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Research Article

Outcome of Ultrasound-Guided Adductor Canal Block and PeriArticular Local Anesthetic Injection in Knee Osteoarthritis Undergoing Total Knee Arthroplasty: A Single Institutional Experience

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Abstract

Background: Total knee arthroplasty (TKA) is now routinely performed for end-stage knee osteoarthritis (OA), helping improve patient's quality of life (QoL) and reducing the global economic burden. For effective pain management, peripheral nerve blocks and periarticular local injections are commonly used. The aim of this study was to compare the effectiveness of periarticular injection (PAI) of local anesthetic and ultrasound-guided adductor canal block (ACB) in post-TKA patients.
Methods: This prospective study included 60 patients with knee OA undergoing TKA, who were divided into two groups of 30 patients each: ACB group (20 ml of 0.25% ropivacaine) and PAI group (20 ml of 0.5% ropivacaine solution diluted in 20 ml of normal saline with one ampoule of cefuroxime and 4 mg of dexamethasone). The outcomes compared were Visual Analog Scale (VAS) scores on postoperative days (POD) 0, 1, and 2 at rest and during rehabilitation; knee range of motion (ROM); length of hospital stay; and opioid dosage required.
Results: VAS scores at rest for both groups were similar at all time intervals. However, during mobilization, a significant difference was observed in VAS scores on POD 1 (1.90 ± 0.88 vs. 2.83 ± 0.70; $P = 0.001$) and POD 2 (0.70 ± 0.60 vs. 1.47 ± 0.51; $P = 0.001$). Knee ROM showed a significant difference on POD 0 (84.83 ± 5.80 vs. 81.50 ± 5.28; $P = 0.023$), with no significant differences on POD 1 and 2. The opioid dose required was significantly lower in the ACB group (1.17 ± 0.65 vs. 3.07 ± 0.87; $P < 0.001$). Moreover, hospital stay was significantly shorter in the ACB group compared to PAI group (2.53 ± 0.63 vs. 3.07 ± 0.87; $P = 0.009$).
Conclusion: The ultrasound-guided ACB group demonstrated better pain control, improved early knee ROM, reduced opioid consumption, and a shorter duration of hospital stay compared to the PAI group.

Keywords: Knee Osteoarthritis; Total Knee Replacement; Visual Analog Scale

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Background

Total knee arthroplasty (TKA) has become a standard surgical intervention for individuals with end-stage knee osteoarthritis (OA). This procedure significantly improves patients' quality of life (QoL) by restoring mobility and function while reducing the overall economic burden associated with chronic knee conditions (1). Accordingly, developing an effective postoperative pain management plan is crucial. Such a plan facilitates early rehabilitation exercises and mobilization, improves functional recovery and range of motion (ROM), and minimizes the need for analgesic medications. Moreover, optimal pain control shortens hospital stays and reduces overall healthcare costs (2).

Despite the benefits of TKA, approximately 20% of patients report postoperative dissatisfaction, with persistent chronic pain identified as a major contributing factor (3). Inadequate pain management can impair mobility and increase the risk of complications such as deep vein thrombosis (DVT) and pulmonary embolism (PE) (3). Therefore, establishing an effective pain management protocol is essential for patients following TKA.

Multiple strategies are used for postoperative pain control, including nonsteroidal anti-inflammatory drugs (NSAIDs), opioids, patient-controlled analgesia (PCA), and regional anesthetic techniques such as periarticular injections, nerve blocks, and epidural analgesia (4-6). Although epidural analgesia can offer substantial pain relief, it is associated with drawbacks that include hypotension, lower-limb weakness, and urinary incontinence (7).

Among regional techniques, peripheral nerve blocks - specifically femoral nerve blocks (FNB) and adductor canal blocks (ACB) - are commonly used. While FNB provides effective analgesia, it may cause weakness of the quadriceps muscle due to blockade of both sensory and motor fibers. This weakness can delay rehabilitation and increase fall risk (8). In contrast, ACB selectively blocks sensory fibers while sparing the extensor mechanism, allowing earlier ambulation and rehabilitation.

