



Original Article

Adductor Canal Blockade versus Continuous Epidural Analgesia using 0.25% Ropivacaine + 2mcg/ml Fentanyl for Early Mobilisation after Total Knee Joint Replacement: A Prospective Randomised Controlled Clinical Study

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OPEN ACCESS

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Received: 25-05-2026

Accepted: 19-06-2026

Available online: 30-06-2026

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Medical and Pharmaceutical Research

ABSTRACT

Background and Aim: The present prospective randomised controlled clinical study was done to compare adductor canal blockade versus continuous epidural analgesia using 0.25% ropivacaine + 2mcg/ml fentanyl for early mobilization after total knee joint replacement.

Materials and Methods: This comparative study was conducted on 60 patients undergoing unilateral total knee replacement, randomly allocated into two groups of 30 each (n=30 each). Group A received spinal anaesthesia with continuous epidural analgesia, whereas Group B received spinal anaesthesia with continuous adductor canal block for postoperative pain management. Postoperatively, continuous infusion of ropivacaine with fentanyl was administered through the respective catheters. Hemodynamic parameters, pain scores (VAS), sensory and motor block, and postoperative recovery were evaluated at predefined intervals up to 48 hours following surgery.

Results: Mobilization at 8 hours postoperatively was significantly higher in Group B compared to Group A (73.33% vs 46.67%; p=0.0366), indicating earlier postoperative mobilization in patients receiving adductor canal block. Mean VAS score was comparatively lower in Group B patients as compared to Group A patients with significant difference at 8, 24 and 48 hours. On postoperative day 2, Group B demonstrated better knee flexion and extension range of motion compared to Group A, with a higher proportion of patients achieving active movement (73.33% vs 43.33%) and fewer requiring passive movement (6.67% vs 23.34%). The differences were statistically significant (p=0.0475). The mean length of hospital stay was significantly lower in Group B compared to Group A (2.30 ± 1.64 vs 3.34 ± 2.10 days; p=0.0368), indicating faster postoperative recovery in patients receiving adductor canal block. Hemodynamic stability, rescue analgesic requirement, and adverse effects remained comparable between both groups.

Conclusion: ACB and CEA showed comparable postoperative analgesia after unilateral lower limb surgery. However, adductor canal block proved superior for total knee replacement by improving early mobilization, functional recovery, and reducing complications. It supports ACB as the preferred technique and highlights the need to optimize perioperative protocols for better outcomes.

Keywords: Total Knee Arthroplasty (TKA); Osteoarthritis; Adductor Canal Block (ACB); Continuous Epidural Analgesia (CEA); Postoperative Pain Management; Fentanyl; Ropivacaine.

INTRODUCTION

Osteoarthritis is a chronic progressive condition associated with worsening pain and health-related quality of life.¹ Total knee arthroplasty (TKA) is a common surgical procedure that can cause severe postoperative pain.²

Anesthesia management involving “multimodal analgesic regimens”, including regional anesthesia techniques such as femoral nerve block (FNB)(L2-L4), adductor canal block (ACB) and local infiltration analgesia (LIA), is commonly used for TKA.^{3,4}

Continuous epidural analgesia (CEA) is a neuraxial technique used for postoperative pain relief after major orthopaedic surgery. Its benefits must be balanced against adverse effects, including urinary retention and hypotension.⁵ Adductor canal block (ACB) provides targeted analgesia and has demonstrated similar analgesic efficacy to femoral nerve block in patients undergoing TKA.⁶ Volunteer and clinical trials have also demonstrated relative preservation of quadriceps strength with ACB compared with femoral nerve block.^{7,8}

Ropivacaine, an amide-type local anaesthetic and a pure S-enantiomer, has gained popularity as an alternative to bupivacaine due to its favourable safety profile, reduced cardiotoxicity, and greater differential blockade with relative preservation of motor function.⁹ Choosing the right dose of local anesthetic agent (LA) in ACB for pain management in TKR is an important patient-centric decision.

Fentanyl is an opioid adjuvant used with local anaesthetics in regional anaesthesia. Neuraxial fentanyl can prolong sensory analgesia, whereas evidence for an additional benefit in peripheral nerve blocks is inconsistent. Potential opioid-related adverse effects include nausea, vomiting, pruritus and respiratory depression.¹⁰

This prospective cohort study aimed at comparing the early outcomes of ACB versus CEA in patients who underwent a unilateral TKR in terms of ambulation ability, early functional recovery, and pain control.

