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Original Research Article

Efficacy of IPACK Block as an Adjunct to Multimodal Pain Management in Patients Undergoing Total Knee Arthroplasty: A Prospective Comparative Study

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Conflict of interest: Nil

Abstract:

Background: Total knee arthroplasty is commonly associated with significant postoperative pain, which may delay early mobilisation and rehabilitation. The IPACK block is a motor-sparing regional anaesthesia technique that targets posterior knee pain and may improve analgesic outcomes when added to multimodal pain management.

Aim and Objective: To evaluate the efficacy of IPACK block in multimodal postoperative pain management among patients undergoing total knee arthroplasty.

Materials and Methods: This prospective comparative study was conducted at Gandhi Medical College, Bhopal, between June 2025 and April 2026. A total of 60 patients undergoing elective unilateral total knee arthroplasty were included and divided into two groups of 30 each. Group I received an ultrasound-guided IPACK block along with standard multimodal analgesia, while Group II received standard multimodal analgesia alone. Postoperative pain was assessed using VAS scores at rest and during movement. Rescue analgesic requirement, tramadol consumption, time to ambulation, knee flexion at 48 hours, length of hospital stay, and adverse events were recorded.

Results: Postoperative VAS scores were significantly lower in the IPACK group compared with the control group at 6, 12, 24, and 48 hours. Mean time to first rescue analgesia was significantly longer in Group I than Group II (7.8 ± 2.3 hours vs 4.2 ± 1.6 hours; $p < 0.001$). Tramadol consumption during the first 24 hours was significantly lower in the IPACK group (82.5 ± 28.4 mg vs 132.7 ± 41.6 mg; $p < 0.001$). Patients receiving an IPACK block also achieved earlier assisted ambulation and better knee flexion at 48 hours. No major block-related complication was observed.

Conclusion: IPACK block is a safe and effective adjunct to multimodal analgesia in total knee arthroplasty. It provides better early postoperative pain relief, reduces opioid requirement, and facilitates early functional recovery without significant motor weakness.

Keywords: IPACK Block, Total Knee Arthroplasty, Multimodal Analgesia, Postoperative Pain, VAS Score, Early Ambulation.

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Introduction

Total knee arthroplasty (TKA) is one of the most commonly performed procedures for end-stage knee osteoarthritis. Still, moderate-to-severe postoperative pain remains a major barrier to early mobilization, physiotherapy participation, patient satisfaction, and timely discharge. Effective perioperative analgesia after TKA therefore requires a multimodal approach that combines systemic analgesics, periarticular infiltration, and motor-sparing regional anaesthesia techniques [1]. Traditional femoral nerve block provides good analgesia but may weaken quadriceps function and delay ambulation; hence, adductor canal block has increasingly been preferred because it provides predominantly sensory analgesia while preserving motor strength [2].

However, adductor canal block mainly covers the anteromedial aspect of the knee and may not adequately relieve posterior knee pain, which is frequently reported after TKA. The IPACK block, or infiltration between the popliteal artery and the posterior capsule of the knee, was developed to target the articular sensory branches that supply the posterior capsule while avoiding significant motor

blockade of the tibial and common peroneal nerves [3]. When used as part of multimodal analgesia, the IPACK block may improve early posterior knee pain, reduce rescue opioid requirement, and facilitate early functional recovery. However, available studies have shown variable results regarding its magnitude of clinical benefit [4,5].

Recent meta-analyses suggest that IPACK block is a useful adjunct to existing TKA analgesic protocols, particularly when combined with adductor canal block, but further institution-based clinical evidence is still required to clarify its practical effectiveness in routine settings [5,6]. Therefore, the present study was planned at Gandhi Medical College, Bhopal, to evaluate the efficacy of the IPACK block in multimodal pain management among patients undergoing total knee arthroplasty.

Materials and Methods

Study Design and Setting: This hospital-based prospective comparative study was conducted in the Department of Anaesthesiology in collaboration with the Department of Orthopaedics, Gandhi Medical College and associated Hamidia Hospital, Bhopal, Madhya Pradesh. The study was carried out over a period of 6 months between September 2025 and March 2026.

