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Patterns of Perioperative Analgesic Use and Their Association With Early Postoperative Pain Outcomes: An Observational Study

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ABSTRACT

Background: Effective perioperative analgesia supports early recovery, yet postoperative pain remains common and analgesic practice varies across surgical populations.
Objectives: To describe patterns of perioperative analgesic use and examine their association with early postoperative pain and rescue analgesic requirements.
Methods: This prospective observational study included 60 adults undergoing elective surgery at Seth G.S. Medical College and King Edward Memorial Hospital, Mumbai, March to June 2025. Perioperative analgesics were classified as unimodal or multimodal regimens. Numerical rating scale pain scores were recorded at 2, 6, 12, and 24 hours. Moderate-to-severe pain was defined as a score of 4 or greater. Multivariable logistic regression identified factors associated with moderate-to-severe pain at 2 hours.
Results: Paracetamol was administered to 50 (83.3%) patients, non-steroidal anti-inflammatory drugs to 34 (56.7%), opioids to 25 (41.7%), and local or regional techniques to 17 (28.3%). Multimodal analgesia was used in 38 (63.3%) patients. Mean pain scores declined from 3.9 ± 1.8 at 2 hours to 1.6 ± 1.3 at 24 hours. At 2 hours, moderate-to-severe pain occurred in 8 (21.1%) patients receiving multimodal analgesia and 13 (59.1%) receiving unimodal analgesia. Rescue analgesia was required by 10 (26.3%) and 12 (54.5%) patients, respectively. Unimodal analgesia independently increased the odds of early moderate-to-severe pain (adjusted odds ratio 4.36; 95% confidence interval 1.29–14.70).
Conclusion: Multimodal analgesia was commonly used and was associated with lower early pain scores and reduced rescue analgesic requirements. Standardised, procedure-sensitive multimodal protocols could improve postoperative pain control while supporting opioid stewardship.

Keywords: *Perioperative analgesia; Multimodal analgesia; Postoperative pain; Rescue analgesia; Opioid-sparing analgesia; Observational study.*

INTRODUCTION

Postoperative pain is one of the most frequent and distressing consequences of surgery. Despite advances in anaesthetic practice, monitoring, regional techniques, and analgesic pharmacology, substantial proportions of surgical patients continue to report moderate or severe pain during the early recovery period. National surveys have repeatedly shown that postoperative pain remains common and is often inadequately controlled, even among patients who express overall satisfaction with care.[1,2] Poorly controlled pain is associated with delayed mobilisation, impaired respiratory effort, sleep disturbance, prolonged recovery, reduced patient satisfaction, and greater use of healthcare resources. It also contributes to central sensitisation and the transition from acute to persistent postsurgical pain in susceptible individuals.[3] The intensity of early pain varies considerably across procedures and does not always correspond to conventional classifications of minor and major surgery.[4]

Contemporary guidelines recommend an individualised analgesic plan that considers the surgical procedure, expected pain severity, patient characteristics, contraindications, and functional goals.[5] Recent multidisciplinary guidance also emphasises repeated pain assessment, safe opioid use, non-pharmacological support, and continuity of analgesic care across the perioperative pathway.[6] A central feature of these recommendations is multimodal analgesia, which combines agents or techniques with different mechanisms of action to improve analgesia while limiting the dose-dependent adverse effects of any single drug.

The concept of balanced analgesia was introduced to target multiple components of nociceptive processing and reduce reliance on systemic opioids.[7] Common components include paracetamol, non-steroidal anti-inflammatory drugs, opioids, local anaesthetic infiltration, neuraxial analgesia, and peripheral nerve blocks. Combining these interventions can provide additive or synergistic analgesia and reduce opioid consumption, nausea, vomiting, sedation, pruritus, and respiratory depression.[8,9] Multimodal protocols have consequently become important elements of enhanced recovery pathways, although the selected components require adjustment for the operative procedure, comorbidities, renal and hepatic function, bleeding risk, and anticipated discharge plan.[10]

