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Original Article

# Safety and Efficacy of Transdermal Buprenorphine, Transdermal Ketoprofen Patch Over Conventional Analgesics in Post Operative Pain in Hip Arthroplasty

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## ABSTRACT

**Background:** Total hip arthroplasty (THA) is one of the most successful orthopedic procedures for relieving pain and restoring function in patients with advanced hip disorders. However, postoperative pain remains a major concern affecting rehabilitation, early ambulation, hospital stay, and patient satisfaction. Transdermal analgesic patches have emerged as an alternative strategy for sustained postoperative pain control with fewer systemic adverse effects.
**Aim:** To compare the safety and efficacy of transdermal buprenorphine patch and transdermal ketoprofen patch with conventional analgesics in postoperative pain management following total hip arthroplasty.
**Methodology:** This prospective comparative study was conducted at Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly over a period of 18 months. A total of 96 patients undergoing primary unilateral total hip arthroplasty were enrolled and divided equally into three groups of 32 each. Group A received transdermal buprenorphine patch, Group B received transdermal ketoprofen patch, and Group C received conventional paracetamol regimen. Pain intensity was assessed using Numeric Rating Scale (NRS) at serial postoperative intervals. Rescue analgesic requirement, adverse drug events, duration of hospital stay, patient acceptability, and satisfaction were recorded and compared.
**Results:** Pain scores were significantly lower in the transdermal buprenorphine group throughout the postoperative period, with consistently lower NRS scores from postoperative day 2 to postoperative day 5 compared with ketoprofen and conventional analgesic groups ($p<0.001$). Rescue analgesia was required in 12.5% patients in Group A, 21.9% in Group B, and 56.3% in Group C. Adverse drug events occurred in 28.1%, 37.5%, and 53.1% patients respectively. Mean hospital stay was shortest in the ketoprofen group (5.9 ± 1.3 days) and longest in the conventional group (7.2 ± 1.7 days).
**Conclusion:** Transdermal buprenorphine and ketoprofen patches were effective and safe alternatives to conventional analgesics after THA. Buprenorphine showed superior analgesic efficacy with reduced rescue analgesic requirement and improved postoperative recovery.

***Keywords****: Total Hip Arthroplasty; Transdermal Buprenorphine; Transdermal Ketoprofen; Postoperative Pain; Analgesia.*

## INTRODUCTION

Total hip arthroplasty (THA) is widely regarded as one of the most successful procedures in modern orthopedics and has significantly improved the management of painful and disabling hip disorders. It offers reliable pain relief, restoration of joint function, improved mobility, and better quality of life in patients with advanced osteoarthritis, avascular necrosis of the femoral head, fracture neck of femur, inflammatory arthritis, and other degenerative hip conditions (1). Over the past

few decades, the number of total hip arthroplasties performed worldwide has steadily increased because of longer life expectancy, increasing prevalence of osteoarthritis, improved implant survival, and broader surgical indications (2,3). Learmonth et al. famously described total hip replacement as “the operation of the century” because of its outstanding long-term success and patient outcomes (1).

Despite excellent surgical outcomes, postoperative pain remains a major challenge after total hip arthroplasty. Pain during the immediate postoperative period can interfere with early mobilization, delay rehabilitation, prolong hospital stay, reduce patient satisfaction, and negatively affect recovery (4,5). If not adequately controlled, postoperative pain may also contribute to complications such as sleep disturbance, delayed physiotherapy participation, thromboembolic events, pulmonary complications, and prolonged functional limitation. Effective pain control is therefore a crucial part of perioperative management following THA (4).

Traditionally, postoperative pain after THA has been managed using multimodal analgesic regimens consisting of paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs), opioids, and regional anesthesia techniques. While these approaches are effective, they are often associated with side effects and practical limitations. Opioids may cause nausea, vomiting, sedation, constipation, dizziness, respiratory depression, and delayed recovery, whereas NSAIDs may be associated with gastrointestinal irritation, renal dysfunction, and cardiovascular adverse effects in susceptible individuals (6,7). Repeated oral or intravenous administration may also produce fluctuating drug levels and inconsistent pain control. These limitations have encouraged the search for safer and more convenient analgesic alternatives.

Transdermal drug delivery systems have emerged as a useful option in postoperative pain management because they allow continuous absorption of medication through the skin with sustained plasma drug concentration over a prolonged duration (8,9). This route bypasses gastrointestinal absorption and first-pass metabolism, improves patient compliance, avoids repeated injections, and provides prolonged analgesia with minimal fluctuation in drug levels. Transdermal delivery is therefore increasingly being explored in orthopedic postoperative pain protocols.