Study Population: The study included adult patients undergoing elective unilateral total knee arthroplasty for advanced knee osteoarthritis. A total of 60 patients were enrolled and divided into two groups of 30 patients each. Group I received an ultrasound-guided IPACK block as part of multimodal postoperative analgesia, while Group II received conventional multimodal analgesia without an IPACK block.

Inclusion Criteria: Patients aged 50–80 years, belonging to American Society of Anesthesiologists physical status I–III, scheduled for elective unilateral total knee arthroplasty under spinal anaesthesia, and willing to participate in the study were included. The ASA physical status classification was used for preoperative risk stratification as it remains a standard system for describing the preoperative systemic status of surgical patients [7].

Exclusion Criteria: Patients were excluded if they had a refusal to participate, allergy to local anaesthetic drugs, coagulopathy or ongoing anticoagulant therapy, infection at the block site, pre-existing neurological deficit in the operative limb, severe hepatic or renal dysfunction, psychiatric illness affecting pain assessment, chronic opioid use, revision total knee arthroplasty, bilateral knee arthroplasty, or failed spinal anaesthesia requiring conversion to general anaesthesia.

Sample Size: The final sample size was 60 patients, with 30 patients in each group. The sample size was selected based on feasibility within the available study duration and patient load at the study centre. This sample size was considered adequate for assessing clinically relevant differences in early postoperative pain scores and rescue analgesic requirement between the two groups.

Group Allocation: Eligible patients were allocated into two groups using a simple random allocation method. Group I patients received an IPACK block in addition to standard multimodal analgesia. Group II patients received standard multimodal analgesia alone. Both groups were managed using the same institutional perioperative anaesthesia and analgesia protocol, except for the administration of the IPACK block.

Preoperative Preparation: All patients underwent routine pre-anaesthetic evaluation one day before surgery. Detailed history, general physical examination, airway assessment, systemic examination, and relevant laboratory investigations were performed. Patients were informed about the visual analogue scale for pain assessment, where 0 represented “no pain” and 10 represented “worst imaginable pain.” The visual analogue scale is a validated and widely used tool for assessing pain intensity in acute and postoperative settings [8].

Patients were kept nil per oral according to standard fasting guidelines. On arrival in the operating room, baseline heart rate, non-invasive blood pressure, oxygen saturation, and electrocardiography were recorded. Intravenous access was secured, and all patients received standard monitoring throughout the procedure.

Anaesthesia Technique: All patients received spinal anaesthesia under aseptic precautions in the sitting or lateral position. After skin infiltration with local anaesthetic, spinal anaesthesia was administered at the L3–L4 or L4–L5 interspace using a 25G spinal needle. Hyperbaric bupivacaine was used according to institutional protocol. After confirming adequate sensory and motor block, surgery was allowed to proceed.

Intraoperative fluids, sedation, vasopressors, and other supportive medications were administered as required. Surgical technique and perioperative care were kept uniform as far as possible in both groups.

IPACK block Technique: In Group I, ultrasound-guided IPACK block was performed under strict aseptic precautions after completion of surgery and before shifting the patient from the operating room or recovery area. The patient was placed in the supine or slightly lateral position with the knee flexed as required for proper ultrasound visualization.

A high-frequency linear or low-frequency curvilinear ultrasound probe was placed over the popliteal fossa to identify the popliteal artery, femoral condyles, and posterior capsule of the knee. After identifying the tissue plane between the popliteal artery and the posterior capsule, a block needle was advanced under real-time ultrasound guidance using an in-plane technique. After careful negative aspiration, local anaesthetic was injected into the interspace between the popliteal artery and the posterior capsule of the knee.

The IPACK block was used as a motor-sparing posterior knee analgesic technique intended to block the articular sensory branches supplying the posterior capsule while minimizing involvement of the tibial and common peroneal nerves [3]. Patients were monitored for signs of vascular puncture, local anaesthetic systemic toxicity, neurological deficit, or any other block-related complication.

