

Current Concepts

Reducing Postoperative Opioid Use in Orthopaedics: A Review of Multimodal Analgesia Strategies, Patient Outcomes, and Implementation into Practice

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The opioid crisis has underscored the urgent need for safer, more effective postoperative pain management strategies in orthopaedic surgery. Traditionally, opioids have played a central role in post-surgical analgesia. Still, emerging evidence supports the use of multimodal analgesia (MMA) protocols to reduce and possibly eliminate opioid dependence while maintaining effective pain control. This review focuses exclusively on opioid-sparing strategies in orthopaedic procedures, drawing from randomized controlled trials, retrospective case series, and meta-analyses. Across upper extremity surgery, joint arthroplasty, and ambulatory procedures, MMA has consistently demonstrated reduced opioid consumption, equivalent or improved pain scores, and enhanced functional recovery. Integration with Enhanced Recovery After Surgery (ERAS) pathways has further standardized MMA as best practice. With proper implementation, routine opioid use in postoperative orthopaedic care can be minimized, mitigating risks of chronic use, including dependence, among other adverse effects. This review suggests that opioid-sparing protocols should be the standard of care in orthopaedics, with opioids serving only as a rescue medication for breakthrough pain when absolutely necessary.

INTRODUCTION

The opioid epidemic remains one of the most pressing public health crises in the United States. Between 1999 and 2021, nearly 645,000 people died from overdoses involving opioids, with prescription opioids contributing significantly to this toll.¹ Orthopaedic surgeons have historically ranked among the highest prescribers of opioids across all medical specialties.² Notably, they are responsible for approximately 7.7% of all opioid prescriptions, the third highest in the United States, behind only family medicine and internal medicine practitioners.²⁻⁴ Following orthopaedic procedures, particularly in outpatient settings, patients are frequently discharged with opioid prescriptions that exceed their analgesic needs, contributing to diversion, misuse, and long-term dependence.⁵ Studies have shown upwards of 6-10% of opioid-naïve patients continued using 6 months after surgery. These findings indicate perioperative opioid prescription is a significant factor leading to new

chronic opioid dependence.^{6,7} Furthermore, research has shown that approximately 20-70% of all opioid tablets go unused, providing a significant supply available for misuse, diversion, and distribution.^{8,9} In addition to possible addiction and diversion, opioids carry an extensive side effect profile, including sedation, postoperative ileus, respiratory depression, nausea, and delirium.^{10,11}

In response to this growing concern, there has been a paradigm shift toward safer, more individualized postoperative pain management strategies. Multimodal analgesia (MMA) has emerged as a key approach that targets multiple pain pathways using a combination of pharmacologic and regional techniques.¹² This strategy seeks to reduce reliance on opioids while providing effective analgesia through the use of various components of MMA, including pharmacologic agents and regional techniques.¹³ By leveraging the additive or synergistic effects of these agents, MMA reduces opioid consumption and minimizes associated side effects such as nausea, constipation, sedation, and respiratory depression.¹⁴

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The implementation of MMA has been further standardized through Enhanced Recovery After Surgery (ERAS) pathways, which are multimodal perioperative care protocols designed to reduce surgical stress, shorten hospital stays, and promote faster recovery.¹⁵ Within orthopaedic surgery, ERAS programs have demonstrated success in integrating opioid-sparing strategies without compromising pain control.¹⁶ In total joint arthroplasty and spine surgery, ERAS protocols incorporating scheduled non-opioid medications, early mobilization, patient education, and regional anesthesia have yielded reduced opioid requirements, shorter lengths of stay, and improved patient satisfaction.¹⁷ Despite this progress, variation in implementation across practices persists, and widespread adoption remains an ongoing challenge.

This review examines the evidence supporting multimodal analgesia and opioid-sparing protocols in orthopaedic surgery. We summarize clinical outcomes across common procedures such as hand surgery and total joint arthroplasty, discuss implementation strategies within the ERAS framework, and highlight opportunities for reducing unnecessary postoperative opioid use.