Buprenorphine is a partial μ-opioid receptor agonist with potent analgesic activity and long duration of action. Its transdermal formulation has shown promising results in acute and postoperative pain because of stable drug release, prolonged effect, and relatively favorable safety profile (10,11). It is associated with effective pain control and lower risk of respiratory depression compared with conventional opioid therapy. Similarly, ketoprofen is a non-steroidal anti-inflammatory drug with analgesic and anti-inflammatory properties. In transdermal patch form, it provides continuous local and systemic analgesic effect with improved tolerability and minimal gastrointestinal exposure (12). Previous studies have reported good clinical response with ketoprofen patches in musculoskeletal and postoperative pain conditions.

Recent literature increasingly supports multimodal and opioid-sparing approaches for postoperative pain management in total joint arthroplasty (13,14). However, evidence directly comparing transdermal buprenorphine patch and transdermal ketoprofen patch with conventional analgesics in patients undergoing total hip arthroplasty remains limited. Comparative evaluation of these treatment modalities is important in order to determine the most effective and practical analgesic strategy in the postoperative period.

Therefore, the present study was conducted to assess the safety and efficacy of transdermal buprenorphine patch and transdermal ketoprofen patch compared with conventional analgesic therapy in patients undergoing primary unilateral total hip arthroplasty. Pain scores, rescue analgesic requirement, adverse effects, postoperative recovery, and patient satisfaction were evaluated. The findings of this study may help optimize postoperative pain management strategies and improve early functional recovery following total hip arthroplasty (15).

## AIM AND OBJECTIVES

### Aim

To compare the safety and efficacy of transdermal buprenorphine patch and transdermal ketoprofen patch with conventional analgesics in postoperative pain management following primary unilateral total hip arthroplasty.

### Objectives

### Primary Objective

To compare serial postoperative pain intensity using Numeric Rating Scale (NRS) among patients receiving transdermal buprenorphine patch, transdermal ketoprofen patch, and conventional analgesics following total hip arthroplasty.

### Secondary Objectives

To compare rescue analgesic requirement among study groups. To assess frequency and pattern of adverse drug events. To evaluate time to mobilization and postoperative recovery parameters including duration of hospital stay. To assess patient acceptability, satisfaction, and overall tolerability of the prescribed analgesic modality.

## METHODOLOGY

## MATERIAL AND METHODS

This prospective comparative study was conducted in the Department of Orthopaedics at Shri Ram Murti Smarak Institute of Medical Sciences (SRMS IMS), Bareilly. The study included postoperative patients undergoing **Total Hip Arthroplasty (THA)** between 01 April 2024 and 30 September 2025 after obtaining approval from the Institutional Ethics Committee. The total study duration was 18 months. The study was conducted to compare the safety and efficacy of transdermal buprenorphine patch and transdermal ketoprofen patch with conventional analgesics in postoperative pain control following primary unilateral **Total Hip Arthroplasty (THA).**

The study population consisted of adult patients undergoing primary unilateral **Total Hip Arthroplasty (THA)** for various hip pathologies admitted under the Department of Orthopaedics during the study period. Patients aged more than 18 years planned for primary unilateral **THA** were included in the study. Patients undergoing bilateral **THA**, those with known contraindications to transdermal buprenorphine patch or transdermal ketoprofen patch, patients on chronic strong opioid therapy, patients with a history of intravenous drug abuse or alcohol dependence, and patients with psychiatric disorders were excluded from the study.

A total of 96 patients fulfilling the eligibility criteria were enrolled and divided into three equal groups of 32 patients each. Allocation into groups was done according to the planned postoperative analgesic protocol. Group A received **transdermal buprenorphine patch 10 mg**, applied 12 hours preoperatively and continued until postoperative day 7. Group B received **transdermal ketoprofen patch 30 mg once daily**, continued until postoperative day 7. Group C received **conventional analgesic therapy** consisting of intravenous paracetamol 1000 mg twice daily followed by oral paracetamol 650 mg three times daily up to postoperative day 7.

Detailed demographic and baseline clinical characteristics were recorded preoperatively for all participants, including age, sex, body weight, body mass index, diagnosis, ASA grading, and baseline pain score. Clinical diagnoses included avascular necrosis of femoral head, fracture neck of femur, secondary osteoarthritis, and other hip pathologies requiring **Total Hip Arthroplasty.** Surgical duration and perioperative parameters were documented.

All surgeries were performed under standard institutional protocol by experienced orthopaedic surgeons. Postoperatively, all patients followed a uniform rehabilitation protocol. Gait training, range-of-motion exercises, and muscle-strengthening exercises were initiated from postoperative day 1 under supervision of the physiotherapy team. Patients were mobilized according to tolerance and clinical recovery.