Postoperative Analgesia Protocol: Both groups received standard multimodal analgesia as per institutional protocol. This included paracetamol, non-steroidal anti-inflammatory drugs or COX-2 inhibitors when not contraindicated, and rescue opioid analgesia when required. Multimodal analgesia after total knee arthroplasty is recommended because it improves pain control while reducing opioid exposure and opioid-related adverse effects [1].

Rescue analgesia was provided when the patient reported moderate-to-severe pain or when the VAS score exceeded 4. Tramadol was used as a rescue analgesic, and the total requirement during the first 24 hours was recorded.

Outcome Measures: The primary outcome measure was postoperative pain intensity assessed using a VAS score at rest and during movement. Pain scores at rest were recorded at 2, 6, 12, 24, and 48 hours after surgery. Pain scores during movement were recorded at 6, 12, 24, and 48 hours after surgery.

Secondary outcome measures included time first to rescue analgesic requirement, total rescue analgesic consumption during the first 24 hours, number of patients requiring rescue analgesia within 6 hours, time to first assisted ambulation, knee flexion achieved at 48 hours, length of hospital stay, and incidence of adverse events.

Adverse events assessed included nausea, vomiting, dizziness, sedation, hypotension, motor weakness, neurological deficit, vascular puncture, local anaesthetic systemic toxicity, and any other block-related complication.

Data Collection: Data were recorded using a structured case record form. Baseline demographic and clinical variables included age, sex, body mass index, ASA physical status, diagnosis, side of surgery, and duration of surgery. Postoperative pain scores and recovery parameters were recorded by an investigator involved in postoperative assessment.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage. Comparison of continuous variables between the two groups was performed using the independent sample t-test. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 60 patients undergoing total knee arthroplasty were included in the study and analyzed. Patients were divided into two groups of 30 each. Group I received an IPACK block as part of multimodal analgesia, while Group II received conventional multimodal analgesia without an IPACK block. No patient was excluded after enrolment, and complete postoperative pain and recovery data were available for all participants.

The two groups were comparable with respect to baseline demographic and clinical characteristics. The mean age of patients was 63.8 ± 7.0 years, with a slight female predominance. There was no statistically significant difference between the groups in terms of age, sex distribution, body mass index, ASA physical status, or duration of surgery, suggesting that both groups were well matched at baseline.

Table 1: Baseline demographic and clinical characteristics

Variable	Group I: IPACK block (n=30)	Group II: Control (n=30)	p value
Age, years	63.4 ± 7.2	64.1 ± 6.8	0.699
Male/Female	12/18	11/19	0.790
BMI, kg/m²	27.6 ± 3.4	28.1 ± 3.7	0.587
ASA I/II/III	4/21/5	3/22/5	0.916
Duration of surgery, minutes	96.8 ± 12.5	98.3 ± 13.1	0.652

Postoperative pain scores were lower in the IPACK group at all assessed time points. At rest, the mean VAS score was significantly lower in Group I compared with Group II at 6 hours, 12 hours, and 24 hours postoperatively. Although pain scores were also lower at 2 hours, the difference was less marked. During knee movement, Group I showed consistently better pain control, particularly during

the first 24 hours, which is clinically important for early physiotherapy and mobilisation.

Table 2: Postoperative VAS pain scores at rest

Time after surgery	Group I: IPACK block	Group II: Control	p value
2 hours	2.1 ± 0.8	2.6 ± 0.9	0.027
6 hours	2.4 ± 0.9	3.8 ± 1.1	<0.001
12 hours	2.8 ± 1.0	4.3 ± 1.2	<0.001
24 hours	2.5 ± 0.8	3.5 ± 1.0	<0.001
48 hours	2.0 ± 0.7	2.5 ± 0.8	0.014

Table 3: Postoperative VAS pain scores during movement

Time after surgery	Group I: IPACK block	Group II: Control	p value
6 hours	3.4 ± 1.0	4.8 ± 1.2	<0.001
12 hours	3.8 ± 1.1	5.2 ± 1.3	<0.001
24 hours	3.3 ± 0.9	4.5 ± 1.1	<0.001
48 hours	2.8 ± 0.8	3.4 ± 0.9	0.009

The mean time to first rescue analgesic requirement was significantly longer in the IPACK group compared with the control group. Patients receiving an IPACK block required less rescue analgesia during the first 24 hours after surgery. The mean tramadol consumption was 82.5 ± 28.4 mg in Group I and 132.7 ± 41.6 mg in Group II, and this difference was statistically significant.

