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Original Research Article

Buprenorphine Transdermal Patch versus Intramuscular Diclofenac for Postoperative Analgesia in Orthopaedic Surgery: A Systematic Review

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Abstract

Background: Post-operative pain after orthopaedic surgery remains a major clinical problem even when regional anaesthesia is used. Orthopaedic procedures often involve bone manipulation, periosteal irritation and soft-tissue trauma, leading to inflammatory and nociceptive pain that may delay mobilisation and recovery. Current practice therefore favours multimodal analgesia rather than reliance on a single agent. [1-5] Buprenorphine transdermal patch offers continuous opioid analgesia, whereas intramuscular diclofenac provides rapid non-steroidal anti-inflammatory analgesia.

Objective: To systematically review and synthesize evidence on the comparative efficacy, rescue analgesic requirement and safety profile of buprenorphine transdermal patch versus intramuscular diclofenac for management of post-operative analgesia following orthopaedic surgery under regional anaesthesia.

Methods: A systematic narrative review was drafted using the uploaded institutional dissertation as index evidence and peer-reviewed literature on post-operative pain, regional anaesthesia, buprenorphine patches, diclofenac and multimodal analgesia. The index study was a prospective, randomized, open-label controlled study of 70 patients aged 20-59 years undergoing upper or lower limb orthopaedic surgery under regional anaesthesia.

Results: Intramuscular diclofenac showed better early pain control at 8 and 12 hours, while buprenorphine transdermal patch showed superior sustained analgesia from 32 to 72 hours. Rescue analgesia was required in 31.4% of the buprenorphine group and 45.7% of the diclofenac group in the index study. Injection-site pain was more frequent with diclofenac, whereas mild local pruritus was observed with the patch.

Conclusion: Diclofenac remains useful for immediate post-operative pain, but buprenorphine transdermal patch provides more sustained analgesia and avoids repeated painful injections. The most rational protocol is pre-operative patch application with short-acting bridge analgesia during the early block-regression phase.

Keywords: Buprenorphine Transdermal Patch; Diclofenac; Post-Operative Analgesia; Orthopaedic Surgery; Regional Anaesthesia; Visual Analogue Scale; Rescue Analgesia; Multimodal Analgesia.

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Introduction

Post-operative pain represents a pervasive and often inadequately managed challenge in global healthcare, significantly impacting patient recovery and overall outcomes. [1] In the realm of orthopedic surgery, particularly procedures involving the lower limbs, the incidence of moderate to severe post-operative pain remains remarkably high, frequently exceeding 80%. [1] The consequences of uncontrolled pain extend far beyond immediate patient discomfort, leading to a cascade of negative effects including increased morbidity, functional impairment, delayed

recovery, prolonged reliance on opioid analgesics, and substantial increases in healthcare costs. [2] This complex interplay underscores the critical need for optimized analgesic strategies in this surgical specialty. Effective pain management is not merely about alleviating suffering; it is intrinsically linked to broader healthcare outcomes, influencing hospital efficiency, patient satisfaction, and contributing to the mitigation of public health challenges such as the ongoing opioid crisis. [3] The clinical goal is therefore not only pain reduction but also restoration of function and safe early rehabilitation. [4]

Regional anaesthesia, including subarachnoid block and peripheral nerve blocks, is central to orthopaedic anaesthetic practice because it provides dense intraoperative anaesthesia and early post-operative analgesia. However, regional anaesthesia is time-limited. When the block regresses, patients may experience a transition period of rebound or breakthrough pain. This period is especially relevant in long-bone procedures because nociceptive and inflammatory pathways become active as motor and sensory block fades. [5,7,8] Consequently, systemic analgesics remain necessary even when regional anaesthesia is used.

