONV, sedation and satisfaction), which strengthens confidence that the effect is real within this practice context.

Overall, the results support considering intravenous lidocaine infusion as a pragmatic opioid-sparing adjunct in elective spine surgery. As ERAS pathways continue to mature and expand across spine procedures [8–11], interventions that are inexpensive, familiar and standardisable are particularly valuable. Larger multicentre trials and implementation studies should now focus on optimising infusion duration, identifying patient subgroups most likely to benefit, and testing whether these early improvements translate into shorter length of stay and reduced longer-term opioid exposure.

CONCLUSION

Perioperative intravenous lidocaine infusion at 2 mg/kg/h reduced opioid requirement and improved pain and early recovery-relevant outcomes after elective spine surgery in this cohort, without safety concerns. Used with protocolised dosing and appropriate patient selection, intravenous lidocaine can be incorporated into opioid-sparing multimodal analgesia and ERAS-aligned perioperative pathways.

DECLARATION

Conflicts of interests: The authors declare no conflicts of interest.
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