

Comparative Evaluation of Efficacy of Transdermal Buprenorphine Patch versus Intraoperative Cocktail Injection for Post-operative Pain Relief in Total Hip Arthroplasty

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Learning Point of the Article:

In total hip arthroplasty, periarticular cocktail infiltration offers superior early post-operative pain relief while transdermal buprenorphine patch provides sustained analgesia in the later post-operative period.

Abstract

Introduction: Effective post-operative pain control after total hip arthroplasty (THA) is essential for early mobilization, faster rehabilitation, and improved patient satisfaction. The present study was to compare the analgesic effectiveness and safety of a 5 mg transdermal buprenorphine patch versus an intraoperative periarticular cocktail injection for post-operative pain relief in THA patients, by assessing pain intensity and rescue analgesia use.

Materials and Methods: This observational analytical study was carried out in the Department of Orthopedics at Gandhi Medical College and Hamidia Hospital, Bhopal, between May 2023 and April 2024. A total of 44 adult patients scheduled for THA were enrolled and divided into two equal groups. Group 1 (n = 22) received a 5 mg transdermal buprenorphine patch applied 12 h before surgery. At the same time, Group 2 (n = 22) received an intraoperative periarticular cocktail injection composed of 0.2% ropivacaine, cefuroxime, triamcinolone, ketorolac, adrenaline, and normal saline (45 mL). Post-operative pain was assessed using the visual analog scale (VAS), with scores recorded preoperatively and at 4, 8, 12, 24, 48, 72, and 120 h after surgery. The requirement and timing of rescue analgesia, as well as any adverse events, were monitored throughout the study period.

Results: Baseline demographic and surgical variables were comparable between the two groups. VAS scores were similar preoperatively (P = 0.763) and at 4 h postoperatively (P = 0.853). From 8 to 72 h postoperatively, the intraoperative cocktail group reported significantly lower VAS scores (e.g., at 8 h: 5.45 ± 1.63 vs. 7.73 ± 1.42 ; $P < 0.001$) and required fewer rescue analgesic doses (mean 1.91 vs. 3.73; $P = 0.008$). After 120 h, pain levels converged (3.55 ± 1.26 vs. 2.95 ± 1.62 ; $P = 0.194$), suggesting more sustained pain relief in the buprenorphine patch group. Both methods were safe, with only minor and non-significant adverse events.

Conclusion: Intraoperative cocktail infiltration provided superior early post-operative analgesia and reduced the need for rescue analgesia, while transdermal buprenorphine patches offered comparable and possibly more sustained pain relief by post-operative day 5. Both modalities were well tolerated. Tailoring the choice of analgesic strategy to patient-specific needs and surgical context may optimize pain management in hip arthroplasty. To the best of our knowledge, this is the first study directly comparing transdermal buprenorphine patches with periarticular cocktail infiltration for post-operative pain management in THA.

Keywords: Hip arthroplasty, post-operative pain, buprenorphine patch, intraoperative cocktail injection, Visual analog scale, rescue analgesia.

Author's Photo Gallery



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Introduction

Arthroplasty or joint replacement surgery is performed to restore joint function by replacing damaged or diseased articular surfaces with prosthetic components. The knee and hip joints are most affected due to their susceptibility to degenerative conditions such as osteoarthritis, rheumatoid arthritis, avascular necrosis, and traumatic injuries [1,2]. Total hip arthroplasty (THA) is now routine and a highly successful orthopedic procedure that helps relieve pain, restore mobility, and improve the quality of life for patients suffering from end-stage joint diseases. Over the past few decades, the number of these surgeries has increased significantly, primarily due to advancements in surgical techniques, prosthetic designs, and perioperative care [3,4].