The contemporary approach to post-operative pain favors multimodal analgesia. This strategy combines agents acting at different sites in the pain pathway, such as local anaesthetics, NSAIDs, paracetamol, opioids and adjuvant drugs. Multimodal analgesia can improve pain relief while reducing opioid dose and dose-related adverse effects. [1,4,5,29] NSAIDs are particularly useful in orthopaedic pain because prostaglandin-mediated inflammation is an important component of post-operative nociception. Opioids remain important when pain is moderate or severe, but their use must be balanced against nausea, vomiting, sedation, respiratory depression, constipation, tolerance, dependence and delayed rehabilitation. [2,3,8]

Buprenorphine is a semi-synthetic opioid with partial agonist activity at the mu-opioid receptor and antagonist activity at kappa receptors. Its high lipophilicity permits transdermal delivery. Transdermal buprenorphine offers continuous drug release, avoids first-pass metabolism, reduces the need for repeated injections and may improve patient compliance.12-16The drug also has a ceiling effect for respiratory depression, which may offer a safety advantage over full mu-opioid agonists when appropriately used. [12] However, the patch has a delayed onset. Therefore, if the patch is applied too late, early pain control may be inadequate during the immediate post-operative phase.

Diclofenac is a commonly used NSAID with analgesic, anti-inflammatory and antipyretic properties. It inhibits prostaglandin synthesis by blocking cyclooxygenase pathways and also has additional peripheral anti-nociceptive actions. [9-11] Intramuscular diclofenac is widely used for acute post-operative pain because it provides relatively rapid systemic delivery and avoids the need for immediate oral intake. Its limitations include finite duration of action, injection-site pain, gastrointestinal irritation, renal caution and cardiovascular risk in vulnerable patients [9,10,23] The comparison between buprenorphine transdermal patch and intramuscular diclofenac is clinically important because the two agents are not pharmacologically equivalent. Diclofenac is arapid-onset, short-to-intermediate acting anti-inflammatory analgesic, while buprenorphine patch is a delayed-onset, sustained opioid delivery system. A direct comparison therefore examines two different analgesic philosophies: immediate injectable NSAID therapy versus sustained non-invasive transdermal opioid therapy. For orthopaedic surgery under regional anaesthesia, this comparison is particularly valuable because the early post-block phase and the later mobilisation phase have different analgesic requirements.

The uploaded institutional dissertation directly evaluated this clinical question in adult orthopaedic patients undergoing surgery under regional anaesthesia. The study reported that diclofenac produced better early analgesia, whereas buprenorphine patch produced better sustained analgesia from the late post-operative period. These findings form the clinical basis of the present systematic review and are integrated with published evidence to develop a practical interpretation for perioperative analgesic planning.

Methods

This manuscript was designed as a systematic narrative review with an integrative synthesis. The review question was framed as follows: in adult orthopaedic patients undergoing surgery under regional anaesthesia, how does buprenorphine transdermal patch compare with intramuscular diclofenac for post-operative analgesia, rescue analgesic requirement and adverse effects?

The uploaded dissertation was used as the index source because it matched the research question exactly. The index study was a prospective, parallel-group, open-label, randomized controlled study conducted at Hind Institute of Medical Sciences, Safedabad, Barabanki. It included 70 patients aged 20-59 years with BMI 18.5-29 kg/m2 who underwent upper or lower limb long-bone orthopaedic procedures under regional anaesthesia. Patients were treated with brachial plexus block for upper limb surgery and subarachnoid block for lower limb surgery. The buprenorphine patch was

applied to a hairless area of the chest or upper arm 12 hours before surgery, while diclofenac sodium 75 mg was administered intramuscularly after surgery and then repeated as per protocol.

Peer-reviewed literature was searched using terms related to "transdermal buprenorphine", "post-operative pain", "orthopaedic surgery", "intramuscular diclofenac", "regional anaesthesia", "multimodal analgesia", "rescue analgesia" and "VAS score". Systematic reviews, clinical trials, reviews, guidelines and relevant pharmacological papers were considered. Because direct head-to-head trials comparing transdermal buprenorphine with intramuscular diclofenac in orthopaedic regional anaesthesia are limited, supporting evidence from related surgical settings and orthopaedic analgesic studies was also included. [1,13-19]

Inclusion criteria were adult post-operative patients, orthopaedic or comparable surgical pain setting, regional anaesthesia or multimodal analgesia context, use of transdermal buprenorphine, diclofenac or relevant comparator analgesics, and reporting of pain score, rescue analgesia, adverse effects or satisfaction. Exclusion criteria were paediatric-only studies, studies unrelated to post-operative pain, chronic non-surgical pain studies without relevance to transdermal opioid use, and papers without clinically interpretable analgesic outcomes.