Periarticular injections (PAI) have gained popularity because they target nociceptors directly within the knee joint. Their advantages include reduced postoperative pain, earlier mobilization and rehabilitation, decreased reliance on NSAIDs and opioids, and preservation of extensor muscle strength. Consequently, both PAI and ACB are widely used for postoperative pain management following TKA (9, 10).

A review of the literature suggests that combining single-dose ACB with PAI may improve Visual Analog Scale

(VAS) scores, although some studies report no significant difference between the techniques (11, 12). Given these mixed findings, the present study aims to evaluate the outcomes of ACB and PAI in patients undergoing TKA.

Methods

This prospective, non-randomized, comparative study was conducted on patients undergoing TKA for knee OA at a tertiary healthcare center between January 1, 2025, and July 31, 2025. A total of 60 patients with varus knee OA and a body mass index (BMI) < 35 kg/m^2 were included. Patients with inflammatory arthritis, severe deformities, bilateral TKA, or revision surgery were excluded. The participants were divided into two groups to compare clinical outcomes and the safety of each analgesic technique. All surgeries were performed under regional anesthesia, followed by a standardized postoperative rehabilitation protocol.

Group A: Ultrasound-Guided ACB

Group A included 30 patients who underwent TKA using either the medial parapatellar (MPA) or subvastus (SV) approach without a tourniquet. Closure was performed in layers with the drain in place. The surgical field was then prepared for administration of the ACB.

The ultrasound probe was positioned at the midpoint between the inguinal crease and the medial femoral condyle. The femoral artery beneath the sartorius muscle was identified. An 18-gauge spinal needle was inserted anterolateral to the femoral vessel and advanced deep to the sartorial fascia. A total of 20 ml of 0.25% ropivacaine was injected.

Group B: Periarticular Local Anesthetic Injection

Similarly, Group B included 30 patients who underwent TKA using either the MPA or SV approach without a tourniquet. After implantation of the femoral and tibial components, a PAI was administered into the posterior cruciate ligament (PCL), posterior capsule, quadriceps tendon, patellar tendon, collateral ligaments, and synovium. The injection mixture consisted of 20 ml of 0.5% ropivacaine diluted with 20 ml of normal saline, one ampoule of cefuroxime, and 4 mg of dexamethasone. Closure was performed in layers, and a drain was placed.

Postoperative Protocol: All the patients operated were mobilized, and physiotherapy exercises started on the same day once the effect of regional anesthesia had worn off. The exercises were performed as per protocol for TKA patients. In the postoperative period, both groups received the given analgesics as per institutional protocol: intravenous (IV) paracetamol (1 g) every 8 hours, intramuscular (IM) diclofenac (one ampoule) every 12 hours, and IV pantoprazole every 12 hours. If pain remained uncontrolled despite the protocol, IV tramadol (50 mg) was supplemented to alleviate pain symptoms. On the postoperative day (POD) 1, oral analgesics were given: paracetamol (650 mg, twice daily), diclofenac (25 mg, twice daily), and pantoprazole (40 mg, twice daily).

The parameters assessed were: (a) VAS score at rest and during mobilization; (b) knee ROM on POD 0, 1, and 2; (c) need for analgesics; and (d) length of hospital stay. On the POD 0, all the parameters were evaluated 6 hours after the surgery. The patient's discharge was assessed on the basis of the ability to do the active straight leg raise test (SLRT), ambulate with a walker, climb stairs, walk to the washroom, and achieve adequate knee flexion. Additional criteria included surgical wound condition and pain relief with oral NSAIDs.

Statistical Analysis: The patients' scores in both groups were compared using SPSS software (version 16.0, SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean ± standard deviation (SD). The independent t-test was calculated for all the outcome variables - VAS scores at rest and during rehabilitation, knee ROM, doses of analgesics required, and duration of hospital stay for both groups. A significance level of P < 0.05 was considered for all outcome measures. The sample size was calculated using the following formula:

$$n = [z^2 * p * (1-p)/e^2] / [1 + (z^2 * p * (1-p)/e^2 * N)]$$

where z = 1.96 [corresponding to a 95% confidence interval (CI)], p is the proportion, N is the population size, and e is the margin of error.