MATERIALS AND METHODS

The present study was conducted in a prospective, randomized, double-blind manner after obtaining approval from the Institutional Ethics Committee and written informed consent from all participants. A total of 60 patients of either sex, aged 20-70 years, belonging to American Society of Anaesthesiologists (ASA) physical status I and II, scheduled for elective unilateral TKA surgeries under spinal anaesthesia, were included in the study.

Patients who refused consent, had contraindications to spinal anaesthesia, known allergy to study drugs, coagulopathy, infection at the injection site, severe systemic illness, or were pregnant were excluded from the study. All patients were evaluated during the preoperative visit, and routine investigations were carried out as per institutional protocol. Patients were kept nil per oral as per standard fasting guidelines and were premedicated accordingly. On the day of surgery, patients were shifted to the operating room, where standard ASA monitors, including heart rate, non-invasive blood pressure, and peripheral oxygen saturation, were attached. An intravenous line was secured, and patients were preloaded with intravenous fluids.

Patients were randomly allocated into two groups of 32 each using a computer-generated randomization sequence. Randomization was performed using sealed opaque envelopes, and both the patient and the observer were blinded to group allocation. In Group A (n = 30) Patient received spinal anaesthesia along with continuous epidural catheter for postoperative analgesia, while in Group B (n = 30) Patient received spinal anaesthesia along with continuous adductor canal block for postoperative analgesia. The study drug was prepared by an anaesthesiologist not involved in patient management or data collection.

For the Epidural Group (Group A): After skin sterilization, the epidural needle was inserted between the lumbar vertebrae at level of L2-L3 or L3-L4 after skin infiltration with 2ml of 2% lignocaine. Once the needle tip anchored in the interspinous ligament, the conformation of the proper position of the tip of the epidural needle in the epidural space was done by a loss of resistance (LOR) technique using a syringe containing air. An epidural catheter was placed at the L2-L3 or L3-L4 level and inserted upward by 5 cm and fixed to the skin, a 3 ml solution of lignocaine 2% and 1:200,000 epinephrine was used as a test dose. After that Spinal anaesthesia was delivered to the patient at L2-L3 or L3-L4 level with 27G Whitacre spinal needle. After completion of surgery, a continuous infusion of solution containing 2.5mg/ml Isobaric Ropivacaine + 2mcg/ml Fentanyl was started with 5ml loading dose and maintained at 3ml/hr.