Pain assessment was performed using the Numeric Rating Scale (NRS), a validated scale ranging from 0 to 10, where 0 indicated no pain, 1–3 mild pain, 4–6 moderate pain, and 7–10 severe pain. Pain scores were recorded at 1 hour, 2 hours, 4 hours, 8 hours, 12 hours, and 24 hours postoperatively, followed by assessment on postoperative day 2, postoperative day 3, and postoperative day 5.

Rescue analgesia was administered according to institutional protocol. Patients with **NRS score ≥7** received intravenous tramadol 100 mg diluted in 100 ml normal saline. The maximum permissible daily dose was 400 mg. Requirement for rescue analgesia, number of patients requiring rescue medication, and time to first rescue dose were documented and analyzed.

Safety assessment included monitoring and documentation of adverse drug events throughout the postoperative period. Adverse effects including nausea, vomiting, constipation, drowsiness, headache, allergic reaction, and patch-site erythema were recorded. Any untoward clinical event requiring medical management was documented.

Recovery parameters including time to ambulation, postoperative hospital stay, tolerance to physiotherapy, patient acceptability of treatment, and overall satisfaction with pain control were assessed during follow-up.

All collected data were entered into a structured data sheet and analyzed statistically. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage. Comparison between study groups was performed using Chi-square test for categorical variables and One-way ANOVA for continuous variables. All statistical tests were two-sided, and a p-value of $<0.05$ was considered statistically significant.

The methodology was designed to comprehensively assess pain relief, rescue analgesic requirement, adverse effects, recovery profile, and patient satisfaction associated with transdermal buprenorphine patch and transdermal ketoprofen patch compared with conventional analgesics in patients undergoing **Total Hip Arthroplasty (THA).** The findings of the study aim to provide clinically relevant evidence regarding optimal postoperative pain management strategies following **THA**.

## RESULTS

A total of 96 patients undergoing primary unilateral total hip arthroplasty were included in the study and were equally distributed into three groups with 32 patients in each group. Group A received transdermal buprenorphine patch, Group B received transdermal ketoprofen patch, and Group C received conventional analgesic therapy with paracetamol. All patients completed follow-up up to postoperative day 7 and were included in the final analysis.

The mean age of patients in Group A was 56.8 ± 9.4 years, in Group B 58.2 ± 10.1 years, and in Group C 57.6 ± 8.9 years. There was no statistically significant difference among the groups with respect to baseline demographic characteristics. Male patients constituted 61.5% of the study population, while female patients accounted for 38.5%.

Serial postoperative pain assessment using the Numeric Rating Scale demonstrated lower pain scores in both transdermal patch groups compared with the conventional analgesic group throughout the postoperative period. Group A consistently showed the lowest pain scores from the early postoperative period till postoperative day 5, indicating better and sustained pain control. Pain reduction was statistically significant across most assessment intervals.

The requirement for rescue analgesia was highest in the conventional analgesic group. In Group A, only **12.5%** of patients required rescue analgesia, compared to **21.9%** in Group B and **56.3%** in Group C. This finding suggests superior analgesic efficacy with transdermal buprenorphine and better pain control with ketoprofen patch compared with conventional therapy.

Adverse drug reactions were observed in all three groups but were comparatively fewer in the transdermal patch groups. Nausea and vomiting were more frequently seen in the conventional analgesic group, whereas mild patch-site erythema was noted in a small number of patients receiving patch therapy. Overall tolerability was better with transdermal treatment modalities.

Patient satisfaction and treatment acceptability were highest in patients receiving transdermal buprenorphine patch. A total of **90.6%** patients in Group A reported satisfaction with pain control, compared with **78.1%** patients in Group B and **56.3%** patients in Group C. Acceptability towards route of administration was also higher in the patch groups. Patients treated with transdermal patches achieved earlier ambulation and had shorter hospital stay compared with those receiving conventional analgesic therapy.

Overall, both transdermal buprenorphine and transdermal ketoprofen patches demonstrated better postoperative analgesic efficacy compared with conventional analgesics following total hip arthroplasty. Among the three groups, transdermal buprenorphine showed the most favorable outcomes in terms of pain relief, reduced rescue analgesic requirement, improved patient satisfaction, and better postoperative recovery.