Results

A total of 60 patients with knee OA who underwent TKA were included in the study. The demographic parameters of both groups in the study showed no significant statistical difference, as shown in table 1.

Table 1. Demographic characteristics of patients in the adductor canal block (ACB) and periarticular injection (PAI) groups

Parameters	ACB group	PAI group	P-value
Age (year) (mean ± SD)	63.83 ± 7.55	63.03 ± 7.16	0.675
Male/female ratio	14:16	16:14	-
BMI (kg/m2) (mean ± SD)	28.33 ± 3.31	28.43 ± 2.85	0.901

BMI: Body mass index; ACB: Adductor canal block; PAI: Periarticular injection; SD: Standard deviation

The VAS score at rest for both groups was similar across all time points: POD 0 (1.87 ± 0.97 vs. 2.17 ± 0.83; P = 0.205), POD 1 (1.13 ± 0.68 vs. 1.27 ± 0.69; P = 0.455), and POD 2 (0.47 ± 0.51 vs. 0.63 ± 0.56; P = 0.230) (Figure 1, Table 2).

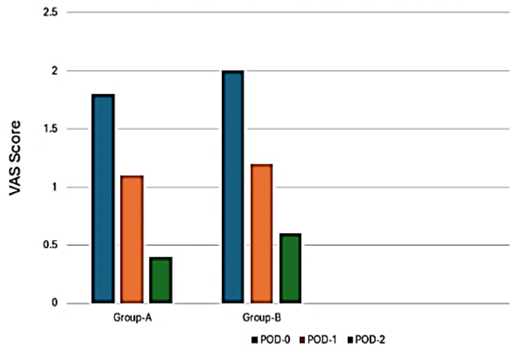

Figure 1. Comparison of mean Visual Analog Scale (VAS) scores at rest between Group A and Group B [Group A: Adductor canal block (ACB); Group B: Periarticular injection (PAI)]

Conversely, VAS score during mobilization showed significant lower values in Group A (ACB) in comparison to Group B (PAI) at POD 1 (1.90 ± 0.88 vs. 2.83 ± 0.70, P < 0.001) and POD 2 (0.70 ± 0.60 vs. 1.47 ± 0.51; P < 0.001) (Figure 2, Table 2).

Table 2. Visual Analog Scale (VAS) scores at rest and during rehabilitation

Parameters	ACB group (mean ± SD)	PAI group (mean ± SD)	P-value
VAS score at rest			
POD 0	1.87 ± 0.97	2.17 ± 0.83	0.205
POD 1	1.13 ± 0.68	1.27 ± 0.69	0.455
POD 2	0.47 ± 0.51	0.63 ± 0.56	0.230
VAS score during mobilization			
POD 0	3.20 ± 0.89	3.43 ± 0.86	0.305
POD 1	1.90 ± 0.88	2.83 ± 0.70	< 0.001
POD 2	0.70 ± 0.60	1.47 ± 0.51	< 0.001

ACB: Adductor canal block; PAI: Periarticular injection; POD: Postoperative day; VAS: Visual analog scale; SD: Standard deviation

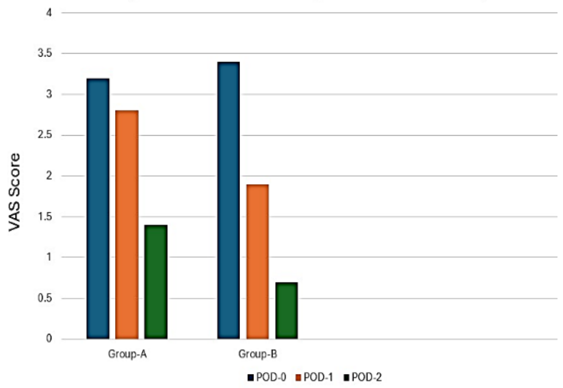

Figure 2. Comparison of mean Visual Analog Scale (VAS) scores during mobilization between Group A and Group B [Group A: Adductor canal block (ACB); Group B: Periarticular injection (PAI)]