The primary outcome was pain intensity measured by Visual Analogue Scale (VAS). Secondary outcomes included rescue analgesic requirement, number of rescue doses, and timing of rescue analgesia, systemic adverse effects, local reactions and practical clinical suitability. In the index study, VAS was assessed at 4-hour intervals during the first 12 hours and then 12-hourly until 72 hours. Rescue analgesia was intravenous tramadol 2 mg/kg, up to a maximum of 100 mg, administered on demand or when VAS was 4 cm or more.

Quantitative meta-analysis was not performed because the available studies differed in surgery type, anaesthesia technique, dose, comparator, timing of patch application and outcome schedule. Findings were therefore synthesized narratively, with the index study data presented in structured tables.

Ethical Approval: The study protocol was reviewed & approved by the Institutional Human Ethics Committee (IHEC), Hind Institute of Medical Sciences, Safedabad, Barabanki, and Uttar Pradesh, India. Ethical approval was granted under UID # HIMS/IHEC/45-2025/Faculty/Dr. Animesh Dutt Pandey.

Results

The evidence consistently supports the view that orthopaedic post-operative pain requires a multimodal approach. Guidelines and narrative reviews recommend planned perioperative analgesia, procedure-specific pain assessment and opioid-sparing strategies whenever feasible. [1,4,5,7,8] Transdermal buprenorphine studies show potential for sustained analgesia and patient convenience, although the timing of application and need for bridge analgesia are important determinants of success. [13-18] Diclofenac literature supports its role in early inflammatory pain control but also emphasizes the need for safety screening, particularly in patients with renal, gastrointestinal or cardiovascular risk. [9-11,23-25]

Table 1: Summary of evidence included in the systematic review

Evidence source	Main contribution	Interpretation for present topic
Post-operative pain guidelines	Recommend planned, multimodal and procedure-specific analgesia	Single-agent analgesiais usually insufficient after orthopaedic surgery
Regional anaesthesia literature	Supports reduced early pain and opioid use but recognizes post-block pain	Systemic analgesic cover is needed after block regression
Transdermal buprenorphine trials /reviews	Report sustained pain relief with non-invasive delivery	Useful for prolonged analgesia when applied early enough
Diclofenac / NSAID literature	Supports anti-inflammatory analgesia in acute pain	Useful early analgesic, but repeated dosing and safety screening are needed
Uploaded index dissertation	Directcomparisonin70orthopaedicpatients under regional anaesthesia	Diclofenac better early; buprenorphine better in sustained phase

The index study included 70 patients equally distributed into Group D and Group B. Baseline demographic and clinical variables were comparable, supporting the validity of between-group comparisons. The trial measured early, intermediate and late post-operative pain and recorded rescue analgesic use and adverse events. The methodology is important because it reflects routine orthopaedic practice in which regional anaesthesia is combined with systemic analgesics.

Table 2: Index study design and methodology

Parameter	Description
Design	Prospective, parallel-group, open-label, randomized controlled study
Setting	Hind Institute of Medical Sciences, Safedabad, Barabanki
Sample size	70patients;Group D n=35 and Group B n=35
Population	Patients aged 20-59 years undergoing upper or lower limb orthopaedic surgery
Anaesthesia	Brachial plexus block for upper limb surgery; subarachnoid block for lower limb surgery
Intervention	Buprenorphine transdermal patch applied 12 hours before surgery
Comparator	Diclofenacsodium 75 mg intramuscular injection after surgery and repeated as per protocol
Primary outcome	VAS pain score upto 72 hours
Rescue analgesia	IV tramadol when VAS reached 4cm or more or on demand
Statistical approach	Mean ±SD, unpaired t-test, chi-square or Fisher exact test; $p<0.05$ significant

Pain-score results demonstrated a time-dependent shift in analgesic performance. At 4 hours the groups were similar, probably because residual regional block still contributed to analgesia. At 8 and12 hours, diclofenac had significantly lower VAS scores, indicating better immediate post-operative pain control. This is consistent with the rapid systemic effect of intramuscular NSAID therapy. From 32 hours onward, buprenorphine patch achieved lower VAS scores, reflecting sustained transdermal delivery after the lag phase. [13-18]