**Table 1: Baseline Demographic and Clinical Characteristics of Study Population (N=96)**

| Parameter | Group A (Buprenorphine) n=32 | Group B (Ketoprofen) n=32 | Group C (Conventional) n=32 | p-value |
|---|---|---|---|---|
| Mean age (years) | 56.8 ± 9.4 | 58.2 ± 10.1 | 57.6 ± 8.9 | 0.81 |
| Male | 20 (62.5%) | 19 (59.4%) | 20 (62.5%) | 0.94 |
| Female | 12 (37.5%) | 13 (40.6%) | 12 (37.5%) | |
| Mean BMI (kg/m²) | 27.2 ± 3.1 | 26.9 ± 2.8 | 27.4 ± 3.0 | 0.73 |
| AVN femoral head | 16 (50.0%) | 15 (46.9%) | 17 (53.1%) | 0.88 |
| Neck femur fracture | 10 (31.3%) | 11 (34.4%) | 9 (28.1%) | |
| Secondary OA/others | 6 (18.7%) | 6 (18.7%) | 6 (18.8%) | |

**Table 2: Comparison of Postoperative Numeric Rating Scale (NRS) Scores**

| Time Interval | Group A (Buprenorphine Patch) | Group B (Ketoprofen Patch) | Group C (Conventional Analgesics) | p-value |
|---|---|---|---|---|
| 1 hour | 6.4 ± 1.0 | 6.8 ± 0.9 | 7.3 ± 1.1 | 0.012 |
| 2 hours | 6.1 ± 0.9 | 6.5 ± 0.9 | 7.1 ± 1.0 | 0.009 |
| 4 hours | 5.9 ± 0.9 | 6.2 ± 1.0 | 6.9 ± 1.0 | 0.004 |
| 8 hours | 5.3 ± 0.8 | 5.8 ± 0.9 | 6.4 ± 0.9 | <0.001 |
| 12 hours | 5.0 ± 0.8 | 5.5 ± 0.8 | 6.1 ± 0.9 | <0.001 |
| 24 hours | 4.8 ± 0.9 | 5.2 ± 0.8 | 5.9 ± 0.9 | <0.001 |
| POD 2 | 4.4 ± 0.8 | 4.9 ± 0.8 | 5.6 ± 0.7 | <0.001 |
| POD 3 | 4.0 ± 0.7 | 4.5 ± 0.8 | 5.3 ± 0.8 | <0.001 |
| POD 5 | 3.2 ± 0.6 | 3.8 ± 0.7 | 4.6 ± 0.8 | <0.001 |

**RESULT**

The above table illustrates postoperative pain intensity assessed by Numeric Rating Scale among all three study groups at serial time intervals. At **1 hour**, mean NRS score was **6.4 ± 1.0** in Group A, **6.8 ± 0.9** in Group B, and **7.3 ± 1.1** in Group C (**p=0.012**). At **2 hours**, scores reduced to **6.1 ± 0.9**, **6.5 ± 0.9**, and **7.1 ± 1.0** respectively (**p=0.009**). At **4 hours**, mean NRS scores were **5.9 ± 0.9** in Group A, **6.2 ± 1.0** in Group B, and **6.9 ± 1.0** in Group C (**p=0.004**). At **8 hours**, pain scores further declined to **5.3 ± 0.8**, **5.8 ± 0.9**, and **6.4 ± 0.9** respectively (**p<0.001**). At **12 hours**, mean NRS score was **5.0 ± 0.8** in Group A, **5.5 ± 0.8** in Group B, and **6.1 ± 0.9** in Group C (**p<0.001**). At **24 hours**, values were **4.8 ± 0.9**, **5.2 ± 0.8**, and **5.9 ± 0.9** respectively (**p<0.001**). On **postoperative day 2**, NRS score was **4.4 ± 0.8** in Group A, **4.9 ± 0.8** in Group B, and **5.6 ± 0.7** in Group C. On **postoperative day 3**, values were **4.0 ± 0.7**, **4.5 ± 0.8**, and **5.3 ± 0.8** respectively. By **postoperative day 5**, scores further reduced to **3.2 ± 0.6** in Group A, **3.8 ± 0.7** in Group B, and **4.6 ± 0.8** in Group C. The difference between groups remained statistically significant throughout the postoperative period (**p<0.001**), with Group A demonstrating the lowest pain scores overall.

**Table 3: Rescue Analgesic Requirement and Adverse Events**

| Parameter | Group A (Buprenorphine Patch) | Group B (Ketoprofen Patch) | Group C (Conventional Analgesics) | p-value |
|---|---|---|---|---|
| Required rescue analgesia | 4 (12.5%) | 7 (21.9%) | 18 (56.3%) | <0.001 |
| Mean tramadol dose (mg) | 46.8 ± 22.5 | 71.4 ± 28.6 | 142.5 ± 45.2 | <0.001 |
| Nausea/Vomiting | 5 (15.6%) | 7 (21.9%) | 12 (37.5%) | 0.041 |
| Constipation | 2 (6.3%) | 3 (9.4%) | 6 (18.8%) | 0.180 |
| Patch-site erythema | 2 (6.3%) | 4 (12.5%) | — | 0.290 |
| Drowsiness | 3 (9.4%) | 2 (6.3%) | 5 (15.6%) | 0.470 |
| **Overall adverse events** | **9 (28.1%)** | **12 (37.5%)** | **17 (53.1%)** | **0.032** |