The knee ROM (knee flexion) on POD 0 was significantly greater in the ACB group compared to PAI group (84.83 ± 5.80 vs. 81.50 ± 5.28; P = 0.023), while ROM on POD 1 (89.83 ± 5.17 vs. 89.33 ± 5.04; P = 0.706) and POD 2 (96.50 ± 5.28 vs. 96.17 ± 4.68; P = 0.796) showed no significant differences, as shown in figure 3.

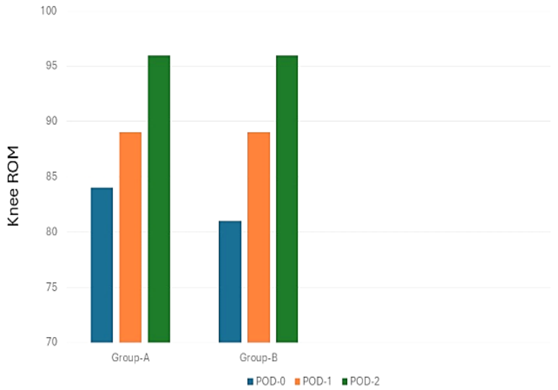

Figure 3. Comparison of mean knee range of motion (ROM) values during mobilization between Group A and Group B [Group A: Adductor canal block (ACB); Group B: Periarticular injection (PAI)]

The number of doses of tramadol (1.17 ± 0.65 vs. 3.07 ± 0.87; P < 0.001) and duration of hospital stay (2.53 ± 0.63 vs. 3.10 ± 0.80; P < 0.001) were significantly lower in the ACB group (Table 3).

Table 3. Comparison of outcome measures between the adductor canal block (ACB) and periarticular injection (PAI) groups

Parameters	ACB group (mean ± SD)	PAI group (mean ± SD)	P-value
Knee ROM (knee flexion)			
POD 0	84.83 ± 5.80	81.50 ± 5.28	0.023
POD 1	89.83 ± 5.17	89.33 ± 5.04	0.706
POD 2	96.50 ± 5.28	96.17 ± 4.68	0.797
No. of doses of tramadol	1.17 ± 0.65	3.07 ± 0.87	< 0.001
Duration of hospital stay (day)	2.53 ± 0.63	3.10 ± 0.87	0.009

ACB: Adductor canal block; PAI: Periarticular injection; POD: Postoperative day; ROM: Range of motion; SD: Standard deviation

Discussion

Effective pain management is of utmost importance in all postoperative TKA patients. Adequate pain control facilitates early mobilization and rehabilitation, improves ROM, and helps prevent immobility-related complications (12).

Although various modalities exist, only a limited number of surgeons routinely use the ACB and PAI of local anesthetic for postoperative TKA pain management. The present study compares these two modalities to evaluate their effectiveness in pain control and their impact on functional outcomes.

Multiple studies have used different combinations of local anesthetic agents. Some have used ropivacaine, morphine, and ketorolac, while others have used bupivacaine, morphine, and adrenaline. In the current study, ropivacaine was selected for both groups because of its intrinsic vasoconstrictive properties, which prolong its duration of action (13, 14).

Previous research has shown that periarticular local anesthetic injection may offer better pain control than ACB during the first eight hours following TKA (11). However, beyond this initial period, ACB has been found to provide more sustained pain relief (15). In our study, no statistically significant difference was observed in VAS scores at rest between the groups at any time point. During mobilization, ACB group showed no significant difference on POD 0, but demonstrated significantly lower VAS scores on POD 1 and POD 2. Rajkumar et al. reported significant differences in VAS scores at rest and during mobilization on POD 0 (16), whereas Grosso et al. reported higher VAS scores in the ACB group compared with the PAI group (11).