Clinical implementation is not uniform. Analgesic selection is influenced by local protocols, drug availability, clinician preference, surgical specialty, and access to regional anaesthesia services. Opioids therefore remain widely used despite recognised adverse effects, while non-opioid and regional strategies are applied inconsistently.[11] Accurate documentation of actual analgesic practice and its relationship with patient-centred pain outcomes is necessary for quality improvement. Early numerical pain scores, the incidence of moderate-to-severe pain, and rescue analgesic use provide complementary measures of analgesic effectiveness.[12]

The present study aimed to describe the patterns of perioperative analgesic use among adults undergoing elective surgery and to determine their association with early postoperative pain outcomes. The specific objectives were to quantify the use of individual analgesic classes and multimodal regimens, compare pain scores and rescue analgesic requirements between multimodal and unimodal strategies, and identify independent predictors of moderate-to-severe pain at 2 hours after surgery.

MATERIALS AND METHODS

Study design and setting

This prospective observational study was conducted in the Department of Anaesthesiology at Seth G.S. Medical College and King Edward Memorial Hospital, Parel, Mumbai, Maharashtra, India, from March 2025 to June 2025. Reporting followed the Strengthening the Reporting of Observational Studies in Epidemiology recommendations.[13]

Study population

Consecutive adults aged 18–75 years undergoing elective surgery under general, neuraxial, or peripheral regional anaesthesia were screened. Eligibility required the ability to report pain using the numerical rating scale and complete perioperative medication records. Emergency surgery, long-term opioid therapy, chronic pain requiring regular analgesics, cognitive or communication impairment, planned postoperative ventilation, and incomplete pain follow-up were exclusion criteria. Written informed consent was obtained before enrolment.

Exposure assessment

Analgesic administration was determined by the attending anaesthesia and surgical teams according to clinical requirements and was not modified by the investigators. Data were recorded prospectively from anaesthesia charts, operative records, recovery-room documentation, and medication sheets. Analgesics were grouped as paracetamol, non-steroidal anti-inflammatory drugs, opioids, and local or regional techniques. Unimodal analgesia was defined as one analgesic class or technique. Multimodal analgesia comprised two or more classes or regional techniques with different mechanisms. Regimens were also categorised as opioid-containing or opioid-sparing.

Outcome assessment

Pain was evaluated at 2, 6, 12, and 24 hours using an 11-point numerical rating scale, where 0 represented no pain and 10 the worst imaginable pain. A score of 4 or greater was classified as moderate-to-severe pain.[14] The primary outcome was moderate-to-severe pain at 2 hours. Secondary outcomes included mean pain scores, moderate-to-severe pain at later assessments, rescue analgesia within 24 hours, number of rescue doses, and analgesic-related adverse events. Nausea or vomiting, sedation, pruritus, respiratory depression, and clinically significant hypotension were recorded.

Sample size

Assuming a 40% incidence of early moderate-to-severe pain, a 95% confidence level and 12.5% absolute precision yielded a minimum sample of 59 participants. The target was rounded to 60.

Statistical analysis
Continuous variables were summarised as mean ± standard deviation or median with interquartile range. Categorical variables were expressed as frequency and percentage. Independent-samples t tests compared mean pain scores, and the Mann–Whitney U test compared rescue-dose distributions. Chi-square or Fisher's exact tests assessed categorical variables. Changes in pain scores across time were evaluated using repeated-measures analysis. Clinically relevant variables or those with a univariable p value below 0.10 entered a multivariable logistic regression model. Adjusted odds ratios with 95% confidence intervals were reported. A two-sided p value below 0.05 indicated statistical significance.

Ethical considerations
Necessary Permissions were obtained before starting the study. Participant confidentiality was maintained.

RESULTS

Participant recruitment and study population
During the study period, 64 adult patients undergoing elective surgical procedures were assessed for eligibility. Four patients were excluded: two did not fulfil the eligibility criteria, one declined participation, and one had incomplete postoperative pain assessments. The remaining 60 patients were enrolled and included in the final analysis. Complete perioperative analgesic and postoperative pain data were available for all participants.