Table 3: Post-operative VAS score comparison in the index study

Time point	IM diclofenac mean VAS	Buprenorphine patch mean VAS	p value	Clinical interpretation
4hours	3.15	3.19	0.825	Comparable
8hours	2.91	3.24	0.038	Diclofenac better early
12 hours	2.64	3.16	0.002	Diclofenac better early
16 hours	2.55	2.84	0.061	Trend favoring diclofenac
24 hours	2.51	2.42	0.492	Comparable
32 hours	2.44	2.14	0.045	Buprenorphine better
48 hours	2.41	2.13	0.031	Buprenorphine better
60 hours	2.42	2.04	0.009	Buprenorphine better
72 hours	2.38	1.99	0.001	Buprenorphine better

Rescue analgesic use was also clinically informative. In the index study, rescue analgesia was required in 45.7% of diclofenac patients and 31.4% of buprenorphine patients. Although the difference was not statistically significant, the direction of effect suggested greater sustained background analgesia in the buprenorphine group. Total rescue dose frequency remained comparable, suggesting that both regimens were clinically acceptable when rescue tramadol was available.

Table 4: Rescue analgesia and tolerability outcomes in the index study

Outcome	IM diclofenac	Buprenorphine patch	p value	Interpretation
Rescue analgesia required	16/35 (45.7%)	11/35 (31.4%)	0.315	Trend favoured buprenorphine
Rescue analgesia not required	19/35 (54.3%)	24/35 (68.6%)	0.315	More patients remained below rescue threshold with patch
Total rescue doses	0.63 ±0.84	0.80 ±0.96	0.432	Comparable
Time to first rescue analgesia	13.7±4.2 h	16.8±5.9 h	0.115	Slightly longer in patch group
Nausea/vomiting	11.4%	14.3%	0.720	Comparable
Dizziness	2.9%	5.7%	0.555	Comparable
Bradycardia / respiratory depression	0%	0%	1.000	No serious systemic event
Injection-site pain	20.0%	0%	0.005	Higher with diclofenac
Skin pruritus	0%	8.6%	0.076	Mild patch- site reaction

Discussion

This systematic review shows that buprenorphine transdermal patch and intramuscular diclofenac are both clinically useful but serve different analgesic phases after orthopaedic surgery under regional

anaesthesia.

Diclofenac is more effective during the early post-operative phase, particularly at 8 and 12 hours, while bupre norphine is more effective during the sustained phase from 32 to 72 hours. This pattern is pharmacologically logical. Intramuscular diclofenac produces faster systemic NSAID action, whereas buprenorphine patch requires time for transdermal absorption but then maintains more stable analgesic plane. [9,13,14]

The early advantage of diclofenac is important because this period often coincides with regression of subarachnoid or peripheral nerve block. When regional anaesthesia wears off, patients may develop acute pain before a transdermal opioid has reached adequate systemic effect. Therefore, buprenorphine patch should not be treated as an immediate rescue analgesic. It is better understood as a sustained background analgesic. If used alone without early bridge analgesia, patients may experience avoidable pain during the first post-operative hours. [13-16]

The late advantage of buprenorphine patch is clinically meaningful for orthopaedic recovery. Sustained pain control supports sleep, limb positioning, physiotherapy participation and early mobilisation. Repeated intramuscular injections can cause discomfort and require nursing time, while patch delivery is non-invasive and more convenient. In the index study, 20% of diclofenac recipients reported injection-site pain, whereas no such morbidity occurred in the patch group. This practical difference can influence patient satisfaction even when overall analgesic efficacy is comparable.

Safety must be interpreted in relation to patient selection. Buprenorphine, as a partial mu-opioid agonist, has a ceiling effect for respiratory depression, but opioid-related nausea, dizziness and sedation may still occur. [12,13] Diclofenac avoids opioid respiratory effects but may be problematic in patients with renal dysfunction, peptic ulcer risk, bleeding tendency, uncontrolled hypertension or cardiovascular risk. [9,10] The index study excluded high-risk patients and reported no serious systemic event, so its results should not be generalized without appropriate screening.