Table 4: Rescue analgesic requirement and early recovery parameters

Parameter	Group I: IPACK block	Group II: Control	p value
Time to first rescue analgesia, hours	7.8 ± 2.3	4.2 ± 1.6	<0.001
Tramadol consumption in the first 24 hours, mg	82.5 ± 28.4	132.7 ± 41.6	<0.001
Patients requiring rescue analgesia within 6 hours, n (%)	8 (26.7%)	19 (63.3%)	0.004
Time to first assisted ambulation, hours	18.6 ± 4.5	24.8 ± 5.2	<0.001
Knee flexion achieved at 48 hours, degrees	71.4 ± 8.6	63.2 ± 9.1	0.001
Length of hospital stay, days	4.1 ± 0.8	4.6 ± 1.0	0.038

Functional recovery parameters also favoured the IPACK group. Patients in Group I achieved assisted ambulation earlier than those in Group II. Mean knee flexion at 48 hours was significantly higher in Group I, indicating better tolerance to early postoperative physiotherapy. The length of hospital stay was slightly shorter in the IPACK group, and the difference was statistically significant.

Postoperative adverse events were fewer in the IPACK group, although most differences were not statistically significant. Nausea and vomiting were more common in the control group, likely reflecting higher opioid requirements. No patient in either group developed foot drop, vascular injury, local anaesthetic systemic toxicity, or clinically significant motor weakness attributable to the block.

Table 5: Postoperative adverse events

Adverse event	Group I: IPACK block (n=30)	Group II: Control (n=30)	p value
Nausea/vomiting	3 (10.0%)	8 (26.7%)	0.095
Dizziness/sedation	2 (6.7%)	5 (16.7%)	0.228
Hypotension	1 (3.3%)	2 (6.7%)	0.554
Motor weakness	0 (0.0%)	1 (3.3%)	0.313
Block-related complication	0 (0.0%)	0 (0.0%)	—

Discussion

The present prospective comparative study evaluated the efficacy of the IPACK block as part of multimodal pain management in patients undergoing total knee arthroplasty at Gandhi Medical College, Bhopal. The main finding of the study was that patients who received the IPACK block had significantly lower postoperative VAS scores at rest and during movement, especially during the first 24 hours after surgery. The IPACK group also had a longer time to first rescue analgesic requirement, lower tramadol consumption, earlier assisted ambulation, and better knee flexion at 48 hours. These findings suggest that the addition of an IPACK block provided clinically useful analgesic benefit without causing relevant motor weakness or block-related complications.

Pain after total knee arthroplasty is multifactorial and arises from both anterior and posterior knee structures. Modern analgesic protocols therefore emphasize multimodal analgesia rather than relying on a single intervention. The PROSPECT recommendations for total knee arthroplasty support the use of paracetamol, NSAIDs or COX-2 inhibitors, adductor canal block, periarticular local infiltration analgesia, and opioids mainly as rescue analgesics [1]. However, adductor canal block mainly provides analgesia to the anteromedial aspect of the knee and may not adequately cover posterior capsular pain. This is the anatomical basis for adding the IPACK block, which targets the sensory articular branches supplying the posterior capsule while avoiding significant motor blockade of the tibial and common peroneal nerves [3,9].

In the present study, VAS scores were significantly lower in the IPACK group at 6, 12, and 24 hours, both at rest and during movement. This is consistent with the randomized trial by Ochroch et al., in which patients receiving an IPACK block had a lower incidence of posterior knee pain at 6 hours post-surgery compared with the sham block group [3]. Similarly, Guo et al. reported in a systematic review and meta-analysis that adding IPACK to adductor canal block reduced postoperative VAS scores and improved early activity performance without increasing adverse effects [10]. These findings support the concept that IPACK is most useful in the early postoperative period, when posterior knee pain may limit physiotherapy and knee mobilisation.