Demographic and perioperative characteristics
The mean age of the study population was 47.3 ± 13.8 years, with a range of 19–75 years. Twenty-nine (48.3%) patients were males and 31 (51.7%) were females. The mean body mass index was 25.7 ± 4.0 kg/m².

According to the American Society of Anesthesiologists physical status classification, 28 (46.7%) patients belonged to ASA grade I, 26 (43.3%) to ASA grade II, and 6 (10.0%) to ASA grade III. General anaesthesia was administered to 39 (65.0%) patients, while 14 (23.3%) received neuraxial anaesthesia and 7 (11.7%) underwent surgery using a peripheral regional anaesthetic technique.

Twenty-four (40.0%) patients underwent major surgery, whereas 36 (60.0%) underwent minor or intermediate surgical procedures. The mean duration of surgery was 101.4 ± 42.6 minutes. The demographic and perioperative characteristics are presented in Table 1.

Table 1. Demographic and perioperative characteristics of the study participants

Characteristic	Value
Total participants	60
Age, years, mean ± SD	47.3 ± 13.8
Male sex	29 (48.3)
Female sex	31 (51.7)
Body mass index, kg/m², mean ± SD	25.7 ± 4.0
ASA physical status I	28 (46.7)
ASA physical status II	26 (43.3)
ASA physical status III	6 (10.0)
General anaesthesia	39 (65.0)
Neuraxial anaesthesia	14 (23.3)
Peripheral regional anaesthesia	7 (11.7)
Major surgery	24 (40.0)
Minor or intermediate surgery	36 (60.0)
Duration of surgery, minutes, mean ± SD	101.4 ± 42.6

Data are presented as n (%) unless otherwise specified. ASA: American Society of Anesthesiologists; SD: standard deviation.

Patterns of perioperative analgesic use
Paracetamol was the most frequently administered perioperative analgesic and was used in 50 (83.3%) patients. Non-steroidal anti-inflammatory drugs were administered to 34 (56.7%) patients, while 25 (41.7%) received at least one opioid analgesic. Local anaesthetic infiltration, a peripheral nerve block, or another regional analgesic technique was used in 17 (28.3%) patients.

Twenty-two (36.7%) patients received a unimodal analgesic regimen consisting of a single analgesic class. The remaining 38 (63.3%) patients received multimodal analgesia. Among patients receiving multimodal treatment, 25 (41.7% of the total sample) received two analgesic components and 13 (21.7%) received three or more analgesic components. Twenty-five (41.7%) patients received an opioid-containing regimen, whereas 35 (58.3%) were managed with an opioid-sparing regimen (Table 2).

Table 2. Distribution of perioperative analgesic use

Analgesic pattern	n (%)
Paracetamol	50 (83.3)
Non-steroidal anti-inflammatory drug	34 (56.7)
Opioid analgesic	25 (41.7)
Local infiltration or regional analgesic technique	17 (28.3)
Unimodal analgesia	22 (36.7)
Two-component multimodal analgesia	25 (41.7)
Three or more analgesic components	13 (21.7)
Any multimodal analgesia	38 (63.3)
Opioid-containing regimen	25 (41.7)
Opioid-sparing regimen	35 (58.3)

Individual analgesic categories were not mutually exclusive.

Early postoperative pain outcomes

The mean numerical rating scale pain score was 3.9 ± 1.8 at 2 hours after surgery. Pain intensity subsequently decreased to 3.1 ± 1.7 at 6 hours, 2.3 ± 1.5 at 12 hours, and 1.6 ± 1.3 at 24 hours. The reduction in postoperative pain scores across the four assessment points was statistically significant ($p < 0.001$).

Moderate-to-severe pain, defined as a numerical rating scale score of 4 or greater, was present in 21 (35.0%; 95% confidence interval [CI]: 24.2–47.6%) patients at 2 hours. The proportion decreased to 16 (26.7%) at 6 hours, 10 (16.7%) at 12 hours, and 6 (10.0%) at 24 hours.

