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Intermittent Bolus via Surgeon-Placed Adductor Canal Catheter for Postoperative Analgesia in Total Knee Arthroplasty: An Observational Longitudinal Study

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ABSTRACT

Effective postoperative pain control after total knee arthroplasty (TKA) is essential for early mobilization and better outcomes. The adductor canal block (ACB) provides effective, motor-sparing analgesia. **Objectives:** To evaluate the efficacy of surgeon-placed ACB in reducing postoperative pain and analgesic requirements in patients undergoing TKA. **Methods:** This observational longitudinal study was conducted in the hospital's Orthopedic Department from 14th February 2026 to 13th May 2026. A total of 38 patients were enrolled through consecutive sampling and underwent standard TKA under spinal anesthesia, with ACB placement by an experienced surgeon. Pain was assessed using the visual analogue scale preoperatively and at 24 and 48 hours postoperatively. Data on time to first analgesia and analgesia consumption during 0-48 hours were collected. Statistical analysis included the Friedman test with Bonferroni-corrected post-hoc comparisons for longitudinal data, and the Wilcoxon Signed-Rank test for postoperative analgesia consumption. **Results:** Overall mean age was 63.7 ± 7.4 years, and 31 (81.6%) were females. Median pain VAS score decreased from baseline 7.0 (1.0) to 4.0 (2.0) at 24 hours, and 1.0 (2.0) at 48 hours. Similarly, 29 (76.3%) patients required no rescue medication in the first 24 hours, and 32 (84.2%) during the 24–48 hours period. Median analgesia consumption dropped from 0.0 (25.0) mg to 0.0 (0.0) mg across these intervals (p=0.007). **Conclusions:** The surgeon-placed ACB was associated with low postoperative pain scores and minimal need for rescue analgesia among patients undergoing TKA in this setting.

INTRODUCTION

Total Knee Arthroplasty (TKA) is a procedure that is frequently associated with intense post-operative pain despite comprehensive multimodal analgesia [1]. Various modes of analgesia have been used in the past for effective control of pain post-operatively after TKA [2]. Relieving pain without compromising motor function is a challenge for the operating surgeon in the early post-operative period [3]. Early mobilization is now standard in most orthopedic surgeries, especially following total joint replacement, to promote early ambulation and rapid recovery [4]. Epidural analgesia is frequently associated with a high failure rate and side effects such as urinary retention, blocking motor power, and hence delaying early mobilization are limitations of this technique. Femoral nerve block provides excellent analgesia, but there is usually a motor blockade, and hence the risk of in-hospital falls is increased [5]. The saphenous nerve is a distal sensory branch that supplies sensation to the skin of the medial, anteromedial, and posteromedial surfaces of the lower leg. Saphenous nerve block has been tested in a few case studies and found to be effective in reducing pain during knee flexion during the first 24 hours after TKA. Further improvement in the safe and effective

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perioperative pain control measures has shifted the TKAs to an outpatient setting [6]. The Adductor Canal Block (ACB) is a relatively new block with encouraging results, as quadriceps muscle strength is minimally affected, as only the motor nerve to the vastus medialis of the quadriceps muscle is compromised. In this technique, the surgeon performs an intraoperative trans articular ACB guided by anatomical landmarks [6, 7]. Samuel *et al.* conducted a study and observed that the mean pain score after 24 hours was 5.05 ± 1.84, and the mean morphine consumption was 44.67 ± 26.45 mg [6]. Jenstrup *et al.* also observed that Morphine consumption from 0 to 24 h was less with ACB as compared to placebo (40 ± 21 vs. 56 ± 26 mg, p=0.006). Pain was significantly reduced with ACB during 45° flexion of the knee (p=0.001), but not at rest (p=0.006) [8].

The rationale of this study was to evaluate the outcomes of the surgeon-placed ACB for the management of postoperative pain in patients undergoing TKA. Post-operative pain relief and early ambulation after primary TKA are the primary objectives of surgeons to achieve a successful primary TKA. Multiple modalities have been used in the past. Surgeon-placed ACB is a relatively newer technique that can help to reduce pain and the need for postoperative analgesia. But, limited work has been done before, and no local evidence exists in the literature in this regard. Therefore, this study was aimed to evaluate the efficacy of surgeon-placed ACB in reducing postoperative pain and analgesic requirements in patients undergoing TKA.