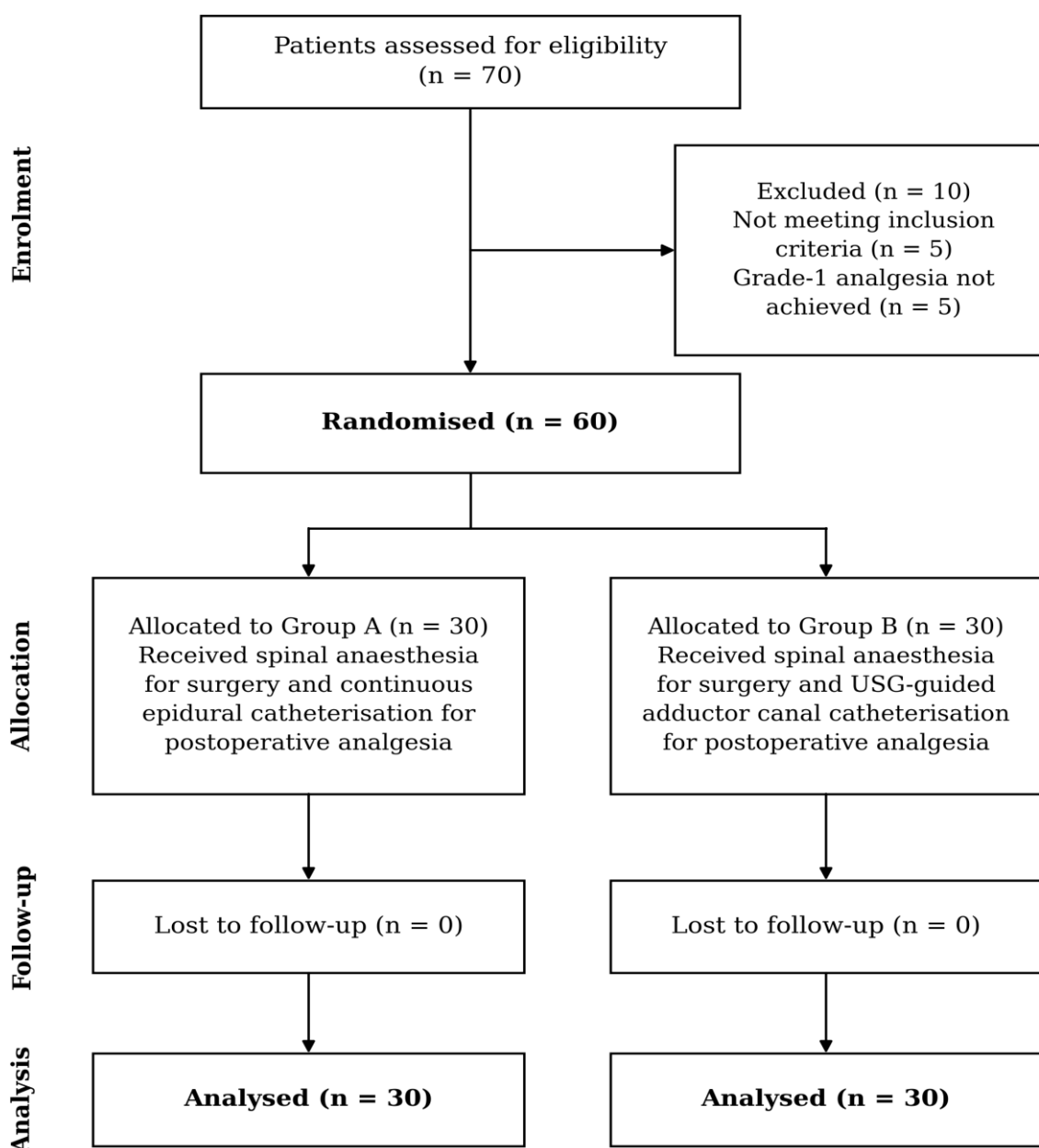
For the Adductor Group (Group B): Spinal anaesthesia was delivered to all the patients with CSE kit at L2-L3 or L3-L4 level with 27G Whitacre spinal needle and tuohy's needle. After completion of surgery, with complete aseptic precautions, using a portable Sono ultrasound system, the linear probe was placed vertically to the thigh, midway between the anterior superior iliac spine and the base of the patella, the adductor canal is roofed by sartorius muscle and bounded medially by adductor longus muscle and laterally by vastus medialis muscle. Eighteen Gauge, Tuohy's needle was used. Before proceeding, skin was infiltrated with 5ml of 2% lignocaine, the saphenous nerve was identified as it lies adjacent proximally

lateral then distally superior to the femoral artery, using an in-plane approach, after negative aspiration, the tip of the needle was placed deep to the sartorius muscle, at the lateral border of the artery, Once the needle is in position, the catheter was introduced through it, then the needle was removed. 2 to 3 ml of LA was injected through the needle under ultrasound guidance to confirm placement and the rest of the bolus was injected through the catheter while visualizing the spread of LA. The Epidural catheter was secured to the skin with a sterile dressing after applying a sterile surgical glue. And continuous infusion of solution containing 2.5mg/ml Isobaric Ropivacaine + 2mcg/ml Fentanyl was started with 5ml loading dose and maintained at 3ml/hr.

Post operative Heartrate (HR), SBP, DBP, MAP, SpO₂, VAS, sensory block grade and motor block grade were recorded at pre defined intervals.

Sample size was determined based on previous studies and statistical considerations to achieve adequate power. At the end of the study, data were compiled and analyzed using appropriate statistical software. Quantitative variables were expressed as mean $\pm$ standard deviation and compared using the independent sample t-test, while qualitative variables were expressed as percentages and analyzed using the Chi-square test. A p-value < 0.05 was considered statistically significant.