The reduced requirement for rescue analgesia in the present study is also clinically important. The mean time to first rescue analgesic was longer in the IPACK group, and total tramadol consumption during the first 24 hours was lower. A reduction in opioid requirement is desirable after total knee arthroplasty because opioids are associated with nausea, vomiting, sedation, dizziness, constipation, delayed mobilisation, and reduced patient satisfaction. The lower frequency of nausea and vomiting in the IPACK group in our study may be explained by reduced opioid exposure, although the difference was not statistically significant. Similar opioid-sparing trends have been reported in some meta-analyses, although the magnitude of benefit has varied depending on the background analgesic regimen used [5,10].

The improvement in early ambulation and knee flexion observed in the present study may be related to better dynamic pain control. Pain during movement is more relevant than pain at rest after total knee arthroplasty because early physiotherapy, active knee bending, standing, and walking are essential components of recovery. In our study, patients in the IPACK group achieved first assisted ambulation earlier and had better mean knee flexion at 48 hours. This finding is in agreement with the rationale of motor-sparing regional anaesthesia. Unlike femoral nerve block, which may impair quadriceps strength and increase fall risk, adductor canal block and IPACK block aim to provide analgesia while preserving motor function [11]. Therefore, the combination of motor-sparing anterior and posterior knee analgesia appears practically useful in enhanced recovery pathways.

However, published literature on the IPACK block is not entirely uniform. Patterson et al. reported lower pain scores in the post-anaesthesia care unit among patients receiving an IPACK block. Still, they did not find significant differences in opioid consumption, physical therapy pain scores, walking distance, or length of stay [12]. Similarly, Chatmaitri et al. found that adding an IPACK block to a combination of an adductor canal block and periarticular injection did not significantly reduce postoperative pain intensity or opioid use [13]. These differences may be explained by variation in study design, local anaesthetic dose and volume, timing of block, use of sham control, surgical technique, periarticular infiltration protocols, and baseline multimodal analgesic regimens. When a strong periarticular infiltration protocol is already used, the incremental benefit of IPACK may become smaller.

The present study showed no major block-related complications. No patient developed foot drop, vascular injury, local anaesthetic systemic toxicity, or clinically significant motor weakness. This is important because posterior knee analgesia using more proximal sciatic or tibial nerve blocks may compromise motor function. The IPACK block was specifically developed to deposit local anaesthetic in the plane between the popliteal artery and posterior capsule, thereby targeting articular sensory branches while minimizing motor nerve involvement [3,9]. The absence of neurological complications in our study supports the safety of the block when performed under real-time ultrasound guidance by trained personnel.

The findings of this study have practical significance for routine total knee arthroplasty analgesia in a tertiary care setting. Addition of the IPACK block may be particularly useful in patients where early mobilisation is a priority, in those expected to have significant posterior knee pain, and in opioid-sensitive patients. In resource-limited settings, the technique may also help improve recovery quality without relying heavily on systemic opioids. Nevertheless, its benefit should be interpreted as an adjunctive analgesic effect rather than a standalone intervention. IPACK block should be integrated into a structured multimodal regimen that includes systemic non-opioid analgesics, physiotherapy, patient education, and careful postoperative monitoring.

This study has certain limitations. First, it was a single-centre study with a relatively small sample size of 60 patients, which may limit generalizability. Second, the study assessed early postoperative outcomes only up to 48 hours; therefore, the effect of IPACK block on longer-term functional recovery, chronic postsurgical pain, and patient-reported quality of recovery could not be evaluated. Third, blinding was not complete, which may have influenced subjective pain reporting. Fourth, local anaesthetic spread was not objectively confirmed beyond ultrasound-guided deposition. Despite these limitations, the study provides useful clinical evidence that the IPACK block can improve early postoperative analgesia and functional recovery after total knee arthroplasty.

Conclusion

The present study showed that adding an IPACK block to multimodal analgesia improved postoperative pain control after total knee arthroplasty. Patients receiving IPACK block had lower VAS scores, delayed need for rescue analgesia, reduced opioid consumption, and earlier mobilisation. The block was not associated with significant motor weakness or major complications. Thus, the IPACK block appears to be a safe and effective adjunct for improving early postoperative recovery after total knee arthroplasty.

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