However, despite these improvements, managing post-operative pain remains a significant challenge. Poor pain control can delay rehabilitation, extend hospital stays, and reduce patient satisfaction [5]. Pain after THA is often severe and requires effective pain relief to support early mobilization and faster recovery. Conventional treatment options such as systemic opioids, non-steroidal anti-inflammatory drugs (NSAIDs), and regional anesthesia are commonly used and effective to some extent. Still, they come with risks of side effects and inconsistent efficacy across patients [6].

To address these limitations, newer pain management strategies have been explored. Among them, transdermal buprenorphine patches and intraoperative cocktail injections have shown promise in providing sustained, opioid-sparing pain relief [7, 8]. Nevertheless, there is limited evidence directly comparing these two methods in the context of joint replacement surgeries. Although both modalities have been evaluated individually, there is a paucity of direct comparative evidence between them. While numerous studies have examined pain management in total knee replacement, this is the first study to directly compare these two modalities in the context of THA.

This study aims to compare the analgesic efficacy and safety of transdermal buprenorphine patches with intraoperative cocktail injections in patients undergoing hip or knee arthroplasty. By determining which method offers better pain control while being safe and patient-friendly, this research hopes to contribute to improved recovery, earlier rehabilitation, and greater overall satisfaction following joint replacement surgery.

Materials and Methods

This observational analytical study was conducted on 44 adult patients scheduled for THA in the Department of Orthopedics at Gandhi Medical College and Hamidia Hospital, Bhopal. The

study was carried out over a period from May 2023 to April 2024.

The study protocol was reviewed and approved by the Institutional Ethics Committee of Gandhi Medical College and Hamidia Hospital (IEC letter number – 18862/MC/IEC/2023 dated May 09, 2023). Written informed consent was obtained from all participants before enrolment in the study.

Inclusion criteria

The study included adult patients who were scheduled to undergo THA at Hamidia Hospital, Bhopal and received either a transdermal buprenorphine patch or intraoperative periarticular cocktail injection for post-operative pain management. Only those patients who were willing to participate in the study and provided written informed consent were enrolled.

Exclusion criteria

Patients with a known hypersensitivity to the buprenorphine patch or contraindications to any of the drugs used in the cocktail injection were excluded from the study. In addition, individuals with uncontrolled diabetes mellitus or with abnormal liver function tests or renal function tests (RFT) were not considered eligible for participation.

Materials and Methods

Patients who underwent total hip replacement and received either transdermal buprenorphine patch or intraoperative periarticular cocktail injection for post-operative pain relief as per surgeon's preference and institute policies were included in the study.

All eligible patients underwent a thorough clinical evaluation, including measurement of vital signs, height, weight, and body mass index. Routine laboratory tests were performed, including complete blood count, erythrocyte sedimentation rate, liver and RFTs, coagulation profile, and random blood sugar levels. Comorbid conditions, such as hypertension, diabetes mellitus, rheumatoid arthritis, and other immunocompromised states, were documented. A history of steroid or immunosuppressant use, as well as lifestyle factors such as smoking, alcohol consumption, and tobacco chewing, was also recorded. A detailed physical examination of the hip was carried out to assess flexion, coronal plane, and rotational deformities. Pre-operative pain levels were recorded using the visual analog scale (VAS) and functional status was evaluated using the Harris Hip score.



Figure 1: 5 mg transdermal buprenorphine patch used in the present study.

In group 1, patients who received a 5 mg transdermal buprenorphine patch were included. The patch was applied 12 h before surgery and was retained for 7 days postoperatively (Fig. 1 and 2).

In group 2, patients who received an intraoperative periarticular cocktail injection were included. This 45 mL periarticular cocktail consisted of 20 mL of 0.2% ropivacaine, 1.5 g cefuroxime, 1 mL of triamcinolone acetate (40 mg/mL), 1 mL of ketorolac (30 mg/mL), 0.5 mL of adrenaline, and 20 mL of normal saline (Fig. 3). It was injected periarticularly and subperiosteally around the acetabulum – including the superior, inferior, anterior, and posterior surfaces as well as the lateral femur, tensor fascia lata, and gluteus maximus during surgery by the operating surgeon (Fig. 4).