PRINCIPLES OF MULTIMODAL ANALGESIA IN ORTHOPAEDICS

Multimodal analgesia (MMA) refers to the concurrent use of multiple analgesic agents and techniques that act via different mechanisms to control pain and reduce opioid consumption.¹⁸ This approach is built on the concept that synergistic modes of analgesia will provide adequate pain control, while minimizing the adverse effects associated with any single medication class, particularly opioids.¹⁹ In orthopaedic surgery, MMA protocols have become a central component of Enhanced Recovery After Surgery (ERAS) pathways and are increasingly recommended in procedure-specific guidelines.¹⁵

MMA regimens typically include a series of non-opioid medications operating by various mechanisms of action. These include:

- **Acetaminophen:** Provides central analgesia with a favorable safety profile when dosed appropriately; reduces perioperative opioid requirements.²⁰
- **Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) / COX-2 (Cyclooxygenase-2) inhibitors (e.g., Celecoxib):** Provide analgesic and anti-inflammatory effects, yet their use in orthopaedics remains debated.²¹ Recent studies have demonstrated increased risk of nonunion, hardware failure, and pseudoarthrosis in patients exposed to NSAIDs undergoing spinal fusion.^{22,23} These findings have raised concerns about NSAID effects on bone healing and in the context of spinal fusion.
- **Gabapentinoids (gabapentin, pregabalin):** Historically used to modulate neuropathic pain pathways; preoperative administration was once considered to reduce acute postoperative pain and opioid consumption in orthopaedic populations.²⁴⁻²⁶ In 2021, the American Academy of Orthopaedic Surgeons found

gabapentin failed to provide statistically significant pain reduction postoperatively. Gabapentin was also associated with a significantly higher rate of adverse effects, including sedation, dizziness, and delirium, which can impair early mobilization and recovery.^{27,28} Given these findings, gabapentin is no longer recommended as the first line in pain management and has commonly been removed from MMA protocols for orthopaedic patients.

- **Corticosteroids (e.g., dexamethasone):** Primarily used to reduce postoperative nausea and vomiting (PONV), with emerging evidence of modest analgesic effects and potential prolongation of regional block duration.²⁹
- **NMDA (N-Methyl-D-Aspartate) receptor antagonists (e.g., low-dose ketamine):** Provide analgesia and opioid-sparing effects, particularly in opioid-tolerant patients or those undergoing major procedures such as spine surgery.³⁰⁻³³

Regional anesthesia plays a pivotal role in orthopaedic MMA. Peripheral nerve blocks (e.g., adductor canal, interscalene, supraclavicular) and neuraxial anesthesia (e.g., spinal, epidural) provide targeted analgesia, reduce systemic opioid exposure, and facilitate early mobilization.³⁴ The use of long-acting local anesthetics, liposomal bupivacaine formulations, and continuous catheter techniques has further extended analgesic benefits into the early postoperative period.³⁵

Opioids remain effective for severe breakthrough pain but are associated with well-documented risks, including respiratory depression, sedation, constipation, PONV, urinary retention, and the potential for long-term dependence.¹⁴ Orthopaedic patients, particularly those undergoing elective procedures, are commonly opioid-naïve, increasing susceptibility to persistent use after perioperative exposure.²⁶ By targeting multiple pain pathways, MMA can provide effective analgesia while simultaneously reducing the need for routine opioid administration, improving recovery profiles, and decreasing the incidence of opioid-related complications without compromising analgesia.¹²

Within orthopaedics, ERAS protocols formalize MMA as the standard for perioperative pain control.¹⁵ These pathways emphasize preoperative patient education, scheduled administration of non-opioid analgesics, intraoperative use of regional techniques, and limited opioid use for breakthrough pain only. Implementation of MMA within ERAS has been shown to improve functional recovery, shorten hospital stays, and increase patient satisfaction in total joint arthroplasty, spine surgery, and upper extremity procedures.^{17,34}

CLINICAL EVIDENCE IN ORTHOPAEDICS

Across orthopaedic subspecialties, evidence demonstrates that MMA provides equivalent or superior analgesia compared to opioid-based regimens and reduces opioid consumption.^{27,29,30,36} These results support reserving opioids

for breakthrough pain only in most postoperative orthopaedic patients. [Table 1]

In two randomized, double-blinded controlled trials, acetaminophen, ibuprofen, and oxycodone were compared following carpal tunnel release and outpatient hand surgery. Across both studies, pain scores were equivalent, while non-opioid groups reported fewer adverse effects. Patients in non-opioid groups required virtually no rescue opioids, supporting non-opioid regimens as sufficient for most outpatient hand procedures.^{10,37-39}

In total joint arthroplasty, ERAS-based MMA protocols including scheduled acetaminophen, NSAIDs or COX-2 inhibitors, periarticular injections, and regional anesthesia consistently reduce opioid requirements without compromising pain control or recovery.^{15,17} A retrospective study of opioid-free pain control in total knee arthroplasty (TKA) patients found that over 70% of patients were discharged without opioids, with no increase in readmissions or uncontrolled pain compared to those prescribed opioids.⁴⁰ Similarly, large-scale database reviews link MMA use in arthroplasty to lower rates of postoperative nausea and vomiting (PONV), earlier ambulation, and shorter hospital stays.¹²