CONSORT FLOWCHART OF THE STUDY



RESULTS

Early mobilization in postoperative period: Table 1 displays comparison of mobilization at 8 hours among the both groups. In group A, mobilization was found in 46.67% patients and in group B, mobilization was found in 73.33% patients. The p-value is 0.0366, that is significant showing the significant difference among the groups regarding mobilization.

Postoperative pain assessment (VAS score): Table 2 presents the comparison of mean VAS Score between Group A and Group B at different time intervals. VAS score was comparatively lower in group B patients as compared to group A patients with significant difference at 8, 24 and 48 hours, otherwise at remaining time points VAS score was comparable among both groups.

Range of motion of knee in postoperative period (Day 2): Table 3 displays extension range of motion of knee on day 2 among the both groups. In group A, 43.33% patients show active, 33.33% shows active assisted and 23.34% shows passive extension of knee range of motion. In group B, 73.33% patients show active, 20% shows active assisted and 6.67 % shows passive extension of knee range of motion. The p-value is 0.0475, that is significant showing the significant difference among the groups regarding range of extension type motion of knee on day 2.

Table 4 displays flexion range of motion of knee on day 2 among the both groups. In group A, 43.33% patients show active, 33.33% shows active assisted and 23.34% shows passive flexion of knee range of motion. In group B, 73.33% patients show active, 20% shows active assisted and 6.67 % shows passive flexion of knee range of motion. The p-value is 0.0475, that is significant showing the significant difference among the groups regarding range of flexion type motion of knee on day 2.

Length of Hospital stay (days): As shown in table 5, in group A, mean length of hospital stay was 3.34 ± 2.10 days and in group B is 2.30 ± 1.64 days. The p value is 0.0368 that is < 0.05 so is significant, The p-value is 0.0368, that is significant showing the significant difference among the groups regarding length of hospital stay.

Table 1: Comparison of mobilization at 8 hours between Group A and Group B.

Mobilization at 8 hours	GROUP A (n=30)		GROUP B (n=30)		p value
	No. of patients	Percent	No. of patients	Percent	
Yes	14	46.67	22	73.33	0.0366(S)
No	16	53.33	8	26.67	
Total	30	100.00	30	100.00	

Test used: Chi-square = 0.205 with 1 degree of freedom

Table 2: Comparison of Postoperative VAS score

Time	VAS Score				P value
	Group A		Group B		
	Mean	SD	Mean	SD	
After block	0.22	0.20	0.31	0.20	0.086
2 hours	0.28	0.20	0.31	0.30	0.650
4 hours	1.16	0.86	1.26	0.68	0.619
6 hours	2.60	1.14	2.80	0.86	0.446
8 hours	3.53	1.05	2.47	1.52	0.002(S)
10 hours	0.26	0.22	0.31	0.32	0.483
12 hours	0.28	0.20	0.32	0.30	0.545
16 hours	1.16	0.86	1.26	0.68	0.619
20 hours	2.60	1.14	2.80	0.86	0.446
24 hours	3.53	1.05	2.56	1.52	0.005(S)
30 hours	1.16	0.86	1.26	0.68	0.619
36 hours	2.60	1.14	2.80	0.86	0.446
48 hours	3.63	1.05	2.47	1.52	0.0009 (S)

Table 3: Comparison of ROM (Extension) between Group A and Group B.

Day-2	GROUP A (n=30)	GROUP B (n=30)	p value
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Type of ROM-Extension	No. of patients	Percent	No. of patients	Percent	0.0475(S)
Active	13	43.33	22	73.33	
Active Assisted	10	33.33	6	20.00	
Passive	7	23.34	2	6.67	
Total	30	100.00	30	100.00	

Test used: Chi-square = 6.0921 with 2 degrees of freedom

Table 4: Comparison of ROM (Flexion) between Group A and Group B.

Day-2 Type of ROM-Flexion	GROUP A (n=30)		GROUP B (n=30)		p value
	No. of patients	Percent	No. of patients	Percent	
Active	13	43.33	22	73.33	0.0475(S)
Active Assisted	10	33.33	6	20.00	
Passive	7	23.34	2	6.67	
Total	30	100.00	30	100.00	

Test used: Chi-square = 6.0921 with 2 degrees of freedom

Table 5: Comparison of Length of Hospital stay (days) in Group A and Group B

Length of Hospital stay (days)	Group A		Group B		p value
	Mean	±SD	Mean	±SD	
	3.34	±2.10	2.30	±1.64	

Test used: student's t- test

DISCUSSION

Comparison of mobilization at 8 hours:

In group A, mobilization was found in 46.67% patients and in group B, mobilization was found in 73.33% patients. The p-value is 0.0366, that is significant showing the significant difference among the groups regarding mobilization. These results indicate that adductor canal block is superior than continuous epidural analgesia in early mobilization of patients in postoperative period.