Post-operative evaluation and rescue analgesia

Post-operative pain was assessed using the VAS at 4, 8, 12, 24, 48, 72, and 120 h after surgery. If the VAS score exceeded 6, rescue analgesia was provided starting with intramuscular diclofenac 75 mg. If further pain control was needed,



Figure 2: Application of the transdermal buprenorphine patch on the lateral aspect of the left shoulder.

intravenous tramadol (1 ampoule in 100 mL normal saline) was given, followed, if necessary by intravenous paracetamol 1 g infusion. The day on which patients were able to ambulate with weight-bearing was noted.

Pain assessment scale

The VAS is a validated, subjective measure for acute and chronic pain. Pain which the patient perceived was graded based on a visual score and scores were recorded accordingly.

Statistical analysis

All data were entered into Microsoft Excel 2010. Continuous variables were expressed as mean \pm standard deviation and compared using the unpaired t-test or Mann–Whitney U-test, depending on data distribution. Categorical variables were compared using the Chi-square test. $P < 0.05$ was considered statistically significant. Statistical analysis was performed using Epi Info 7.0 software.

Results

A total of 44 patients undergoing hip arthroplasty (22 in each group) completed the study. Baseline demographic and clinical characteristics were comparable between the transdermal buprenorphine patch group and the intraoperative cocktail group.

Demographic profile

The mean age was 49.64 ± 18.66 years in the buprenorphine group and 51.14 ± 16.08 years in the cocktail group ($P = 0.777$). Male to female ratios were similar, and both groups were comparable with respect to side of involvement (right vs. left hip) and flexion deformity (Table 1).

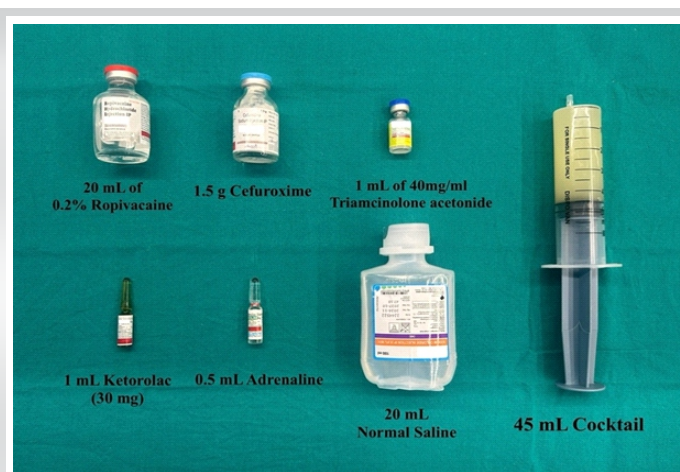


Figure 3: Composition of drugs used in the preparation of the cocktail injection.



Figure 4: Intraoperative administration of analgesic cocktail.

Post-operative pain scores

Pain intensity, assessed by VAS, showed no significant difference preoperatively (7.00 ± 2.00 vs. 7.18 ± 1.97 ; $p = 0.763$) and at 4 h postoperatively (4.73 ± 1.61 vs. 4.64 ± 1.62 ; $p = 0.853$). From 8 h onward, patients receiving intraoperative cocktail injections reported significantly lower pain scores up to 72 h. By 120 h, VAS scores converged, showing comparable pain levels between the groups (Table 2).

Rescue analgesia

86 % of patients in the buprenorphine group required at least one rescue dose versus 59% in the cocktail group. The mean number of injections per patient was higher with buprenorphine (3.73 vs. 1.91). Time to first rescue dose was significantly delayed in the cocktail group ($P = 0.043$), indicating better early post-operative analgesia.