Multimodal strategies are also effective in spine surgery, sports medicine, and orthopaedic trauma. In spine surgery, combining acetaminophen, NSAIDs, low-dose ketamine, and regional or neuraxial techniques decreases opioid use while preserving analgesia.⁴¹ In sports medicine and trauma, peripheral nerve blocks and non-opioid adjuncts have facilitated faster functional recovery and decreased persistent opioid use.¹³

More recently, a study conducted in 2025 implemented an entirely opioid-free perioperative pain protocol for MMA use across five orthopaedic specialties. Results from this study demonstrated non-inferiority to an opioid-containing regimen for pain scores and patient satisfaction while markedly reducing prescribed and consumed morphine milligram equivalents (MME).⁴² These findings, across multiple randomized clinical trials, provide strong evidence that multimodal, opioid-sparing protocols are safe, effective, and acceptable to patients in the outpatient upper extremity setting.

Table 2 provides a comparison of pain scores between MMA protocols and opioids in the postoperative period across orthopaedic specialties. Of note, a study by Bernstein *et al.* at the Department of Orthopaedic Surgery, Naval Medical Center in San Diego assessed tier 2 sports medicine operations, including knee arthroscopy, basic open knee procedures, and shoulder arthroscopy. This study compared opioid pill consumption and Visual Analog Scale (VAS) Pain scores at 2 weeks of follow-up in groups receiving formal MMA protocols. At 2 and 6 weeks, the group receiving a formal MMA protocol reported lower opioid pill consumption and noninferior VAS pain scores.⁴⁴

PATIENT SELECTION, OPTIMAL TIMING, AND REGIMEN DESIGN

MMA has demonstrated clear benefits in outpatient and inpatient postoperative care and is considered appropriate in all surgical patients. In arthroplasty and trauma cases, more generally associated with inpatient care, MMA has been shown to reduce pain, total opioid use, hospital costs, and length of stay.^{43,46} MMA demonstrates particular benefits in high-risk groups such as elderly patients, those with chronic opioid use, and high-risk cardiac and pulmonary cases.⁴⁷ MMA protocols were associated with fewer respiratory and gastrointestinal (GI) adverse effects in inpatient cases.⁴⁸ In the outpatient orthopaedic setting, MMA has been documented in improving readiness for discharge, early mobility, and reducing complication-related risks in discharge. Appropriate MMA has been shown to provide noninferior pain management compared to opioids as well as decrease the need for opioid rescue in outpatient surgery.⁴⁹⁻⁵²

Timing of MMA is a key factor in optimizing pain management in orthopaedic surgery. Current literature reports that preoperative initiation of acetaminophen with COX-2 selective NSAIDs results in superior pain control and reduced opioid use in the postoperative period.^{46,53} MMA protocols should continue throughout the perioperative period and beyond patient discharge to achieve optimal pain management.⁴⁶ Evidence supports scheduled dosing and timing of these therapies compared to an as-needed dosing. In the setting of adherence to MMA protocols and inadequate pain control with acetaminophen and NSAIDs, opioids should be reserved for the control of more severe and breakthrough pain.⁵⁴

Current American Association of Orthopaedic Surgeons (AAOS) Clinical Practice Guidelines recommend the use of acetaminophen and COX-2 selective NSAIDs as first-line agents in MMA for postoperative pain management. No difference in pain management or efficacy was observed between intravenous (IV) and oral formulations. The recommended dosage of these agents is 1000 mg of acetaminophen, typically every 6 hours, combined with ibuprofen 400-600 mg every 4-6 hours, or naproxen 500 mg every 12 hours. The goal of this therapy is to maintain a steady serum medication level, avoiding large peaks and troughs in dosing.^{19,51,55} Local anesthetics and regional nerve blocks should be scheduled for administration intraoperatively and can be continued in the postoperative period if feasible.⁵⁶ Single-dose dexamethasone, 8-10mg IV, has been shown to improve pain management and serve as an effective antiemetic in the perioperative period.⁵⁶ Standard MMA practices should be guided by the patient to avoid adverse effects and complications associated with agents used in MMA.

