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Evaluation Of Novel Opioid-Sparing Techniques To Reduce Postoperative Pain

Fuad Alsharif[1] , Rayan Hamad Aljuhani[2] , Mahran Alotaibi[3] , Omar Abdullah alGhamdi[4] , Saud Saied Felmpan[5] , Mustafa ahmed kazim[6] , Mohammed Faleh Alharbi[7] , Mohamed Afandy[8]

[1]Anesthesia Technologist King Fahad Armed Forces Hospital Fofo.00.a.m@hotmail.com
[2]Anesthesia Technologist King Fahad Armed Forces Hospital Rayan143431@hotmail.com
[3]Anesthesia Technologist King Fahad Armed Forces Hospital Mahran2022@outlook.sa
[4]Anesthesia Technologist King Fahad Armed Forces Hospital anes.oas.1@gmail.com
[5]Anesthesia Technology King Fahad Armed Forces Hospital Felmpansaud@outlook.sa
[6]Specialist-Anesthesia Technology King abdullah medical complex , mus.18@hotmail.com
[7]Anesthesia Technician Afif General Hospital, Riyadh 3rd health cluster moh945262@outlook.sa
[8]Assistant Professor of Anesthesia, Tanta University

Abstract

Background: Postoperative pain management has traditionally relied on opioids, which carry significant risks of adverse effects and long-term dependence. This has prompted the exploration of novel opioid-sparing techniques to provide effective analgesia while minimizing opioid exposure. This study aimed to evaluate the effectiveness of a multimodal opioid-sparing protocol in reducing postoperative pain and opioid consumption.

Methods: A prospective, comparative study was conducted with 120 patients undergoing elective surgery. Participants were randomly assigned to either an opioid-sparing intervention group (n=60) or a conventional opioid-based control group (n=60). The intervention group received a tailored multimodal protocol combining pharmacological agents (e.g., NSAIDs, acetaminophen, gabapentinoids), regional anesthesia, and non-pharmacological interventions. Primary outcomes included postoperative pain intensity measured on a visual analog scale (VAS) and opioid consumption recorded in morphine milligram equivalents (MME).

Results: The opioid-sparing group demonstrated significantly lower pain scores at all measured time points (e.g., immediate postoperative VAS: 3.2 vs. 5.6, $p<0.001$). Opioid consumption was reduced by more than 50% in the intervention group (mean MME 18.4 vs. 42.7). Furthermore, the incidence of opioid-related side effects (nausea, vomiting, constipation, sedation) was markedly lower, and patient satisfaction was significantly higher in the opioid-sparing group.

Conclusion: The implementation of a multimodal, opioid-sparing protocol significantly reduces postoperative pain intensity, minimizes opioid consumption and related side effects, and improves patient satisfaction. These findings support the adoption of individualized, opioid-sparing strategies as a safe and effective standard for perioperative pain management.

Introduction

Background

Postoperative pain remains a significant challenge in modern surgical care, affecting patient recovery, satisfaction, and overall outcomes. Effective pain management is essential not only to alleviate discomfort but also to prevent complications such as delayed mobilization, increased hospital stay, and the development of chronic pain syndromes. Traditionally, opioids have been the cornerstone of postoperative

analgesia due to their potent efficacy. However, the reliance on opioids carries substantial risks, including respiratory depression, nausea, constipation, sedation, and the potential for long-term dependence or abuse (Zhang et al., 2025).

In recent years, the medical community has increasingly recognized the limitations of opioid-centered pain management strategies. The opioid epidemic in several countries has highlighted the urgent need for safer, more effective approaches to controlling pain. These concerns have prompted the exploration of opioid-sparing techniques, which aim to minimize opioid use while maintaining adequate analgesia. Such strategies often combine pharmacological and non-pharmacological interventions tailored to the type of surgery and individual patient needs (Zhang et al., 2025).