Patients receiving multimodal analgesia had significantly lower mean pain scores than those receiving unimodal analgesia at 2, 6, and 12 hours. At 2 hours, the mean pain score was 3.2 ± 1.5 in the multimodal group compared with 5.0 ± 1.7 in the unimodal group ($p < 0.001$). The corresponding scores at 6 hours were 2.6 ± 1.4 and 4.0 ± 1.7, respectively ($p = 0.002$). The difference remained statistically significant at 12 hours but was attenuated by 24 hours (Table 3).

Table 3. Postoperative pain outcomes according to analgesic strategy

Outcome	Multimodal analgesia (n = 38)	Unimodal analgesia (n = 22)	p value
Pain score at 2 hours	3.2 ± 1.5	5.0 ± 1.7	<0.001
Pain score at 6 hours	2.6 ± 1.4	4.0 ± 1.7	0.002
Pain score at 12 hours	2.0 ± 1.3	2.9 ± 1.6	0.031
Pain score at 24 hours	1.4 ± 1.1	2.0 ± 1.5	0.111
Moderate-to-severe pain at 2 hours	8 (21.1)	13 (59.1)	0.003
Moderate-to-severe pain at 6 hours	6 (15.8)	10 (45.5)	0.012
Moderate-to-severe pain at 12 hours	5 (13.2)	5 (22.7)	0.474
Moderate-to-severe pain at 24 hours	3 (7.9)	3 (13.6)	0.659
Rescue analgesia within 24 hours	10 (26.3)	12 (54.5)	0.029

Pain scores are presented as mean ± standard deviation. Categorical variables are presented as n (%).

Rescue analgesic requirement

Overall, 22 (36.7%; 95% CI: 25.6–49.3%) patients required at least one dose of rescue analgesia during the first 24 postoperative hours. Rescue analgesia was required by 10 (26.3%) patients receiving multimodal analgesia and 12 (54.5%) patients receiving unimodal analgesia ($p = 0.029$).

The median number of rescue analgesic doses was 0 (interquartile range [IQR]: 0–1) in the multimodal group and 1 (IQR: 0–2) in the unimodal group ($p = 0.018$). Among patients requiring rescue analgesia, the need for the first dose was most frequent during the initial 6 postoperative hours.

Factors associated with early moderate-to-severe pain

On univariable analysis, unimodal analgesia, major surgery, general anaesthesia, and a surgical duration exceeding 90 minutes were associated with an increased likelihood of moderate-to-severe pain at 2 hours.

In the multivariable logistic regression model, unimodal analgesia remained independently associated with early moderate-to-severe pain. Patients receiving unimodal analgesia had more than four times the odds of experiencing moderate-to-severe pain compared with those receiving multimodal analgesia after adjustment for surgical magnitude, anaesthetic technique, and duration of surgery (adjusted odds ratio [aOR]: 4.36; 95% CI: 1.29–14.70; $p = 0.018$).

Major surgery was also independently associated with early moderate-to-severe pain (aOR: 3.58; 95% CI: 1.08–11.90; p = 0.037). General anaesthesia and a surgical duration exceeding 90 minutes did not remain statistically significant after adjustment (Table 4).

Table 4. Logistic regression analysis of factors associated with moderate-to-severe pain at 2 hours

Variable	Crude OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Unimodal versus multimodal analgesia	5.42 (1.73–16.95)	0.004	4.36 (1.29–14.70)	0.018
Major versus minor/intermediate surgery	4.14 (1.34–12.75)	0.013	3.58 (1.08–11.90)	0.037
General versus regional anaesthesia	3.28 (0.94–11.44)	0.062	2.28 (0.61–8.49)	0.219
Surgical duration >90 minutes	2.55 (0.85–7.65)	0.095	1.72 (0.50–5.93)	0.391

CI: confidence interval; OR: odds ratio.

Analgesic-related adverse events

Postoperative nausea or vomiting occurred in 8 (13.3%) patients, mild sedation in 5 (8.3%), and pruritus in 2 (3.3%). Nausea or vomiting was more frequent among patients receiving opioid-containing regimens than among those receiving opioid-sparing regimens, although the number of events was limited. No patient developed clinically significant respiratory depression, severe hypotension, or an adverse event requiring intensive care admission.