METHODS

This observational longitudinal study was carried out at the Department of Orthopedics, Doctors Hospital, Lahore, from 14th February 2026 to 13th May 2026. The study received approval from the Institutional Review Board of Doctors Hospital & Medical Centre Lahore (Letter No. IRB/01/2025/01, dated February 3, 2025) and from the Research Evaluation Unit of the College of Physicians and Surgeons Pakistan (Letter No. CPSP/REU/OSG-2023-090-3007, dated February 13, 2026). Written informed consent was obtained from all patients. A total of 38 patients undergoing primary TKA under spinal anesthesia were included using a non-probability consecutive sampling technique. Other inclusion criteria were patients of either gender, aged 30 to 80 years, irrespective of body mass index (BMI). The exclusion criteria were patients with bilateral TKA, contraindications, or allergic to analgesic drugs, neurological disorders, or severe bleeding disorders [prothrombin time (PT) >20 seconds and/ or international normalized ratio (INR) >2. A minimum sample size of 30 cases was calculated by using the following formula: n = Z2. 2 / d2; where parameters were set at a 95% confidence level (Z= 1.96), precision (d = 0.7), and pain visual analogue scale (VAS) score 5.05 ± 1.84 after 24 hours post-surgery [6]. An addition of 25% attrition rate due to expected loss to follow-up or missing data led to a final sample of 38 cases. An experienced surgeon performed all procedures under spinal anesthesia. In accordance with the approved protocol, surgeon-placed ACB was defined as a regional anesthetic block involving the injection of a local anesthetic around the adductor canal, targeting the saphenous nerve, to provide analgesia for the knee joint and surrounding structures. During standard TKA, the adductor canal was exposed. To facilitate intermittent dosing, a 5 French feeding tube was placed into the adductor canal under direct vision using a trocar and pituitary rongeur. The skin and tube were placed deep into the adductor canal under vision. The tube was anchored to the skin with the help of steri-strips. Sixty mL of solution was prepared, including one vial of Tramadol (1ml/50mg), Decadron (1ml/4mg), and two vials of Bupivacaine (10ml/50mg each) in normal saline. Tramadol was added to the solution as an off-label perineural adjuvant to prolong the analgesic effect of bupivacaine and reduce postoperative opioid needs, representing an approach that requires further clinical validation for this specific site. The feeding tube was attached to a drip set, allowing 20 ml of the solution to be administered every 8 hours in the form of an intermittent bolus. The first dose of this solution was administered after shifting the patient to the post-surgical ward. In case of a spike of pain, an additional 10 ml of solution was injected. The patient was followed up there until recovery. Those patients who were non-responsive to ACB were given a 100mg injection of Liometacen in one liter of normal saline drip over 24 hours. Demographic data, including age (years), gender (male/ female), and BMI (Kg/m2), were recorded using a structured proforma. Operative time (minutes) was measured from the initial skin incision to the completion of skin closure [9]. Intraoperative blood loss (ml) was estimated by summing the volume of fluid collected in the suction container and the gravimetric measurement of surgical sponges, calculated as the difference between their wet and dry weights [10]. Time to first analgesia (hours) was measured from the administration of spinal anesthesia until the patient requested rescue analgesia due to a VAS score ≥4. Analgesia consumption (mg) was the cumulative amount of rescue medication administered during the first 24 hours (0–24 h) and the second 24 hours (24–48 h) postoperatively, when the pain VAS score was ≥4. Pain was assessed using a 0-10 VAS preoperatively and at 24 and 48 hours postoperatively [11]. Preoperative variables included age and BMI, which were collected as continuous variables and subsequently categorized into ordinal groups: age (≤63 years and >63 years) and BMI (<25 kg/m^2 and ≥25 kg/m^2). Gender was recorded as a nominal variable. Intraoperative

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variables, including operative time and intraoperative blood loss, were measured as continuous data and then dichotomized into ordinal categories (≤120 min vs. >120 min and ≤300 ml vs. >300 ml, respectively). Postoperative variables consisted of time to first analgesia and analgesia consumption, both treated as continuous variables. Pain VAS score was recorded as a discrete variable.

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0. Normality was assessed via the Shapiro-Wilk test. Normally distributed data (age, BMI, and time to first analgesia) were expressed as mean ± SD; non-normally distributed data (operative time, blood loss, VAS scores, and analgesia consumption) were presented as median (IQR). Due to the non-normal distribution of pain scores, the non-parametric Friedman test was utilized for longitudinal hypothesis testing, followed by post-hoc pairwise comparisons with Bonferroni correction. The Wilcoxon Signed-Rank test was used to compare analgesia consumption between the two postoperative time blocks. Subgroup comparisons (stratification). The Mann-Whitney U test was used to test for VAS scores. A p-value ≤0.005 was considered statistically significant.