Our study results were supported by Alsheikh KA et al (2020)¹¹ in their study they found that, the day of first walk was earlier among the ACB group (mean = 1.38) than the CEA group (mean = 2.80) with a highly significant difference (P = 0.001). In addition, the LOS was significantly lower among ACB group (mean = 6.63) when compared with the CEA group (mean = 7.45) (P = 0.043).

Vij et al. (2023)¹² studied children undergoing unilateral lower-extremity orthopaedic surgery, rather than adults undergoing TKA. They found a longer time to rehabilitation initiation in the CEA group than in the continuous peripheral nerve block (CPNB) group (1.89 ± 0.86 versus 1.15 ± 0.78 days; $p=0.0003$), and a longer time to ambulation (2.56 ± 0.93 versus 1.89 ± 0.69 days; $p=0.004$). These findings provide indirect supporting evidence because the population and surgical procedures differed from those in the present study.

In the study done by Varghese AA et al (2025)¹³ functional outcomes clearly favored the AC block, with patients achieving the earliest ambulation and demonstrating the least quadriceps weakness at 24 hours. Although CE provided strong analgesia, the associated motor weakness and hypotension delayed mobilization, a limitation similarly highlighted in studies comparing epidural with peripheral nerve blocks.

Postoperative pain assessment (VAS score) and Dose of rescue analgesia:

In our study VAS score was comparatively lower in group B patients as compared to group A patients with significant difference at 8, 24 and 48 hours, otherwise at remaining time points VAS score was comparable among both groups. On comparison of number of rescue doses of analgesics, it was found that, in group A, 40% patients required 1dose, 16.67% required 2 doses and 10% required 3 rescue doses. In group B, 26.67 % patients required 1 dose and 23.33% required 2 rescue doses. The p-value is 0.162, that is non-significant showing the non-significant difference among the groups regarding number of rescue doses. These results indicate that although comparatively less rescue analgesics was required in ACB, but the difference was not significant.

Our study results were supported by Alsheikh KA et al (2020)¹¹ in their study they found that ACB showed statistically significant results in several aspects compared with CEA for pain control during the resting state within the first postoperative 8, 24, and 48 h in their study, the mean pain score was significantly higher among the CEA group than the

ACB group after 8 h (CEA 3.83 vs ACB 0.98, $P = 0.001$), 24 h (CEA 3.75 vs ACB 1.68, $P = 0.001$), and 48 h (CEA 2.85 vs ACB 0.48, $P = 0.001$) providing evidence that ACB provides superior pain management compared with CEA.

Our study results were also supported by Vij N et al (2023)¹² in their study they found that, there were no statistically significant differences in pain scores between the CEA and CPNB groups in any postoperative period. There were no significant differences in the need for analgesic rescue at any point in the hospital stay between the CEA and CPNB groups (80.4% versus 86.1%, $p = 0.88$).

Range of motion of knee in postoperative period:

On comparison of range of motion of knee joint in flexion and extension, on day 1, it was found that, in group A, 16.67% patients show active, 33.33% shows active assisted and 50% shows passive extension of knee range of motion. In group B, 50% patients show active, 26.67% shows active assisted and 23.33% shows passive extension of knee range of motion. The p -value is 0.0172, that is significant showing the significant difference among the groups regarding range of extension type motion of knee on day 1.

On comparison of range of motion of knee joint in flexion and extension, on day 2, it was found that, in group A, 43.33% patients show active, 33.33% shows active assisted and 23.34% shows passive extension of knee range of motion. In group B, 73.33% patients show active, 20% shows active assisted and 6.67 % shows passive extension of knee range of motion. The p -value is 0.0475, that is significant showing the significant difference among the groups regarding range of extension type motion of knee on day 2.