Once effective pain control is achieved, early rehabilitation becomes essential for optimal recovery. Early rehabilitation improves knee ROM, enhances extensor mechanism strength, and reduces overall hospital stay. In our study, ACB group demonstrated significantly greater knee ROM on POD 0 compared with PAI group. However, no significant differences in ROM were observed on POD 1 or POD 2. Rajkumar et al. reported better ROM in the ACB group (16), whereas Grosso et al. documented decreased mobilization in the ACB group compared with the PAI group (11).

Additionally, the duration of hospital stay differed significantly, with Group A demonstrating a shorter length of stay than Group B. Sawhney et al. found no significant difference in knee mobilization between groups (15), while Rajkumar et al. found no difference in mobilization or hospital stay unless a combination of ACB and PAI was used. The combined technique produced better mobilization and reduced hospital stay. A comparative analysis of outcome measures - including VAS scores, knee ROM, and length of hospital stay - from various studies is summarized in table 4 (15, 16).

NSAIDs and opioids are commonly used for postoperative pain management after TKA; however, these medications are frequently associated with adverse effects such as nausea, vomiting, and respiratory depression (17-19). Such side effects can hinder postoperative rehabilitation by limiting early mobilization. In the present study, opioid (tramadol) consumption was significantly lower in the ACB group than in the PAI group. This finding is consistent with Rajkumar et al., who also reported reduced opioid use with ACB (16).

Overall, the findings of this study demonstrate the effectiveness of ACB over PAI for managing postoperative pain in patients undergoing TKA. The primary limitation of the study is its small sample size.

Conclusion

Effective pain management is essential in TKA to achieve early mobilization and favorable functional outcomes.

Table 4. Comparison of outcome measures between the present study and previous literature

Parameters		Grosso et al. (11)			Rajkumar et al. (16)			Present study		
		ACB (mean ± SD)	PAI (mean ± SD)	P-value	ACB (mean ± SD)	PAI (mean ± SD)	P-value	ACB (mean ± SD)	PAI (mean ± SD)	P-value
VAS score at rest	POD 0	3.00 ± 2.90	3.00 ± 3.00		0.94 ± 0.91	2.49 ± 1.23	< 0.001	1.87 ± 0.97	2.17 ± 0.83	
	POD 1	3.90 ± 2.30	3.80 ± 2.40		1.42 ± 1.24	1.08 ± 0.99		1.13 ± 0.68	1.27 ± 0.69	
	POD 2	4.10 ± 2.50	3.80 ± 2.40		0.16 ± 0.42	0.14 ± 0.40		0.47 ± 0.51	0.63 ± 0.56	
VAS score at mobilization	POD 0				4.10 ± 0.88	5.59 ± 1.44	< 0.001	3.20 ± 0.89	3.43 ± 0.86	-
	POD 1				4.70 ± 1.28	4.39 ± 0.75		1.90 ± 0.88	2.83 ± 0.70	< 0.001
	POD 2				2.86 ± 0.99	3.41 ± 0.96	0.020	1.47 ± 0.51	0.70 ± 0.60	< 0.001
Knee ROM	POD 0				-	-	-	84.83 ± 5.80	81.50 ± 5.28	0.023
	POD 1				89.20 ± 1.80	87.80 ± 0.82		89.83 ± 5.17	89.33 ± 5.04	
	POD 2				104.90 ± 1.00	102.20 ± 0.77	0.004	96.50 ± 5.28	96.17 ± 4.68	
Average hospital stay (day)		2.90 ± 1.50	2.50 ± 1.20	> 0.05	5.02 ± 0.74	4.86 ± 0.74	> 0.05	2.53 ± 0.63	3.07 ± 0.87	0.009

ACB: Adductor canal block; PAI: Periarticular injection; POD: Postoperative day; VAS: Visual analog scale; ROM: Range of motion; SD: Standard deviation

Ultrasound-guided ACB provides superior pain control compared with PAI, leading to earlier mobilization, improved rehabilitation, better knee ROM, reduced analgesic requirements, and shorter hospital stays.

Conflict of Interest

The authors declare no conflict of interest in this study.

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None.

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