RESULTS

A total of 38 patients underwent TKA with a mean age of 63.7 ± 7.4 years (range: 50.0-76.0). The majority were female, 31 (81.6%). Median operative time was 120.0 (30.0%) minutes, while median blood loss was 300.0 (100.0%) ml. The mean time to first analgesia was 6.3 ± 3.2 hours (Table 1).

Table 1: Baseline and Intraoperative Characteristics of The Study Population

Parameters		n	Mean ± SD / (%)	Median, IQR
Gender	Male	7	18.4%	–
	Female	31	81.6%	–
Age (years)		38	63.7 ± 7.4	–
Body Mass Index (kg/m^2)		38	26.2 ± 2.7	–
Operative Time (min)		38	–	120.0 (30%)
Intraoperative Blood Loss (mL)		38	–	300.0 (100%)
Time to First Analgesia (hours)		9	6.3 ± 3.2	–

Following the surgeon-placed ACB, a highly significant reduction in pain was observed over the 48-hour study period. The median VAS score decreased from a baseline of 7.0 (1.0%) to 4.0 (2.0%) at 24 hours, and further declined to 1.0 (2.0%) at 48 hours. The reduction in pain at each specific time interval was confirmed by post-hoc analysis (p<0.001). Regarding analgesia consumption, 29 (76.3%) patients required no rescue medication in the first 24 hours, which increased to 32 (84.2%) during the 24–48-hour interval. Correspondingly, analgesia consumption dropped significantly from a median of 0.0 (25.0) mg in the first 24 hours to 0.0 (0.0) mg in the second 24-hour period (p=0.007) (Table 2).

Table 2: Longitudinal Pain Scores and Analgesia Requirements

Parameters	Baseline, n (%)	At 24 Hours, n (%)	At 48 Hours, n (%)	p-value
Pain VAS Score	7.0 (1.0%)	4.0 (2.0%)	1.0 (2.0%)	<0.001[a]
Liometacin Dose (Mg)	–	0.0 (25.0%)	0.0 (0.0%)	0.007[b]

[a]Due to non-normal distribution, overall significance across time points was determined by the Friedman Test. Post-hoc pairwise comparisons with Bonferroni correction confirmed significant differences for all pairs (pre-op vs. 24h, 24h vs. 48h, Pre- op vs. 48h).

[b]Comparison between 24 h and 48 h analgesia consumption via the Wilcoxon Signed-Rank Test

Stratification analysis revealed that patients' age and gender did not significantly influence postoperative pain scores (p >0.05). However, a BMI ≥25.0 was associated with significantly lower pain scores at 48 hours compared to the lower BMI group (p=0.045). Patients with intraoperative blood loss >300 mL reported significantly higher pain at both 24 hours (p=0.003) and 48 hours (p=0.009). Similarly, operative times exceeding 120 minutes were associated with significantly higher VAS scores at the 24-hour (p=0.003) and 48-hour (p=0.024) intervals (Table 3).

Table 3: Post-Stratification Comparisons of Pain VAS Scores

Parameters	Category	n	At 0 Hours, n (%)	p-value	At 24 Hours, n (%)	p-value	At 48 Hours, n (%)	p-value
Age (Years)	≤63	21	8.0 (1.0%)	0.561	3.0 (1.5%)	0.399	1.0 (1.5%)	0.467
	>63	17	7.0 (1.0%)		4.0 (3.0%)		2.0 (2.0%)	
Gender	Female	31	8.0 (1.0%)	0.234	3.0 (2.0%)	0.506	1.0 (1.0%)	0.317
	Male	07	7.0 (2.0%)		4.0 (4.0%)		2.0 (3.0%)	
Body Mass Index (Kg/M^2)	<25.0	11	7.0 (1.0%)	0.899	4.0 (3.0%)	0.225	2.0 (2.0%)	0.045
	≥25.0	27	7.0 (1.0%)		3.0 (2.0%)		1.0 (1.0%)	
Operative Time (Min)	≤120	35	8.0 (1.0%)	0.168	3.0 (2.0%)	0.003	1.0 (1.0%)	0.024
	>120	03	7.0 (0.0%)		6.0 (0.0%)		3.0 (0.0%)	
Intraoperative Blood Loss (mL)	≤300	33	7.0 (1.0%)	0.009	3.0 (2.0%)	0.003	1.0 (1.0%)	0.009
	>300	05	8.0 (1.0%)		5.0 (3.0%)		3.0 (4.0%)	