Our study results were again supported by Alsheikh KA et al (2020)¹¹ The second notable finding produced in their study was the degree of knee flexion on day 1 postoperatively which was found to be significantly better in the ACB group. In addition, evidence was generated that early ambulation during the physiotherapy sessions was increased in the ACB group as reported by Kayupov et al (2018)¹⁴

Comparison of Length of Hospital stay (days):

When length of hospital stays in group A, mean length of hospital stay was 3.34 ± 2.10 days and in group B is 2.30 ± 1.64 days. The p value is 0.0368 that is < 0.05 so is significant, when compared using student t test. The p -value is 0.0368, that is significant showing the significant difference among the groups regarding length of hospital stay.

Kayupov et al. (2018)¹⁴ randomised 145 patients to combined spinal–epidural anaesthesia, spinal anaesthesia with continuous ACB, or general anaesthesia with continuous ACB. After 13 protocol deviations, 132 patients remained in the interim analysis. Continuous ACB was associated with greater postoperative walking distances, lower mean daily pain scores and faster discharge. Leung et al. (2018)¹⁵ evaluated continuous ACB against a sham catheter after both groups initially received epidural analgesia, which was discontinued on postoperative day 1. Their study therefore provides a different comparison and should not be interpreted as a direct trial of continuous ACB versus continuous epidural analgesia.

Comparison of haemodynamic parameters:

On comparison of HR in postoperative period, it was found that mean HR was increased in both groups whenever patient feels pain and rescue analgesia was given without significant difference ($P > 0.05$) otherwise, both groups were comparable regarding postoperative mean HR. similarly, mean SBP, DBP and MAP were increased in both groups whenever patient feels pain and rescue analgesia was given without significant difference ($P > 0.05$) otherwise, both groups were comparable regarding postoperative mean SBP, DBP and MAP.

On comparison of adverse effects, Shivering and nausea were found in 13.33 % patients in group A and 6.67 % patients in group B without any significant difference. Otherwise, there were no side effects in any of the cases of both study groups. Kayupov et al. (2018)¹⁴ reported improved ambulation and lower mean daily pain scores with continuous ACB compared with epidural analgesia. A meta-analysis by Gerrard et al. (2017)¹⁶ found that epidural analgesia was associated with higher rates of postoperative nausea and vomiting, hypotension and urinary retention than peripheral nerve blockade, with no significant difference in pooled VAS scores at the reported postoperative intervals. These findings support considering ACB within a multimodal analgesic strategy after TKR.

Side-effect profiles in the study done by Varghese AA et al (2025)¹³ strongly favor the AC block. Hypotension was significantly more common in the CE group, consistent with established literature describing sympathectomy-related blood pressure drops following epidural analgesia. Motor weakness was also more frequent in the CE and CF groups, while the AC group exhibited minimal impairment.

However, certain limitations should be acknowledged. The study was conducted at a single center with a relatively small sample size, which may limit the generalizability of the findings. Additionally, long-term outcomes and patient satisfaction were not assessed. Further multicentric studies with larger sample sizes are required to validate these findings and determine the optimal dosing strategy.

CONCLUSION

In ACB group, mobilization was earlier as compared to CEA group and the difference was statistically significant. Range of motion of knee joint during flexion and extension was significantly higher in ACB group as compared to CEA group on postoperative day 1 and 2. Vas score and rescue analgesic requirement was comparatively lower in ACB group as compared to ACB group but the difference was statistically not significant. Length of hospital stay was significantly lower in ACB group as compared to CEA group. Haemodynamic parameters and adverse effects were comparable among both groups. Thus, ACB appears to be the postoperative analgesia of choice after TKR with superior results in facilitating patients' early functional recovery and mobility.

ACKNOWLEDGEMENT

The authors thank the faculty and staff of the Dept of Anaesthesiology, Jhalawar Medical College, Jhalawar, for their support. The authors gratefully acknowledge Dr. Shailendra Vashistha (Assistant Professor, Transplant Immunology HLA Lab, Department of IHTM, Government Medical College, Kota) and the VAssist Research Team (www.thevassist.com) for assistance with manuscript editing, formatting, and technical support during manuscript submission. The authors thank all participants who took part in the study.

Financial support and sponsorship: Nil.

Conflicts of interest: There are no conflicts of interest.

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