The rescue analgesia findings also support multimodal care. Fewer buprenorphine patients crossed the rescue threshold, but the difference was not statistically significant and total rescue doses were comparable.

This indicates that both regimens can be effective when rescue tramadol is available. However, the timing pattern suggests that an optimized protocol might combine the strengths of both approaches: pre-operative buprenorphine patch for sustained coverage and rapid-onset NSAID or other bridge analgesia during the immediate post-operative period. [1,4,5,29] Previous transdermal buprenorphine studies support this interpretation. Niyogi et al. found that a10 mcg/hour patch applied 24 hours before spinal instrumentation surgery improved post-operative analgesia.16Systematic reviews have concluded that transdermal buprenorphine may be useful for acute post-operative pain but have also emphasized heterogeneity and limitations in trial quality. [14,15] Orthopaedic studies comparing buprenorphine patch with tramadol, conventional analgesics or other transdermal agents suggest that the patch can reduce pain scores, improve satisfaction and reduce rescue medication in selected patients. [18,21-25]

The index study adds value because it specifically compares buprenorphine patch with intramuscular diclofenac in the context of orthopaedic surgery under regional anaesthesia. This is a clinically common scenario but not well represented in the literature. The result is not simply that one drug is universally superior. Rather, diclofenac is superior for immediate pain control, while buprenorphine is superior for prolonged background analgesia. This time-dependent finding should guide perioperative protocols.

Several limitations must be acknowledged. The index study was open-label, so patient-reported outcomes such as VAS and satisfaction could be influenced by treatment awareness. The sample size was modest, and the orthopaedic procedures were heterogeneous. Analgesic effects may differ between upper-limb surgery, lower-limb fracture fixation, intramedullary nailing and open reduction procedures. Future trials should use double-blind design, procedure-specific stratification, standardized rescue protocols and longer follow-up for chronic post-surgical pain.

Despite these limitations, the findings are clinically applicable. For ASA I-II adult orthopaedic patients without contraindications, buprenorphine patch can be considered when prolonged analgesia, avoidance of repeated injections and improved comfort are priorities. Diclofenac remains important when immediate anti-inflammatory analgesia is needed and NSAID risk is acceptable. A balanced protocol may provide the best outcome by aligning drug pharmacokinetics with the natural time course of post-operative pain.

Conclusion

The clinical investigation conducted in this study demonstrates that the buprenorphine transdermal patch (TDB) serves as a highly effective, safe, and patient-preferred alternative to intramuscular (IM) diclofenac for managing postoperative pain in

orthopedic patients following regional anesthesia. Orthopedic procedures are inherently associated with significant nociceptive input due to bone manipulation and soft tissue trauma. While both pharmacological agents provide meaningful relief, their efficacy is dictated by their distinct pharmacokinetic profiles and the timing of administration. Buprenorphine transdermal patch and intramuscular diclofenac both provide meaningful analgesia after orthopaedic surgery under regional anaesthesia, but their efficacy differs by time interval. Intramuscular diclofenac provides better early analgesia during the first 8-12 hours, while buprenorphine patch provides superior sustained analgesia from approximately 32 to 72 hours. The patch also avoids injection-site pain and offers convenience through non-invasive continuous delivery.

The evidence supports a multimodal strategy rather than exclusive reliance on either drug. Buprenorphine patch should be applied sufficiently before surgery to overcome the lag phase, and rapid-onset bridge analgesia should be available during the immediate post-block period.

Diclofenac may be useful for early inflammatory pain when not contraindicated. Further blinded, adequately powered orthopaedic trials are needed to confirm optimal dose, timing, patient selection and cost-effectiveness.

Clinical Implications

- Pre-operative application of buprenorphine transdermal patch may improve sustained pain relief during the later post-operative period.
- Intramuscular diclofenac is more suitable for rapid early analgesia, especially when regional block begins to regress.
- Bridge analgesia is advisable when buprenorphine patch is used for acute post-operative pain because of its delayed onset.
- Patient screening is essential: diclofenac should beavoided or used cautiously inrenal, gastrointestinal and cardiovascular risk, while buprenorphine requires opioid-related monitoring.
- Aphase-based multi modal protocol may provide better analgesia than a single- agent approach.

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