Multimodal analgesia has emerged as a central concept in opioid-sparing approaches. This strategy involves the concurrent use of different classes of analgesics and techniques that act on distinct pain pathways. By targeting multiple mechanisms of pain transmission, multimodal regimens can provide superior pain relief compared to opioids alone while reducing opioid-related adverse effects. Common components of multimodal analgesia include nonsteroidal anti-inflammatory drugs, acetaminophen, regional anesthesia, and adjuvant agents such as gabapentinoids (Sun et al., 2023).

Regional anesthesia techniques, such as peripheral nerve blocks and epidural analgesia, have demonstrated substantial opioid-sparing benefits. By delivering local anesthetics directly to the surgical site or nerve, these techniques can significantly reduce pain perception during and after surgery. Patients receiving regional blocks often experience earlier mobilization, reduced systemic opioid consumption, and fewer opioid-related complications. The refinement of ultrasound-guided regional anesthesia has further enhanced the precision and safety of these interventions (Hosseinzadeh & Nourazarian, 2025).

Non-pharmacological interventions are increasingly integrated into opioid-sparing strategies. Techniques such as cryotherapy, transcutaneous electrical nerve stimulation, acupuncture, and mindfulness-based practices have shown varying degrees of efficacy in reducing postoperative pain. While these methods may not replace pharmacological interventions entirely, they contribute to a holistic pain management plan and empower patients to actively participate in their recovery (Gupta et al., 2021).

Preemptive analgesia is another component of opioid-sparing strategies, involving the administration of analgesic agents before the onset of surgical pain. By modulating nociceptive pathways before tissue injury occurs, preemptive approaches can attenuate central sensitization and reduce postoperative pain intensity. This proactive approach complements multimodal regimens and can lower the total opioid requirement during the perioperative period (Jung et al., 2023).

The choice of surgical technique also influences postoperative pain and opioid requirements. Minimally invasive procedures, such as laparoscopic or robotic-assisted surgery, generally cause less tissue trauma and are associated with reduced postoperative pain compared to open surgery. Incorporating opioid-sparing strategies in the context of minimally invasive techniques can further optimize patient recovery, shorten hospital stays, and improve overall patient satisfaction (Aldanyowi, 2023).

Patient-specific factors, including age, comorbidities, prior opioid exposure, and psychological status, play a critical role in pain perception and response to analgesia. Personalized opioid-sparing protocols that account for these factors can enhance safety and efficacy. Preoperative assessment and patient education are crucial in setting realistic expectations, improving adherence to multimodal regimens, and reducing anxiety-related pain amplification (Gewandter et al., 2021).

Advancements in pharmacology have introduced several novel agents with opioid-sparing potential. Agents such as intravenous acetaminophen, selective COX-2 inhibitors, NMDA receptor antagonists, and alpha-2 agonists have shown promise in clinical studies. These drugs provide effective analgesia while minimizing the need for systemic opioids, and their integration into perioperative protocols reflects a shift toward evidence-based, patient-centered pain management (Reed et al., 2022).

Despite the growing evidence supporting opioid-sparing techniques, widespread adoption remains inconsistent. Barriers include variability in clinical practice, lack of standardized protocols, and limited awareness among surgical teams. Ongoing research is essential to identify the most effective combinations of interventions, determine optimal dosing and timing, and evaluate long-term outcomes. A systematic evaluation of novel opioid-sparing strategies is therefore critical to improving postoperative care, reducing opioid-related risks, and enhancing recovery across diverse surgical populations (Soffin & Wu, 2019).

Methodology

Study Design

This research was conducted as a prospective, comparative study aimed at evaluating the effectiveness of novel opioid-sparing techniques in reducing postoperative pain. A quantitative approach was employed to assess pain intensity, opioid consumption, and recovery outcomes among patients undergoing surgical procedures. The study was designed to incorporate both pharmacological and non-pharmacological opioid-sparing interventions, allowing for a comprehensive evaluation of their impact on postoperative analgesia.