*Comparisons between strata for pain VAS score via the Mann-Whitney U Test

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DISCUSSION

Postoperative pain management following TKA remains a critical determinant of early mobilization, functional recovery, and overall patient satisfaction. In the present study, the use of ACB showed a statistically and clinically significant association with low VAS pain score, along with a distinct reduction in analgesic requirements. The median preoperative VAS score of 7.0 (1.0%) decreased significantly to 4.0 (2.0%) on postoperative day 1 and further to 1.0 (2.0%) on postoperative day 2. This progressive decline in pain scores was found to be statistically significant ($p < 0.001$), suggesting the effectiveness of ACB in providing sustained postoperative analgesia. These findings are consistent with previous studies that have demonstrated significant reductions in postoperative pain with ACB in TKA patients [12]. The median time to first analgesia (6.3 ± 3.2 hours) observed in this study indicates a prolonged duration of analgesic action. As all cases were under spinal anesthesia, this interval includes both the spinal block and ACB effect. Since spinal anesthesia usually lasts 2 to 3 hours, this extended duration shows that ACB effectively increased the initial period of analgesia. This delay is both statistically and clinically meaningful, particularly in the immediate postoperative period when pain intensity is highest. Similar findings have been reported in contemporary literature, where ACB significantly prolonged analgesia compared to conventional systemic approaches [13]. The prolonged analgesia and low rescue drug needs in this study are likely due to using Tramadol as a perineural adjuvant, which is known to enhance block duration via local anaesthetic-like effects [14]. Furthermore, analgesia consumption in this study was minimal, with a median requirement of zero on postoperative days 1 and 2 ($p=0.007$), reflecting a significant opioid-sparing effect. This finding is particularly important as part of improved postoperative recovery pathways (ERAS) protocols, which focus on minimising opioid use to decrease adverse effects, including nausea, vomiting, sedation, and respiratory depression. [15, 16]. The demographic characteristics of the population studied, which had an average age of 63.7 ± 7.4 years and a mean BMI of 26.2 ± 2.7 Kg/m^2, are consistent with the typical population undergoing TKA. This similarity enhances the external validity and generalizability of the study findings [17]. Although a direct comparison group was not included, the analgesic outcomes observed in this study are comparable to those reported for femoral nerve block (FNB). ACB has been shown to provide equivalent analgesia while preserving quadriceps muscle strength, thereby facilitating early ambulation and reducing the risk of postoperative falls [18, 19]. The continued reduction in VAS scores from postoperative day 1 to 2 further supports the sustained analgesic efficacy of ACB, as reported in randomized controlled trials [20, 21].

Despite these encouraging results, it is important to recognise that there are several limitations. Its observational longitudinal design and the absence of a control group restrict the ability to establish definitive causality. Because of the limited sample size and non-inclusion of pediatric population in this study and the single-center design, the conclusions may not apply to other populations. Furthermore, the stratification of the sample into subgroups, for instance (n=3 for operative time >120 and n=5 for blood loss >300), resulted in even smaller cohorts, potentially reducing the statistical power of those specific comparisons. Finally, functional outcomes such as quadriceps strength, time to resume walking, and duration of hospitalization were not assessed, which prevents a more comprehensive evaluation of the overall postoperative recovery. Additionally, using tramadol as an ACB adjuvant is an off-label technique. While a lack of formal electrophysiological assessments leaves the precise neurotoxicity risk profile undetermined, routine clinical monitoring revealed no neurological deficits, prolonged motor blocks, or nerve injuries during the hospital stay. Larger-scale, randomized controlled studies comparing the efficacy of the ACB with other regional anaesthesia methods should be done in the future. These investigations should incorporate a broader range of metrics, evaluating both analgesic effectiveness and long-term functional outcomes.esic effectiveness and long-term functional outcomes.

CONCLUSIONS

The surgeon-placed ACB was linked with low postoperative pain scores and minimal rescue analgesia requirements among patients undergoing TKA in this setting. The low frequency of the need for rescue analgesia suggests the potential effectiveness of this technique in the acute recovery phase.

Authors' Contribution

Conceptualization: AM, JAS
Methodology: HUR
Formal analysis: AK, ABS
Writing and Drafting: UAB
Review and Editing: AM, HUR, AK, JAS, UAB, ABS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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