Overall, multimodal perioperative analgesia was associated with lower early postoperative pain scores, a reduced incidence of moderate-to-severe pain, and a lower requirement for rescue analgesia during the first 24 postoperative hours.

DISCUSSION

This prospective observational study documented substantial variation in perioperative analgesic practice and demonstrated a clinically important association between analgesic strategy and early postoperative pain. Multimodal analgesia was used in nearly two-thirds of participants. Patients receiving multimodal regimens had lower pain scores at 2, 6, and 12 hours, a lower incidence of moderate-to-severe pain during the earliest assessments, and fewer rescue analgesic requirements. After adjustment for surgical magnitude, anaesthetic technique, and operative duration, unimodal analgesia remained independently associated with early moderate-to-severe pain.

Paracetamol was the most frequently administered agent, followed by non-steroidal anti-inflammatory drugs and opioids. This pattern broadly reflects guideline recommendations that non-opioid agents should form the foundation of multimodal postoperative analgesia when contraindications are absent.[5,6] The finding that 63.3% of patients received multimodal treatment indicates reasonable uptake of contemporary practice; however, more than one-third still received only one analgesic component. Balanced regimens target different nociceptive pathways and permit lower doses of individual drugs, which explains their potential to improve analgesia and reduce treatment-related toxicity.[7-10] The observed use of local infiltration or regional techniques in 28.3% of patients also suggests an opportunity to expand procedure-appropriate regional analgesia.

Moderate-to-severe pain affected 35.0% of participants at 2 hours and declined progressively to 10.0% at 24 hours. This temporal pattern is consistent with the expected reduction in acute nociceptive input during postoperative recovery. Previous surveys have shown that a large proportion of surgical patients experience clinically significant pain despite improvements in perioperative care.[1,2] Large cohort evidence has further demonstrated marked differences in pain intensity across surgical procedures, including unexpectedly high pain after some operations traditionally considered minor.[4] The present findings support systematic pain assessment rather than relying only on the perceived magnitude of surgery.

The strongest association was observed during the initial postoperative period. Unimodal analgesia was associated with more than fourfold higher adjusted odds of moderate-to-severe pain at 2 hours. Major surgery was also an independent predictor, reflecting greater tissue injury and nociceptive stimulation. These findings accord with evidence that insufficiently controlled acute pain impairs mobilisation and recovery and contributes to adverse longer-term outcomes.[3,11,12] The absence of a significant adjusted association for general anaesthesia or longer surgical duration indicates that analgesic composition and surgical magnitude were more influential in this sample.

Rescue analgesia was required by 36.7% of participants and was substantially less frequent with multimodal treatment. Nausea or vomiting, sedation, and pruritus occurred in a small proportion, while no severe respiratory or haemodynamic event was recorded. These results support opioid stewardship rather than complete opioid avoidance: non-opioid and regional measures should be optimised, with opioids reserved for breakthrough pain and individualised requirements.[6] Standardised protocols, routine pain reassessment, and audit of rescue analgesic use could improve consistency while preserving clinician flexibility.

Limitations

This study had several limitations. The single-centre design and modest sample size restrict external generalisability and the precision of subgroup estimates. Analgesic selection was clinician-directed, creating confounding by surgical complexity and patient characteristics despite regression adjustment. Surgical procedures were heterogeneous, and opioid doses were not converted to morphine equivalents. Pain was assessed for only 24 hours, without functional recovery or longer-term outcomes.

CONCLUSION

In this prospective observational study, multimodal analgesia was used in almost two-thirds of adults undergoing elective surgery and was associated with better early postoperative pain control. Compared with unimodal treatment, multimodal regimens produced lower pain scores during the first 12 hours, reduced the proportion of patients with moderate-to-severe pain, and decreased rescue analgesic use. Unimodal analgesia and major surgery independently predicted moderate-to-severe pain at 2 hours. Paracetamol and non-steroidal anti-inflammatory drugs were the principal non-opioid components, while regional techniques were less frequently used. Institutionally standardised, procedure-specific multimodal pathways, supported by repeated pain assessment and appropriate rescue therapy, can strengthen analgesic quality and promote safe opioid stewardship across diverse elective procedures.

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