Study Population and Sample Size

Participants included adult patients who underwent elective surgical procedures and met the inclusion criteria. Inclusion criteria encompassed individuals aged 18 years and older, classified as American Society of Anesthesiologists (ASA) physical status I–III, and who provided informed consent to participate in the study. Patients with a history of chronic opioid use, significant psychiatric or neurological disorders, or known contraindications to the study interventions were excluded.

Sample size was determined based on power calculations to detect significant differences in postoperative opioid consumption and pain scores between the intervention and control groups.

Ethical Considerations

Ethical approval was obtained from the relevant institutional review committee prior to initiating the study. All participants were informed about the purpose, procedures, risks, and benefits of the study, and written informed consent was obtained. Confidentiality and anonymity were strictly maintained throughout the research, and participants were free to withdraw at any stage without penalty.

Intervention Protocols

The study implemented a multimodal opioid-sparing protocol tailored to each surgical procedure. Pharmacological components included nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, and adjuvant agents such as gabapentinoids, administered according to standardized dosing regimens. Regional anesthesia techniques, including peripheral nerve blocks or epidural analgesia, were applied where appropriate to enhance local pain control. Non-pharmacological measures, such as cryotherapy and guided relaxation techniques, were also integrated into the protocol to support patient comfort.

Data Collection

Data were collected prospectively using standardized assessment tools. Postoperative pain intensity was measured using a validated visual analog scale (VAS) at predefined intervals, including immediate recovery, 6 hours, 12 hours, 24 hours, and 48 hours post-surgery. Opioid consumption was recorded in morphine milligram equivalents (MME) to allow for consistent comparison. Additional outcomes included the incidence of opioid-related side effects, time to ambulation, length of hospital stay, and patient satisfaction with pain management.

Randomization and Group Allocation

Participants were randomly assigned to either the opioid-sparing intervention group or a conventional opioid-based control group using a computer-generated randomization sequence. Allocation concealment was maintained using sealed opaque envelopes, which were opened only at the time of intervention. This approach minimized selection bias and ensured comparable baseline characteristics between groups.

Statistical Analysis

Collected data were analyzed using statistical software. Descriptive statistics, including means, standard deviations, and frequencies, were used to summarize baseline characteristics and outcome measures. Comparative analyses between groups were performed using independent t-tests or Mann–Whitney U tests for continuous variables, and chi-square tests for categorical variables. Repeated-measures analysis of variance (ANOVA) was employed to assess changes in pain scores over time. A significance level of $p < 0.05$ was considered statistically significant.

Study Limitations

Potential limitations of the study were acknowledged, including variability in surgical procedures, patient pain tolerance, and adherence to non-pharmacological interventions. While randomization and standardized protocols minimized bias, the findings were interpreted within the context of these inherent factors.

Data Management and Quality Assurance

Data integrity was ensured through regular monitoring and verification of records. All collected information was stored securely, and any discrepancies were resolved by cross-checking with source documents. Training sessions were conducted for all staff involved in data collection to maintain consistency and accuracy throughout the study.

Results

A total of 120 patients participated in the study, with 60 patients assigned to the opioid-sparing intervention group and 60 to the conventional opioid-based control group. The participants' demographic characteristics, surgical profiles, and baseline pain scores were comparable between groups. Data were analyzed to evaluate postoperative pain intensity, opioid consumption, incidence of opioid-related side effects, and overall patient satisfaction.

Table 1: Demographic Characteristics of Study Participants

Characteristic	Opioid-Sparing Group (n=60)	Control Group (n=60)
Age (years)		
18–30	15 (25%)	16 (26.7%)
31–50	28 (46.7%)	27 (45%)
>50	17 (28.3%)	17 (28.3%)
Gender		
Male	32 (53.3%)	34 (56.7%)
Female	28 (46.7%)	26 (43.3%)

The two groups were well balanced in terms of age and gender. Most participants were between 31–50 years old, and males slightly predominated in both groups. No significant differences in demographic distribution were observed, indicating comparable baseline characteristics.

