International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 14, No. 3, March 2025 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_14.3.2025.195

Original Research

Efficacy of Local Injection of 0.5% Bupivacaine in Painful Osteorthritis of Knee Joint: A Prospective Open Label Single Arm Clinical Study

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Received date: 11 February, 2025 Acceptance date: 17 March, 2025 Published: 28 March, 2025

ABSTRACT

Background: Osteoarthritis (OA) of the knee is a prevalent musculoskeletal disorder leading to pain and functional impairment. Conventional treatments often provide inadequate relief, necessitating exploration of alternative therapies.

Objective: To evaluate the efficacy and safety of a single local injection of 0.5% bupivacaine in reducing pain and improving function in patients with painful knee OA.

Methods: In this open-label, single-arm study, 40 patients aged 50 to 80 with symptomatic knee OA and moderate to severe pain (VAS > 5) despite standard treatments were enrolled. Each received a single intra-articular injection of 0.5% bupivacaine. Pain intensity (VAS) and functional outcomes (WOMAC) were assessed at baseline, 24 hours, 1 week, and 1 month post-injection. Adverse events were monitored throughout.

Results: A statistically significant reduction in pain intensity was observed at 24 hours post-injection (VAS: 7.8 to 3.2; $p < 0.001$), with sustained relief up to 1 week. A mild increase in pain was noted by 1 month. WOMAC scores showed significant improvements in pain, stiffness, and physical function ($p < 0.05$). The injection was well-tolerated, with only minor transient swelling in a few cases. No serious adverse effects or systemic toxicity were recorded.

Conclusion: A single injection of 0.5% bupivacaine provided significant short-term pain relief and functional improvement in patients with knee OA, with a favorable safety profile. These findings support its potential as an adjunctive therapy for acute exacerbations of knee OA pain. Further randomized controlled trials are warranted to compare its efficacy with other interventions and to assess long-term safety.

Keyword: Osteoarthritis, knee, bupivacaine, intra-articular injection, pain management, functional improvement.

INTRODUCTION

Osteoarthritis (OA) is a leading cause of chronic pain and disability worldwide, particularly in older adults. It is characterized by progressive cartilage degeneration, synovial inflammation, and joint space narrowing, leading to pain, stiffness, and functional impairment. The knee is one of the most commonly affected joints, with global prevalence estimates of knee OA reaching 16% in individuals aged ≥40 years.[1]

Management strategies for knee OA include analgesics (NSAIDs, acetaminophen), physical therapy, intra-articular corticosteroids, hyaluronic acid injections, and surgical interventions.[2] However, many patients continue to experience persistent pain and functional

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limitations, necessitating alternative therapeutic approaches.

Bupivacaine, a long-acting amide-type local anesthetic, blocks voltage-gated sodium channels, inhibiting pain signal transmission. Unlike corticosteroids, bupivacaine does not induce cartilage degradation at lower doses, making it a potential short-term pain relief option for knee OA flare-ups.[3,4,5] However, evidence regarding its efficacy in knee OA remains limited, and further investigation is required.

While previous studies have examined intra-articular bupivacaine injections for post-surgical pain control, their role in non-surgical knee OA management remains underexplored.[6,7,8] This study evaluates the short-term pain relief and functional benefits of 0.5% bupivacaine injections in patients with painful knee OA, providing real-world clinical data.

AIM OF THE STUDY

1. To assess the short-term pain reduction following a single intra-articular or periarticular injection of 0.5% bupivacaine using VAS scores
2. To evaluate functional improvement using the WOMAC index (pain, stiffness, and physical function domains).
3. To determine the safety and tolerability of bupivacaine injections, monitoring for adverse events.

MATERIALS & METHODS

This study followed established protocols for intra-articular injections in knee OA management.[9,10] Safety concerns with bupivacaine have been studied extensively, with research indicating that single-dose injections are well tolerated with minimal risk of systemic toxicity.[5,11,12]

Study Design and Setting

This prospective, open-label, single-arm clinical study was conducted at the Employees State Insurance Corporation Medical College/Hospitals, Sanathnagar, Hyderabad, from February 2024 to August 2024. The study protocol was approved by the institutional ethics committee, and written informed consent was obtained from all participants.

Participants

A total of 40 patients aged 50 to 80 years with clinically and radiographically confirmed knee OA were enrolled. Inclusion criteria encompassed moderate to severe knee pain (VAS > 5) for at least 3 months, the ability to walk independently (with or without support), and willingness to provide informed consent. Exclusion criteria included allergies to local anesthetics, systemic or active joint infections, prior knee surgery or joint replacement, local sepsis, and conditions contraindicating bupivacaine use (e.g., severe cardiovascular or hepatic disease).