**Result**

The above table shows comparison of rescue analgesic requirement and adverse drug events among the three study groups. Rescue analgesia was required in 4 patients (12.5%) in Group A, 7 patients (21.9%) in Group B, and 18 patients (56.3%) in Group C, showing a statistically significant difference (p<0.001). Mean tramadol requirement was 46.8 ± 22.5 mg in Group A, 71.4 ± 28.6 mg in Group B, and 142.5 ± 45.2 mg in Group C (p<0.001). Nausea and vomiting were observed in 15.6% patients in Group A, 21.9% in Group B, and 37.5% in Group C (p=0.041). Constipation was noted in 6.3%, 9.4%, and 18.8% patients respectively (p=0.180). Patch-site erythema was seen in 2 patients (6.3%) in Group A and 4 patients (12.5%) in Group B, while no such event was noted in Group C (p=0.290). Drowsiness was reported in 9.4% patients in Group A, 6.3% in Group B, and 15.6% in Group C (p=0.470). Overall adverse events were recorded in 9 patients (28.1%) in Group A, 12 patients (37.5%) in Group B, and 17 patients (53.1%) in Group C, with a statistically significant intergroup difference (p=0.032). These findings indicate lower rescue analgesic requirement and fewer overall adverse events in the transdermal patch groups compared with conventional analgesic therapy.

**Table 4: Recovery Outcomes and Patient Satisfaction**

| Parameter | Group A | Group B | Group C | p-value |
|---|---|---|---|---|
| Time to ambulation (hours) | 26.4 ± 5.8 | 28.1 ± 6.1 | 34.8 ± 7.2 | <0.001 |
| Hospital stay (days) | 6.1 ± 1.4 | 5.9 ± 1.3 | 7.2 ± 1.7 | 0.003 |
| Good acceptability | 28 (87.5%) | 26 (81.3%) | 20 (62.5%) | 0.019 |
| Satisfied with pain control | 29 (90.6%) | 25 (78.1%) | 18 (56.3%) | 0.002 |

Overall, the results demonstrated that both transdermal analgesic modalities provided better postoperative pain relief compared with conventional analgesics following total hip arthroplasty. Among the three groups, transdermal buprenorphine showed superior efficacy in terms of lower NRS pain scores, reduced rescue analgesic requirement, higher patient satisfaction, and earlier mobilization. Transdermal ketoprofen also showed favorable analgesic benefit with acceptable tolerability. Conventional analgesic therapy was associated with higher pain scores, greater rescue analgesic use, and comparatively delayed recovery.

## DISCUSSION

The present study was undertaken to evaluate the safety and efficacy of transdermal buprenorphine patch and transdermal ketoprofen patch compared with conventional analgesics for postoperative pain management in patients undergoing primary unilateral total hip arthroplasty. Effective postoperative analgesia remains an essential component of recovery after hip arthroplasty, as inadequate pain relief delays mobilization, prolongs hospital stay, reduces patient satisfaction, and may adversely affect rehabilitation outcomes. The findings of the present study demonstrate that both transdermal treatment modalities were effective in controlling postoperative pain, with transdermal buprenorphine showing superior efficacy across most measured parameters.

The demographic profile of patients in the present study was comparable among all three groups, indicating a balanced study population and minimizing selection bias. The mean age in the buprenorphine group was 56.8 ± 9.4 years, in the ketoprofen group 58.2 ± 10.1 years, and in the conventional analgesic group 57.6 ± 8.9 years, with no statistically significant difference. Male patients constituted the majority of the study population, accounting for 61.5%, while females represented 38.5%. Avascular necrosis of the femoral head was the most common indication for surgery, followed by fracture neck femur and secondary osteoarthritis. These observations are comparable with those reported by Learmonth et al., Kurtz et al., and He M et al., who also found that total hip arthroplasty is predominantly performed in middle-aged and elderly patients, commonly for avascular necrosis and degenerative hip disorders. Similar baseline distribution among study groups supports the reliability of comparison between analgesic interventions in the present study.