PATIENT ENGAGEMENT IN MMA

The success of multimodal, opioid-sparing analgesia in orthopaedic surgery depends not only on the medications and techniques used but also on patient engagement through

Table 1. Summary of Multimodal Analgesia and Opioid-Sparing Outcomes in Orthopaedic Surgery

Procedure / Study	Design	Intervention	Key Outcomes	Notes
Carpal Tunnel Release – 2018 ³⁷	RCT, double-blind	Acetaminophen vs Ibuprofen vs Oxycodone	Equivalent pain scores; non-opioid groups had fewer adverse effects; no rescue opioid use needed	Demonstrates opioids are unnecessary for most CTR patients
Various Hand Surgeries – 2018 ³⁹	RCT, double-blind	Acetaminophen vs Ibuprofen vs Oxycodone	Similar pain control; opioid group had more side effects; higher satisfaction in non-opioid groups	Supports non-opioid analgesia for outpatient upper extremity
Upper Extremity Surgery – 2016 ⁴³	Prospective observational cohort	Standard opioid prescribing (varied by procedure)	Mean prescription 24 pills vs mean consumption 8.1 pills (≈34% utilization); soft-tissue procedures required fewer opioids; authors proposed procedure-specific guidelines	Highlights overprescription and supports targeted opioid reduction
Total Knee Arthroplasty – 2023 ⁴⁰	Retrospective cohort	“Upon-request” Opioid Protocol vs Routine Prescription	72% of opioid-naïve patients recovered opioid-free vs 5.4% in controls; no differences in pain, readmissions	High safety profile for eliminating routine opioid prescribing
TKA / THA – 2019 ¹⁵	Literature review of ERAS	Scheduled acetaminophen, NSAIDs, periarticular injection, and regional anesthesia	Lower opioid use; earlier mobilization; shorter hospital stays	Confirms the ERAS framework supports OSA
Spine Surgery – 2015 ⁴¹	Review	MMA, including acetaminophen, NSAIDs, gabapentinoids, and ketamine	Reduced opioid consumption; equivalent pain control; no increase in complications	Supports MMA use in the spine
Across Specialties – 2025 ⁴²	RCT, non-inferiority	Opioid-Free Protocol vs Opioid-Containing	Non-inferior pain scores; large reduction in MME; fewer opioid-related side effects	Demonstrates the safety of opioid-free protocols across orthopaedic specialties
Multiple Orthopaedic Procedures – 2023 ¹⁴	Review	Perioperative MMA protocols	Decreased opioid use, reduced PONV, improved recovery	Broad support across orthopaedic subspecialties

TKA: total knee arthroplasty, THA: total hip arthroplasty

preoperative counseling and comprehensive postoperative follow-up. Aligning patient expectations before surgery and reinforcing opioid-sparing goals after discharge are critical for sustained success.^{12,15,17}

Preoperative counseling is the cornerstone of implementation. In a prospective randomized trial, Ilyas et al. (2020) demonstrated that structured, procedure-specific counseling combined with a multimodal non-opioid analgesic regimen after outpatient hand surgery resulted in equivalent pain scores, higher patient satisfaction, and markedly lower opioid consumption compared to standard opioid prescribing.^{57,58} The counseling emphasized realistic expectations for postoperative pain duration and intensity, the role of non-opioid analgesics as first-line agents, the risks associated with opioid use (including dependence, constipation, sedation, and impaired function), and the availability of opioids only for breakthrough pain if necessary. A similar

study conducted in 2023 demonstrated similar findings of decreased postoperative opioid use in total knee arthroplasty for patients receiving preoperative counseling.⁵⁹ By reframing opioids as a rescue medication rather than a routine part of recovery, patients were more willing to use non-opioid regimens. They frequently discovered that they could recover without opioids.^{37,39} Preoperative counseling should be a standard component of the preoperative visit, ideally supported by a checklist or standardized script to ensure consistent messaging across providers.

Early and structured follow-up reinforces opioid-sparing goals and ensures adequate pain control. Best practices include telephone check-ins within 24–48 hours to assess pain, review adherence to the multimodal regimen, provide tapering guidance for those who received limited opioid prescriptions, and address concerns that could lead to unnecessary emergency department (ED) visits or refills. Doc-

Table 2. Summary Pain Scores of Multimodal Analgesia and Opioid-Sparing Protocols Compared to Opioid Use in Orthopaedic Surgery Postoperative Period