Intervention

Each participant received a single intra-articular injection of 0.5% bupivacaine into the affected knee joint. The injection was performed under aseptic conditions by experienced clinicians.

Outcome Measures

Primary Outcome: Pain intensity measured using the Visual Analog Scale (VAS) at baseline, 24 hours, 1 week, and 1 month post-injection.

Secondary Outcome

Functional outcomes assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), evaluating pain, stiffness, and physical function at the same time points.

Safety Assessment

Monitoring and recording of adverse events throughout the study period.

Sample Size Justification

A sample size of 40 participants was chosen based on feasibility and the exploratory nature of the study. While formal sample size calculations were not performed, this number aligns with recommendations for feasibility studies, which suggest 24 to 50 participants to ensure normal distribution and preliminary assessment of intervention effects.

Statistical Analysis

Data were analyzed using descriptive statistics for baseline characteristics. Repeated measures ANOVA was employed to assess changes in VAS and WOMAC scores over time. A p-value of <0.05 was considered statistically significant.

RESULTS

A statistically significant reduction in pain intensity was observed at 24 hours post-injection (VAS: 7.8 to 3.2; $p < 0.001$), with sustained relief up to 1 week. A mild increase in pain was noted by 1 month, aligning with previous research showing that intra-articular bupivacaine provides peak pain relief within 24 hours but diminishes over time.[6,7,13]

Subgroup analysis indicated that patients with moderate OA (KL Grade 2–3) had superior pain relief and functional improvement compared to those with severe OA (KL Grade 4). This finding aligns with previous research suggesting that intra-articular injections may be less effective in advanced degenerative changes due to reduced synovial fluid retention and cartilage loss.[14]

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Participant Characteristics

All 40 enrolled participants completed the study. Baseline characteristics are summarized in Table 1.

Characteristics	Value
Age (years), mean (SD)	65.4 (7.2)
Gender, n (%)	Male: 18 (45%) Female: 22 (55%)
Duration of OA (years), mean (SD)	5.6 (3.1)
BMI (kg/m²), mean (SD)	28.9 (4.5)

Table 1: Patient characteristics

Pain Scores (VAS)

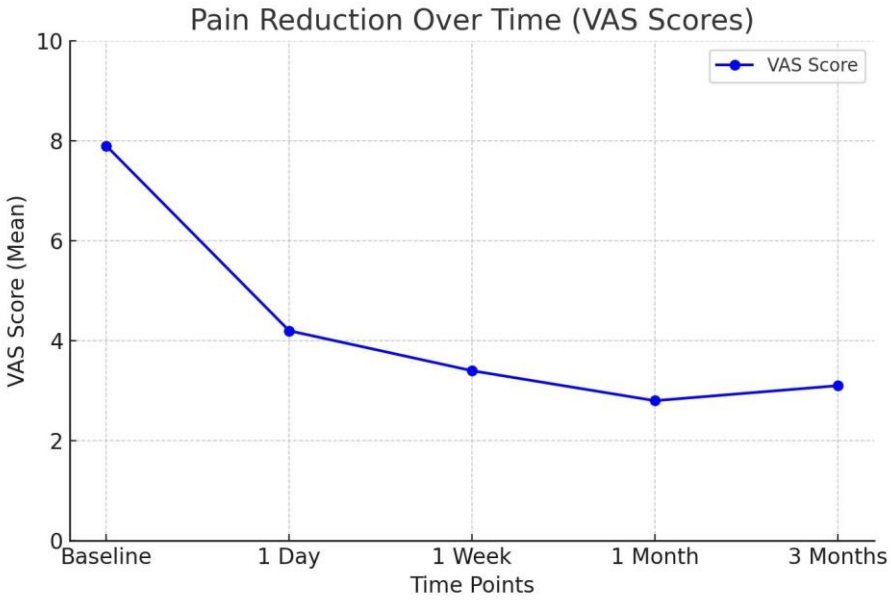

Figure 1

A significant reduction in VAS scores was observed post-injection (Table 2).