Pain intensity measured using the Numeric Rating Scale showed clinically and statistically meaningful differences between the three groups. Patients receiving transdermal buprenorphine had the lowest postoperative pain scores throughout the study period. At one hour after surgery, the mean pain score was 6.4 ± 1.0 in the buprenorphine group compared with 6.8 ± 0.9 in the ketoprofen group and 7.3 ± 1.1 in the conventional analgesic group. This reduction continued steadily over subsequent follow-up. By postoperative day five, pain scores reduced to 3.2 ± 0.6 in the buprenorphine group, 3.8 ± 0.7 in the ketoprofen group, and 4.6 ± 0.8 in the conventional analgesic group. The difference remained statistically significant throughout follow-up. These findings suggest that transdermal buprenorphine provided sustained analgesic effect over several postoperative days. Similar results have been reported by Vadivelu et al. and Dahan et al., who demonstrated prolonged opioid-mediated analgesia and improved postoperative comfort with buprenorphine patches. Kawai et al. also reported effective pain reduction with ketoprofen transdermal delivery following orthopedic procedures. The present findings therefore align with previously published literature and support the use of transdermal analgesics as a valuable modality in postoperative orthopedic pain management.

Rescue analgesic requirement was another important outcome assessed in the present study. The need for intravenous tramadol was significantly lower in patients receiving buprenorphine patch therapy. Only 12.5% of patients in the buprenorphine group required rescue analgesia compared with 21.9% in the ketoprofen group and 56.3% in the conventional analgesic group. Mean rescue tramadol consumption was also lowest in the buprenorphine group at 46.8 ± 22.5 mg, compared with 71.4 ± 28.6 mg in the ketoprofen group and 142.5 ± 45.2 mg in the conventional group. These findings indicate better baseline analgesic control with transdermal modalities, particularly buprenorphine, reducing the dependence on additional opioid rescue medication. Similar observations have been reported by Apfelbaum et al. and Chou et al., who showed that effective multimodal pain control strategies decrease opioid consumption and improve postoperative recovery. Reduced rescue analgesic use also lowers the burden of opioid-related adverse effects and contributes to safer pain management.

Adverse effects associated with analgesic therapy were also evaluated. In the present study, nausea and vomiting were more common among patients receiving conventional analgesics, affecting 37.5% of patients, compared with 15.6% in the buprenorphine group and 21.9% in the ketoprofen group. Patch-site erythema was observed only in a few patients receiving transdermal preparations and was mild, transient, and did not require discontinuation of treatment. Drowsiness and constipation were infrequent across all groups. These findings indicate that transdermal administration is generally well tolerated and associated with fewer systemic adverse effects than conventional analgesic regimens. Similar findings have been described by Lanas et al., who reported increased gastrointestinal adverse events with conventional analgesics, while Vadivelu et al. noted good tolerability with buprenorphine patches in postoperative patients. The local skin reactions seen with transdermal therapy in our study were minimal and clinically insignificant.

Functional recovery parameters also favored the transdermal patch groups. Early ambulation is a critical milestone after total hip arthroplasty, contributing to faster rehabilitation and reduction in postoperative complications. In the present study, the mean time to ambulation was 26.4 ± 5.8 hours in the buprenorphine group, 28.1 ± 6.1 hours in the ketoprofen group, and 34.8 ± 7.2 hours in the conventional analgesic group. This difference was statistically significant and clinically meaningful. Better pain control likely facilitated earlier mobilization among patients receiving transdermal analgesics. These findings are supported by Kehlet and Dahl, who demonstrated that optimized postoperative analgesia directly improves early mobilization after major orthopedic surgery.

Length of hospital stay was also shorter among patients receiving patch-based analgesia. Mean hospital stay was 6.1 ± 1.4 days in the buprenorphine group, 5.9 ± 1.3 days in the ketoprofen group, and 7.2 ± 1.7 days in the conventional analgesic group. Reduced pain intensity, earlier ambulation, and lower complication rates may all have contributed to earlier discharge in the patch groups. Similar results have been reported in orthopedic enhanced recovery studies where improved pain management reduced hospitalization duration and improved overall patient outcomes.

Patient satisfaction and acceptability are important indicators of analgesic effectiveness. In the present study, satisfaction with pain control was highest in the buprenorphine group, where 90.6% of patients reported satisfactory analgesia. This

was followed by 78.1% in the ketoprofen group and 56.3% in the conventional group. Acceptability of route of administration was also better with transdermal therapy, likely due to convenience, reduced need for repeated injections, sustained drug delivery, and improved comfort. High patient satisfaction associated with transdermal buprenorphine in our study is comparable to observations reported by several previous studies evaluating postoperative opioid patches.

Overall, the findings of the present study demonstrate that transdermal analgesic therapy offers a safe, effective, and clinically practical alternative to conventional analgesics in patients undergoing total hip arthroplasty. Both buprenorphine and ketoprofen patches provided better pain relief, lower rescue analgesic requirement, earlier mobilization, shorter hospital stay, and improved patient satisfaction compared with conventional analgesic therapy. Among the two transdermal modalities, buprenorphine consistently demonstrated the most favorable clinical profile. These findings support the integration of transdermal analgesic patches into multimodal postoperative pain management protocols in hip arthroplasty, particularly in settings where sustained pain relief and improved recovery are key priorities.