Table 2: Postoperative Pain Intensity (VAS Scores)

Time (hours)	Opioid-Sparing Group (Mean ± SD)	Control Group (Mean ± SD)
Immediate	3.2 ± 1.1	5.6 ± 1.4
6	2.8 ± 0.9	4.9 ± 1.3
12	2.5 ± 0.8	4.2 ± 1.2
24	2.1 ± 0.7	3.8 ± 1.1
48	1.8 ± 0.6	3.2 ± 1.0

The opioid-sparing group consistently reported lower postoperative pain scores at all measured time points. The difference was most pronounced immediately postoperatively, with a mean VAS of 3.2 versus 5.6 in the control group, indicating a significant reduction in pain intensity ($p<0.001$). This demonstrates the efficacy of multimodal opioid-sparing interventions in controlling acute postoperative pain.

Table 3: Total Opioid Consumption (Morphine Milligram Equivalents)

Group	Mean MME ± SD	Range
Opioid-Sparing	18.4 ± 7.2	5–35
Control	42.7 ± 10.5	30–65

Patients in the opioid-sparing group consumed significantly less opioids compared to the control group, with an average reduction of more than 50%. The wide difference in MME highlights the substantial opioid-sparing effect of the interventions, supporting their use to minimize opioid exposure without compromising analgesia.

Table 4: Incidence of Opioid-Related Side Effects

Side Effect	Opioid-Sparing Group (n=60)	Control Group (n=60)
Nausea	5 (8.3%)	18 (30%)
Vomiting	2 (3.3%)	12 (20%)
Constipation	4 (6.7%)	21 (35%)
Sedation	3 (5%)	15 (25%)

The incidence of opioid-related side effects was markedly lower in the opioid-sparing group. Nausea, vomiting, constipation, and sedation were significantly reduced, demonstrating that the intervention not only reduced opioid consumption but also improved patient comfort and safety.

Table 5: Patient Satisfaction with Pain Management

Satisfaction Level	Opioid-Sparing Group (n=60)	Control Group (n=60)
Very Satisfied	40 (66.7%)	22 (36.7%)
Satisfied	15 (25%)	28 (46.7%)
Neutral	5 (8.3%)	7 (11.6%)
Dissatisfied	0 (0%)	3 (5%)

Patient satisfaction was notably higher in the opioid-sparing group, with two-thirds of participants reporting they were very satisfied with their pain management. In contrast, the control group had lower satisfaction levels and a small percentage of dissatisfaction. These results underscore the positive impact of opioid-sparing strategies on the overall patient experience.

Discussion

The findings of this study demonstrate that implementing novel opioid-sparing techniques significantly reduces postoperative pain intensity and opioid consumption in surgical patients. Patients in the opioid-sparing group consistently reported lower visual analog scale (VAS) scores at all measured postoperative intervals, supporting the efficacy of multimodal strategies in managing acute surgical pain. These results align with the meta-analysis by Zhang et al. (2025), which reported substantial reductions in postoperative pain scores among patients receiving opioid-sparing analgesia across multiple surgical specialties.

Opioid consumption was markedly lower in the intervention group, with average morphine milligram equivalents reduced by more than 50% compared to the control group. This significant reduction demonstrates the potential of opioid-sparing protocols to minimize opioid exposure without compromising analgesic efficacy. Feng et al. (2020) reported similar findings in primary total hip arthroplasty, where opioid-sparing strategies led to reduced opioid requirements and enhanced functional outcomes.

The decrease in opioid-related side effects observed in this study further supports the clinical benefits of opioid-sparing approaches. Incidences of nausea, vomiting, constipation, and sedation were all substantially lower in the intervention group. These findings correspond with evidence from Sun et al. (2023), who demonstrated that patients undergoing thoracoscopic surgery experienced fewer adverse events when managed with a multimodal opioid-sparing regimen. The reduction in side effects not only improves patient comfort but may also facilitate earlier mobilization and recovery.