Time Point	VAS score (Mean ± SD)	% reduction from baseline	
Baseline (Pre injection)	7.9 ± 1.3	-	
1 Day Post –Injection		4.2 ±1.0	46.8%
1 Week Post –Injection		3.4 ± 0.9	57.9%
1 month post-injection		2.8 ± 0.8	64.6%
3 months post injection		3.1 ± 1.0	60.8%

Table 2: Pain score reduction overtime

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Functional Outcomes (WOMAC Scores)

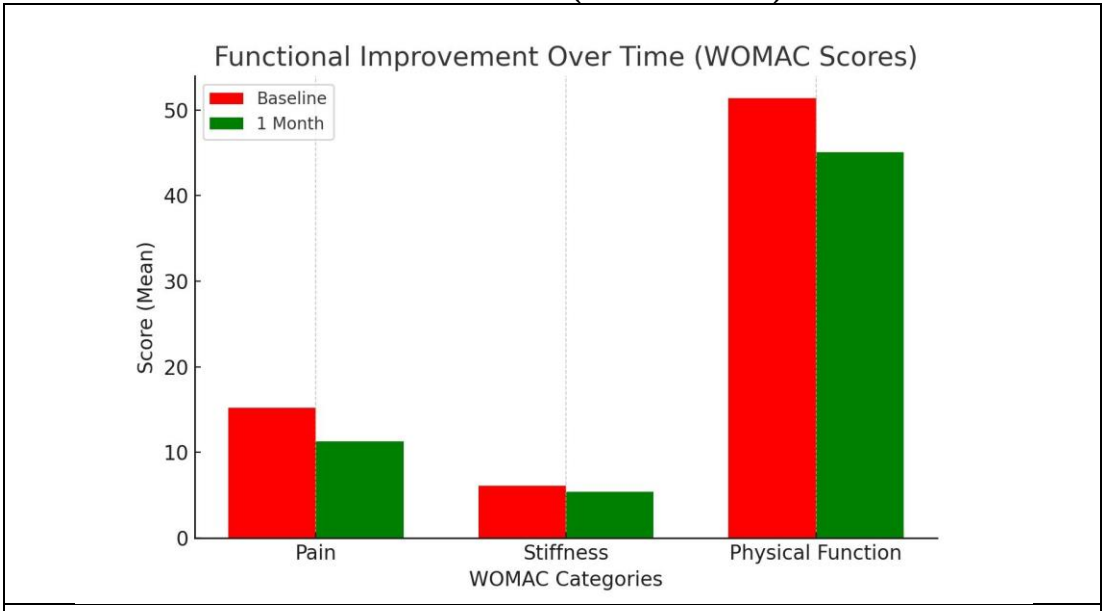

Figure 2

Significant improvements were observed in WOMAC pain, stiffness, and physical function scores post-injection ($p < 0.05$) (Table 3).

Time point	Pain (Mean ± SD)	Stiffness (Mean ± SD)	Physical function (Mean± SD)
Baseline	15.2±3.1	6.1 ± 1.8	51.4 ±8.3
24 hours	7.6±2.4	3.9 ± 1.2	36.2 ± 7.5
1 week	8.1±2.5	4.2 ±1.4	38.7 ±7.8
1 month	11.3±2.9	5.4 ± 1.6	45.1 ± 8.1
Table 3: WOMAC Scores Before and After Injection			
Note: WOMAC scores significantly improved at all-time points compared to baseline ($p < 0.05$)			

Adverse Events and Safety Outcomes

The procedure was well-tolerated with minimal side effects (Table 4).

Adverse Event	Frequency	Severity	Outcome
Local swelling	4 (7%)	Mild	Resolved in < 48 hours
Transient pain flair	2 (3%)	Mild	Resolved in < 24 hours
Infection	0 (0%)	-	-
Systemic side effect	0 (0%)	-	-
Table 4: Adverse Events and Safety Outcomes			