## CONCLUSION

The present study concludes that both transdermal buprenorphine patch and transdermal ketoprofen patch are effective and safe alternatives to conventional analgesics for postoperative pain management following total hip arthroplasty. Both transdermal modalities provided superior pain relief, reduced rescue analgesic requirement, improved patient acceptability, and facilitated earlier postoperative mobilization. Among the study groups, transdermal buprenorphine demonstrated the best overall analgesic efficacy with lower postoperative Numeric Rating Scale scores, fewer rescue analgesic requirements, better patient satisfaction, and favorable recovery outcomes. Transdermal ketoprofen also showed significant benefit compared with conventional analgesic therapy and was well tolerated. Conventional analgesic therapy was associated with relatively higher pain scores, greater need for additional analgesics, increased adverse effects, and delayed mobilization. Therefore, transdermal analgesic patches—particularly buprenorphine—may be considered a valuable component of multimodal postoperative pain management protocols in patients undergoing primary unilateral total hip arthroplasty.

## RECOMMENDATIONS

Based on the findings of the present study, transdermal analgesic patches may be routinely considered as part of multimodal postoperative pain management after total hip arthroplasty. Transdermal buprenorphine may be preferred in patients requiring prolonged and sustained postoperative analgesia with reduced opioid rescue requirements. Transdermal ketoprofen may also be considered as an effective non-invasive analgesic alternative. Further randomized multicentric studies with larger sample sizes and long-term follow-up are recommended to validate these findings and establish standardized postoperative analgesic protocols.

## LIMITATIONS

The present study has certain limitations that should be considered while interpreting the results. First, the study was conducted at a single tertiary care center with a total sample size of 96 patients, which may limit the generalizability of the findings to larger populations and different healthcare settings. Second, the duration of follow-up was limited to the immediate postoperative period up to postoperative day 7; therefore, long-term outcomes such as chronic pain relief, prolonged functional recovery, late adverse reactions, and long-term patient satisfaction could not be evaluated. Third, pain perception is subjective and based on individual patient response despite the use of a standardized Numeric Rating Scale, which may introduce variability. Fourth, factors such as psychological status, pain threshold, and personal expectations toward surgery and analgesia may influence pain reporting and satisfaction scores. Lastly, although the study compared three analgesic modalities effectively, larger multicentric randomized controlled trials with longer follow-up are required to further validate these findings and support wider clinical application.

## REFERENCES


1. Learmonth ID, Young C, Rorabeck C. The operation of the century: total hip replacement. **Lancet.** 2007;370(9597):1508–1519.
2. Maradit Kremers H, Larson DR, Crowson CS, Kremers WK, Washington RE, Steiner CA, et al. Prevalence of total hip and knee replacement in the United States. **J Bone Joint Surg Am.** 2015;97(17):1386–1397.
3. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. **J Bone Joint Surg Am.** 2007;89(4):780–785.
4. Apfelbaum JL, Chen C, Mehta SS, Gan TJ. Postoperative pain experience: results from a national survey suggest postoperative pain continues to be undermanaged. **Anesth Analg.** 2003;97(2):534–540.
5. Kehlet H, Dahl JB. Anaesthesia, surgery, and challenges in postoperative recovery. **Lancet.** 2003;362(9399):1921–1928.
6. Chou R, Fanciullo GJ, Fine PG, Adler JA, Ballantyne JC, Davies P, et al. Clinical guidelines for the use of chronic opioid therapy in chronic noncancer pain. **J Pain.** 2009;10(2):113–130.
7. Lanas A, Chan FKL. Peptic ulcer disease. **Lancet.** 2017;390(10094):613–624.
8. Pergolizzi JV, LeQuang JA, Taylor R, Ossipov MH, Colucci D, Raffa RB. Designing safer analgesics: a focus on μ-opioid receptor pathways. **Expert Opin Drug Discov.** 2018;13(10):965–972.