Discussion

Adequate management of post-operative pain after THA is essential for achieving early mobilization, faster rehabilitation, reduced hospital stay, and improved patient satisfaction. Despite the progress in surgical techniques and anesthesia protocols, pain following THA continues to be a major concern and can significantly influence post-operative recovery. Multimodal analgesia, including systemic opioids, NSAIDs, and regional anesthesia, has been widely used; however, these options may be associated with variable efficacy and

undesirable side effects [5, 6]. This has led to the exploration of alternative modalities such as transdermal buprenorphine patches and periarticular cocktail injections, which aim to provide sustained pain control with fewer adverse events [7, 8].

In the present study, we compared the analgesic efficacy and safety of these two approaches in patients undergoing THA. Demographic and baseline clinical characteristics were similar between the groups, ensuring comparability of outcomes. Our results showed that both groups had similar pre-operative pain scores and no significant difference at 4 h postoperatively. However, from 8 to 72 h, patients receiving periarticular cocktail infiltration reported significantly lower pain scores and required fewer rescue analgesic doses. By 120 h, VAS scores converged, with slightly better sustained relief in the buprenorphine group, though this was not statistically significant. These findings suggest that cocktail infiltration provides superior early analgesia, while buprenorphine patches may offer more consistent late phase pain control.

The baseline comparability of both groups in terms of age, sex distribution, type of surgery, and pre-operative deformities strengthens the internal validity of our results. Similar observations regarding baseline equivalence were reported by Londhe et al. [9]. Functional recovery assessed by the Harris Hip score was marginally higher in the buprenorphine group. However, the difference was not significant, aligning with the findings of Aguilar et al. [10], who also reported no major differences in functional outcomes when comparing buprenorphine patches with other analgesic modalities.

Our findings regarding superior early pain relief with cocktail infiltration are in line with studies by Fu et al. [11] and Hannon et al. [12], who demonstrated adequate early post-operative analgesia with periarticular injections. The higher pain scores in the buprenorphine group during the initial 72 h may be partly due to the lower dose patch (5 mg) used in our study. Previous trials by Yadav et al. [13], Xu et al. [14], Li et al. [15], and Nayak et al. [16] used higher doses (10 mg). They reported more robust early analgesia, suggesting that dose optimization could improve buprenorphine patch performance.

At 120 h, patients in the buprenorphine group reported lower VAS scores than those in the cocktail group, though the difference was not statistically significant. This may be attributed to the sustained-release pharmacokinetics of buprenorphine patches. Similar long-lasting analgesic effects of buprenorphine have been observed by Fang et al. [8], who demonstrated improved sleep quality and reduced late post-operative pain when patches were used as part of multimodal analgesia.

Rescue analgesia requirements further highlighted the early advantage of cocktail infiltration. In our study, 40.9% of cocktail

Table 1: Comparing characteristics of the study population between groups					
Parameters	Buprenorphine patch	Intraoperative cocktail	Total n (%)	Pearson Chi-square/t-value	p-value
Age; years					
20–40	7 (31.8)	8 (36.4)	15 (34.1)	0.082	0.777
41–60	8 (36.4)	7 (31.8)	15 (34.1)		
61–80	5 (22.7)	7 (31.8)	12 (27.3)		
>80	2 (9.1)	0 (0.0)	2 (4.5)		
Sex					
Male	12 (54.5)	13 (59.1)	25 (56.8)	0.093	0.761
Female	10 (45.5)	9 (40.9)	19 (43.2)		
Side					
Right	9 (40.9)	11 (50.0)	20 (45.5)	0.367	0.545
Involved					
Left	13 (59.1)	11 (50.0)	24 (54.5)		
Flexion deformity; degree					
0°	12 (54.5)	9 (40.9)	21 (47.7)	4.203	0.24
10°	2 (9.1)	7 (31.8)	9 (20.5)		
20°	5 (22.7)	5 (22.7)	10 (22.7)		
30°	3 (13.6)	1 (4.5)	4 (9.1)		
Coronal plane (adduction deformity); degree					
0	10 (45.5)	11 (50.0)	21 (47.7)	1.214	0.75
100	5 (22.7)	3 (13.6)	8 (18.2)		
200	5 (22.7)	7 (31.8)	12 (27.3)		
300	2 (9.1)	1 (4.5)	3 (6.8)		
Limb length discrepancy (cm)*	1.73±0.8	1.98±0.87	1.85±0.83	-0.996	0.325
Data are expressed as the number of patients (percentage), the Chi Square test, and *the unpaired “t” test was applied to compute the level of significance. p < 0.05 was considered significant.					