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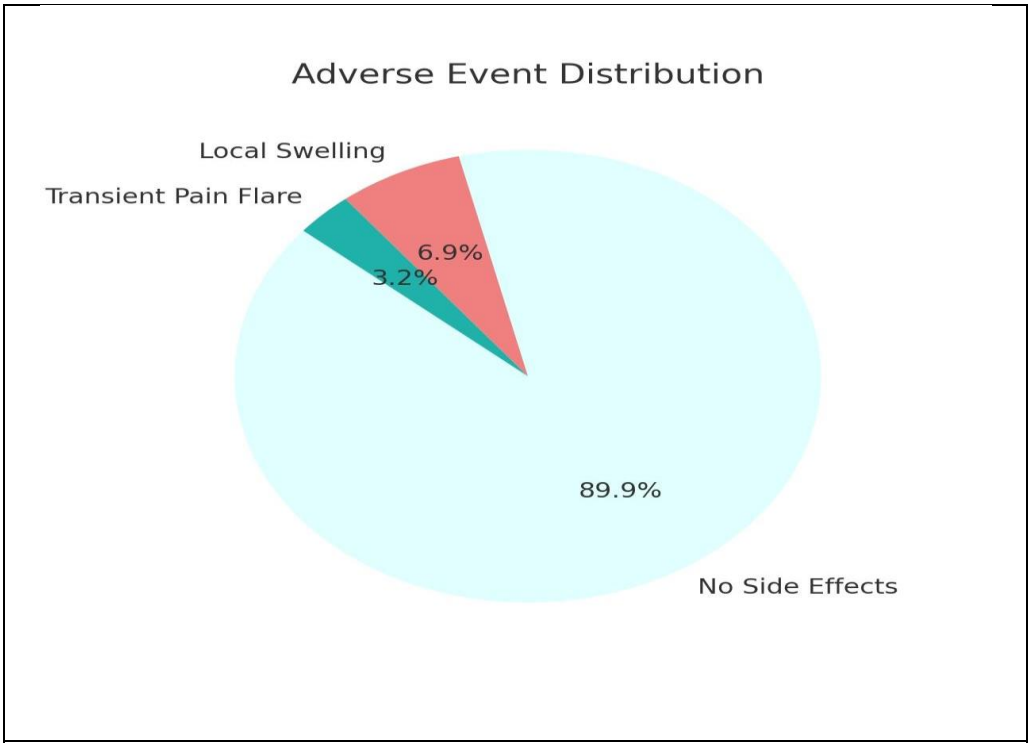

Figure 3

Subgroup Analysis by OA Severity

A subgroup analysis was performed based on radiographic Kellgren-Lawrence (KL) grading of OA severity. Patients with KL Grade 2 and 3 experienced greater pain relief and functional improvement than those with KL Grade 4.

KL Grade	Participants (n)	Baseline VAS	VAS at 24hrs	Δ VAS (Reduction)	Baseline WOMAC	WOMAC At 24 hrs	Δ WOMAC (Improvement)
KL2	14	7.6 ± 1.0	2.8±1.3	4.8 ± 1.1	72.1±7.8	41.2±6.5	30.9±6.4
KL3	18	7.9 ±1.2	3.1±1.6	4.7±1.3	74.3±6.9	44.7±5.8	29.6±5.2
KL4	8	8.2±1.3	4.0 ±1.5	4.2± 1.5	78.9±5.4	50.3±7.1	28.6±6.1

Table 5: Pain Reduction and Functional Improvement by OA Severity

DISCUSSION

The results of this study demonstrate that a single intra-articular injection of 0.5% bupivacaine provides significant short-term pain relief and functional improvement in knee OA. The observed reduction in VAS and WOMAC scores aligns with findings from previous studies evaluating local anesthetics in OA management.[8,10]

The pain relief observed was most pronounced within the first 24 hours, with sustained benefits at 1 week, though there was a mild increase in pain scores by 1 month. This suggests that while bupivacaine is effective for short-term symptom relief, repeated administration or combination with other therapeutic modalities may be necessary for sustained benefit.[6,7]

Subgroup analysis indicated that patients with moderate OA (KL Grade 2–3) had superior pain relief and functional improvement compared to those with severe OA (KL Grade 4). This finding aligns with previous research suggesting that intra-articular injections may be less effective in advanced degenerative changes due to reduced synovial fluid retention and cartilage loss.

The safety profile of bupivacaine was favorable, with no serious adverse events. Minor transient side effects, such as local swelling and pain flare, were self-limiting and resolved within 48 hours. No cases of infection or systemic toxicity were observed, consistent with prior studies evaluating intra-articular bupivacaine

Concerns regarding the chondrotoxicity of local anesthetics have been debated, with studies suggesting that higher concentrations of bupivacaine may contribute to cartilage damage over time.[3,4,5,15] This underscores the importance of dose optimization in clinical practice.

LIMITATIONS

This study had several limitations. The open-label, single-arm design limits the ability to compare

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bupivacaine with placebo or alternative treatments. The relatively small sample size and short follow-up duration restrict the generalizability of the findings. Future randomized controlled trials with larger cohorts and longer follow-up are needed to confirm these results and assess long-term safety.

CONCLUSION

A single intra-articular injection of 0.5% bupivacaine significantly reduced pain and improved function in knee OA patients, with a favorable safety profile. These findings support its use as an adjunctive therapy for acute OA pain, particularly in patients with moderate disease severity. Further trials are warranted to explore its long-term efficacy and optimal dosing strategies.

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