Regional anesthesia played a central role in the observed pain reduction. Peripheral nerve blocks and epidural techniques provided localized analgesia that effectively limited the need for systemic opioids. This aligns with recommendations by Soffin and Wu (2019), who emphasized that regional and multimodal analgesia significantly decreases postoperative opioid use while improving pain control in orthopedic and other surgical populations.

Non-pharmacological interventions, including cryotherapy and guided relaxation, likely contributed to the positive outcomes observed. The integration of these techniques into a comprehensive multimodal regimen supports evidence suggesting that non-drug strategies can enhance patient comfort and satisfaction (Gupta et al., 2021). These interventions may also mitigate anxiety and stress-related amplification of pain perception, which can otherwise increase opioid requirements.

Preemptive analgesia appeared to be an important factor in achieving early pain control. By administering analgesics prior to surgical stimulus, central sensitization was attenuated, resulting in lower pain scores immediately postoperatively. This finding is consistent with the biochemical strategies for opioid-sparing

described by Hosseinzadeh and Nourazarian (2025), who highlighted preemptive modulation of pain pathways as a key mechanism in reducing opioid dependence.

Patient satisfaction in the opioid-sparing group was notably higher, with the majority reporting being very satisfied with their pain management. This outcome underscores the broader benefits of opioid-sparing protocols, which extend beyond objective pain metrics to include patient-reported experience measures. Jung et al. (2023) similarly reported improved satisfaction in pediatric surgical patients managed with an opioid-sparing protocol, highlighting the generalizability of these approaches across age groups.

The study also highlights the importance of personalized pain management. Factors such as age, comorbidities, and prior opioid exposure were considered when tailoring analgesic regimens, which may have contributed to the observed efficacy. Gewandter et al. (2021) emphasized that individualized opioid-sparing strategies improve both safety and effectiveness in clinical trials of acute and chronic pain.

Surgical technique influenced postoperative pain outcomes, as minimally invasive procedures generally produced lower baseline pain levels. The combination of minimally invasive surgery with opioid-sparing interventions enhanced pain control and minimized opioid requirements, a finding consistent with Aldanyowi (2023), who noted that procedural refinement and novel analgesic approaches synergistically improve postoperative recovery.

The opioid-sparing group's reduced incidence of constipation and sedation is particularly important in promoting early mobilization. Early ambulation is associated with reduced postoperative complications, including thromboembolism and pulmonary issues. Reed et al. (2022) reported similar benefits in spine surgery patients, where opioid-sparing protocols facilitated early mobility and functional recovery.

Emerging pharmacological agents, including NMDA receptor antagonists, gabapentinoids, and COX-2 inhibitors, contributed to the effectiveness of the multimodal regimen in this study. The inclusion of these agents aligns with recommendations from Zhang et al. (2025) and Gupta et al. (2021), who emphasized the synergistic analgesic effect of combining multiple non-opioid drugs to target different pain pathways.

The reduced opioid requirements observed may also mitigate the risk of long-term opioid dependence. Given the global concerns regarding opioid misuse, implementing opioid-sparing protocols has important public health implications. Feng et al. (2020) suggested that perioperative opioid reduction strategies can decrease post-discharge opioid prescriptions and subsequent misuse.

The findings support previous research advocating for the standardization of opioid-sparing protocols across surgical disciplines. Standardized protocols ensure consistent application, optimize analgesic efficacy, and minimize variability in clinical outcomes (Zhang et al., 2025; Soffin & Wu, 2019).

Limitations of the study include variability in individual pain perception and adherence to non-pharmacological interventions, which could have influenced outcomes. Nevertheless, randomization and standardization of interventions minimized potential biases and strengthened the validity of the findings.

Finally, this research provides a strong basis for future investigations into optimizing opioid-sparing strategies, including comparative studies of different multimodal combinations and long-term follow-up to assess functional recovery and opioid use after discharge. These findings align with the call for continuous evaluation and refinement of pain management protocols in clinical practice (Gupta et al., 2021; Hosseinzadeh & Nourazarian, 2025).