group patients did not require any rescue medication, compared with only 13.6% in the buprenorphine group. Total rescue injections were nearly double in the buprenorphine group (3.73 vs. 1.91 per patient). These findings are consistent with the meta-analysis by Deng et al. [17], which concluded that the addition of steroids to multimodal periarticular injections prolongs analgesic duration and decreases the need for supplemental analgesia. Similarly, Liu et al. [18] also reported reduced opioid consumption and faster rehabilitation with local cocktail infiltration in THA.

This study adds to the limited literature by providing the first direct head-to-head comparison of transdermal buprenorphine patches and periarticular cocktail infiltration in THA. The findings highlight their complementary roles in optimizing perioperative analgesia.

Limitations of the study include its single-center design and relatively small sample size, which may restrict the generalizability of findings. In addition, only the 5 mg buprenorphine patch was evaluated, which may not reflect the potential efficacy of higher doses. Long-term outcomes, including patient-reported satisfaction, opioid sparing, and functional recovery, were not assessed and should be addressed in future multicenter randomized controlled trials.

Conclusion

This study demonstrated that intraoperative periarticular cocktail infiltration provided superior early post-operative analgesia and significantly reduced the requirement for rescue medication in patients undergoing THA. In contrast, the transdermal buprenorphine patch, while less effective during the initial post-operative period, offered more sustained pain relief by the 5th post-operative day. Both modalities were well tolerated, with no major adverse events reported. These findings suggest that periarticular cocktail infiltration may be the preferred strategy for achieving effective early pain control and facilitating early mobilization. At the same time, buprenorphine patches may serve as a useful adjunct for maintaining prolonged analgesia during recovery. The choice between these techniques should be individualized, taking into account patient needs, comorbidities, and surgical context. Larger multicenter randomized trials with longer follow-up are warranted to validate these results and to optimize multimodal analgesic protocols for hip arthroplasty further.

Clinical Message

In patients undergoing THA, intraoperative periarticular cocktail infiltration should be preferred for achieving effective early post-operative pain relief, thereby facilitating early mobilization and rehabilitation. Transdermal buprenorphine patches may be used as a useful adjunct or alternative for maintaining sustained analgesia in the later post-operative period, especially in patients where prolonged opioid sparing pain control is desirable. An individualized, patient-centered analgesic strategy that integrates surgical factors, comorbidities and recovery goals can optimize post-operative outcomes following hip arthroplasty.

Table 2: Comparison of the mean VAS score between groups

Time interval (hours)	Buprenorphine patch Mean±SD	Intraoperative cocktail Mean±SD	P-value
Pre-operative	7.00±2.00	7.18±1.97	0.763
Post-operative 4 h	4.73±1.61	4.64±1.62	0.853
Post-operative 8 h	7.73±1.42	5.45±1.63	<0.001
Post-operative 12 h	7.45±2.06	6.14±1.64	0.026
Post-operative 24 h	6.95±1.79	5.23±1.60	0.002
Post-operative 48 h	6.36±1.99	4.14±2.29	0.001
Post-operative 72 h	4.77±1.54	3.86±1.32	0.042
Post-operative 120 h	2.95±1.62	3.55±1.26	0.194
VAS: Visual analog scale, SD: Standard deviation			

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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