9. Prausnitz MR, Langer R. Transdermal drug delivery. **Nat Biotechnol.** 2008;26(11):1261–1268.
10. Dahan A, Yassen A, Romberg R, Sarton E, Teppema L, Olofsen E, et al. Buprenorphine induces ceiling in respiratory depression but not in analgesia. **Br J Anaesth.** 2006;96(5):627–632.
11. Cioli V, Putzolu S, Rossi V, Scorza Barcellona P, Corradino C. The role of direct tissue contact in the production of gastrointestinal ulcers by anti-inflammatory drugs in rats. **Toxicol Appl Pharmacol.** 1979;50(2):283–289.
12. Williams KD. Managing pain with transdermal ketoprofen. **Int J Pharm Compd.** 2010;14(3):204–206.
13. White PF, Kehlet H. Improving postoperative pain management: what are the unresolved issues? **Anesthesiology.** 2010;112(1):220–225.
14. Maheshwari AV, Blum YC, Shekhar L, Ranawat AS, Ranawat CS. Multimodal pain management after total hip and knee arthroplasty at the Ranawat Orthopaedic Center. **Clin Orthop Relat Res.** 2009;467(6):1418–1423.
15. Chou R, Gordon DB, de Leon-Casasola OA, Rosenberg JM, Bickler S, Brennan T, et al. Management of postoperative pain: a clinical practice guideline. **J Pain.** 2016;17(2):131–157.
16. Brummett CM, Waljee JF, Goesling J, Moser S, Lin P, Englesbe MJ, et al. New persistent opioid use after minor and major surgical procedures in US adults. **JAMA Surg.** 2017;152(6):e170504.
17. Vadivelu N, Anwar M. Buprenorphine in postoperative pain management. **Anesthesiol Clin.** 2010;28(4):601–609.
18. Kawai S, Uchida E, Kondo M, Ohno S, Obata J, Nawata Y, et al. Efficacy and safety of ketoprofen patch in patients with rheumatoid arthritis: a randomized placebo-controlled study. **J Clin Pharmacol.** 2010;50(10):1171–1179.
19. Basha A, Titiloye A, Kaya I, Alsaleh M. Transdermal buprenorphine patch in the management of postoperative pain in orthopaedic patients: a systematic review of efficacy, safety, adverse effects and cost-benefit analysis. **Eur J Orthop Surg Traumatol.** 2025;35(2):221–229.
20. Nayak T, Ojha MM, Ansari MA, Sehrawat S, Shankar V, Kumar S, et al. Comparison of the efficacy of transdermal buprenorphine versus ketoprofen patches for postoperative analgesia in total knee arthroplasty: a randomized controlled trial. **Cureus.** 2024;16(10):e72382.
21. Agrawal MG, Kanungo H, Gupta M, Mishra K, Soni A, Agrawal N. Transdermal patches for pain relief in orthopedic procedures: a narrative review. **Cureus.** 2024;16(1):e51669.
22. Macheras GA, Tzefronis D, Argyrou C, Nikolakopoulou E, Gálvez Miravete A, Karachalios TS. Pain management after total hip arthroplasty: comparative study of analgesic efficacy and tolerability between oral tramadol-dexketoprofen and injectable paracetamol plus tramadol. **Hip Int.** 2024;34(3):304–310.
23. Pandey K, Shettar V, Kale T. Efficacy of transdermal ketoprofen patch in comparison to transdermal diclofenac patch in postoperative analgesia: a randomized study. **Cureus.** 2023;15(4):e37732.
24. Pergolizzi JV, Magnusson P, LeQuang JA, Breve F, Mitchell K, Chopra M, et al. Transdermal buprenorphine for acute pain in the clinical setting: a narrative review. **J Pain Res.** 2021;14:871–879.
25. Machado FC, Neto GC, Paiva LO, Soares TC, Nakamura RK, Nascimento LF, et al. Transdermal buprenorphine for acute postoperative pain: a systematic review. **Braz J Anesthesiol.** 2020;70(4):419–428.
26. Londhe S, Patwardhan M, Shah R, Oak M. Efficacy and safety of buprenorphine transdermal patch for immediate postoperative analgesia after total knee arthroplasty surgery. **J Arthroplasty.** 2020;35(6 Suppl):S178–S181.
27. Xu X, Xie L, Liu H, Hu Y. Transdermal buprenorphine patch versus oral celecoxib for pain management after total knee arthroplasty: an open-label randomized controlled trial. **Orthop Traumatol Surg Res.** 2020;106(5):915–919.
28. Li WM, Li FD, Xu H, Sun LC. Analgesic impact of buprenorphine transdermal patch in total hip arthroplasty. **Medicine (Baltimore).** 2020;99(24):e20405.
29. Yu S, Dundon J, Solovyova O, Bosco J, Iorio R. Can multimodal pain management in total knee arthroplasty eliminate patient-controlled analgesia and femoral nerve blocks? **Clin Orthop Relat Res.** 2018;476(1):101–109.
30. Desai SN, Badiger SV, Tokur SB, Naik PA. Safety and efficacy of transdermal buprenorphine versus oral tramadol for the treatment of postoperative pain following surgery for fracture neck of femur: a prospective randomized clinical study. **Indian J Anaesth.** 2017;61(3):225–229.