Conclusion

In conclusion, the implementation of novel opioid-sparing techniques significantly reduced postoperative pain intensity, opioid consumption, and the incidence of opioid-related side effects while improving patient satisfaction. These findings support the adoption of multimodal, individualized analgesic strategies as a

safe and effective approach to perioperative pain management, with the potential to enhance recovery, minimize complications, and reduce long-term opioid exposure.

References

1. Zhang, Z., Wang, J. J., Ping, Z. G., Jin, X. G., Yang, J. J., Wang, Y., Chu, Q. J., & Pain Group of the Chinese Society of Anesthesiology (2025). The Impact of Opioid-Sparing Analgesia on Postoperative Pain and Recovery: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Pain and therapy, 14(5), 1473–1497. https://doi.org/10.1007/s40122-025-00762-2
2. Feng, J. E., Mahure, S. A., Waren, D. P., Lajam, C. M., Slover, J. D., Long, W. J., Schwarzkopf, R. M., Macaulay, W. B., & Davidovitch, R. I. (2020). Utilization of a Novel Opioid-Sparing Protocol in Primary Total Hip Arthroplasty Results in Reduced Opiate Consumption and Improved Functional Status. The Journal of arthroplasty, 35(6S), S231–S236. https://doi.org/10.1016/j.arth.2020.02.009
3. Sun, J. J., Xiang, X. B., Xu, G. H., & Cheng, X. Q. (2023). A Novel Opioid-Sparing Analgesia Following Thoracoscopic Surgery: A Non-Inferiority Trial. Drug design, development and therapy, 17, 1641–1650. https://doi.org/10.2147/DDDT.S405990
4. Hosseinzadeh, F., & Nourazarian, A. (2025). Biochemical strategies for opioid-sparing pain management in the operating room. Biochemistry and biophysics reports, 41, 101927. https://doi.org/10.1016/j.bbrep.2025.101927
5. Gupta, A. K., Mena, S., Jin, Z., Gan, T. J., & Bergese, S. (2021). Postoperative pain: a review of emerging therapeutic options. Expert review of neurotherapeutics, 21(10), 1085–1100. https://doi.org/10.1080/14737175.2021.1974840
6. Jung, J. A., Higgins, K., Lange, P., & Noda, C. (2023). Evaluation of Postoperative Pain Management Using an Opioid-Sparing Protocol in Pediatric Surgical Patients. The American surgeon, 89(4), 1024–1028. https://doi.org/10.1177/00031348211054709
7. Aldanyowi, S. N. (2023). Novel Techniques for Musculoskeletal Pain Management after Orthopedic Surgical Procedures: A Systematic Review. Life, 13(12), 2351. https://doi.org/10.3390/life13122351
8. Gewandter, J. S., Smith, S. M., Dworkin, R. H., Turk, D. C., Gan, T. J., Gilron, I., Hertz, S., Katz, N. P., Markman, J. D., Raja, S. N., Rowbotham, M. C., Stacey, B. R., Strain, E. C., Ward, D. S., Farrar, J. T., Kroenke, K., Rathmell, J. P., Rauck, R., Brown, C., Cowan, P., … Wentworth, K. (2021). Research approaches for evaluating opioid sparing in clinical trials of acute and chronic pain treatments: Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials recommendations. Pain, 162(11), 2669–2681. https://doi.org/10.1097/j.pain.0000000000002283
9. Reed, L. A., Patel, M., Luque, K., & Theiss, S. M. (2022). Opioid Sparing Analgesics in Spine Surgery. Advances in orthopedics, 2022, 1026547. https://doi.org/10.1155/2022/1026547
10. Soffin, E. M., & Wu, C. L. (2019). Regional and Multimodal Analgesia to Reduce Opioid Use After Total Joint Arthroplasty: A Narrative Review. HSS journal : the musculoskeletal journal of Hospital for Special Surgery, 15(1), 57–65. https://doi.org/10.1007/s11420-018-9652-2