Procedure/ Study	Pain Assessment Measurement	Follow-up Time	Intervention	Pain Score	p-value (when compared to opioids)	Notes
Endoscopic Carpal Tunnel Release – 2018³⁷	Average Worst Daily Pain (0-10)	5 days	Oxycodone	2.8	$p > 0.05$	Noninferior
			Ibuprofen	2.5		
			Acetaminophen	2.8	$p > 0.05$	
Various Hand Surgeries – 2018³⁹	VAS Pain Score (0-10)	5 days	Oxycodone	3.1	$p > 0.05$	Noninferior
			Ibuprofen	3		
			Acetaminophen	2.2	$p > 0.05$	
Across Specialties – 2025⁴²	Verbal Numeric Pain Rating Scale (0-10)	2 weeks	Opioid-Containing Group	5	$p = 0.0003$	Superior pain control with MMA
			Opioid-Free Group	3		
Forefoot surgery – 2025⁴⁵	VAS Pain Score (0-10)	2 weeks	Opioid-Containing Group	1	$p = 0.26$	Noninferior
			Opioid-Free Group	1.4		
Sports Medicine – 2024⁴⁴	VAS Pain Score (0-10)	2 weeks	Opioid Group without Protocol	2.74	$p = 0.17$	Noninferior
			MMA Protocol Group	1.96		

umenting actual opioid use during follow-up enables continuous refinement of prescribing guidelines and further reduces unused tablets that might otherwise contribute to diversion.⁶⁰ Postoperative follow-up can be delegated to nursing staff or physician assistants using structured call templates. Integrating these steps into Enhanced Recovery After Surgery (ERAS) pathways ensures that counseling and follow-up are consistently applied alongside the pharmacologic components of the multimodal protocol.^{15,61,62}

DISCUSSION & FUTURE PERSPECTIVES

The body of evidence supporting multimodal analgesia (MMA) and opioid-sparing strategies in orthopaedic surgery is robust, spanning randomized controlled trials, prospective cohort studies, and large retrospective analyses. Across subspecialties, including hand, upper extremity, arthroplasty, spine, and trauma, MMA protocols have repeatedly demonstrated equivalent or superior pain control and improved functional outcomes, providing evidence that routine postoperative opioid use is unnecessary for most patients. Despite this evidence, variability in prescribing practices persists. Some surgeons continue to rely on opioids out of habit, perceived patient expectation, or concern about inadequate analgesia. Implementation studies show that preoperative counseling, patient education, and postoperative follow-up are powerful tools for changing both provider and patient behavior. These strategies should be considered core elements of any opioid-sparing protocol.

There remain important research gaps. First, although multiple randomized clinical trials (RCTs) exist for hand and upper extremity surgery, fewer high-quality trials have been conducted in arthroplasty, spine, and orthopaedic trauma settings, where opioid-sparing regimens could have even greater impact on total opioid exposure. Second, while short-term safety and analgesic equivalence are well established, longer-term outcomes such as persistent opioid use, chronic pain rates, and functional recovery beyond 90 days require further investigation. Finally, the optimal combination of multimodal agents, including the role of newer long-acting local anesthetics, remains an area for future study.

Emerging technologies offer opportunities to refine opioid-sparing protocols. Nociception monitoring and individualized pain management algorithms may enable more precise intra- and postoperative analgesic titration, reducing reliance on blanket prescribing. Recent research includes a 2020 randomized controlled trial showing that NOL-guided fentanyl dosing during abdominal surgery significantly lowered postoperative pain scores compared to standard hemodynamic-based dosing. A separate study conducted in 2023 highlighted the Analgesia Nociception Index (ANI) as a physiologic tool for predicting intra- and postoperative pain and optimizing opioid titration, strongly supporting the role of objective nociception monitoring in enabling more precise, individualized analgesia.^{63,64} Integration of real-time patient-reported outcome measures into electronic medical records could also facilitate rapid feedback and iterative protocol improvement.

CONCLUSION

Multimodal, opioid-sparing analgesia in orthopaedic surgery is safe, effective, and supported by evidence. These protocols reduce opioid use, maintain or improve pain control, and enhance recovery. Combining patient counseling, follow-up, and ERAS-standardized approaches can optimize outcomes. Opioids should be reserved for breakthrough pain, prescribed minimally, and tapered appropriately, helping orthopaedics contribute to reducing opioid overprescription while maintaining high-quality care.

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DECLARATION OF CONFLICT OF INTEREST

All authors are employees of the Rothman Opioid Foundation, a 501C3 Non-profit organization. All authors declare they have no other conflicts of interest.

DECLARATION OF FUNDING

The authors declare that they have a financial/personal relationship with the Rothman Opioid Foundation (501C3 Non-profit organization). Authors have no other financial interests/relationships to disclose.

DECLARATION OF ETHICAL APPROVAL FOR STUDY

Ethical approval was not required in conducting this narrative review.

DECLARATION OF INFORMED CONSENT

We declare that there is no information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript that can be used to identify patients.

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