

## ORIGINAL RESEARCH

## ORTHOPEDIC ANESTHESIA

# A comparative study between the analgesic effect of adductor canal block with or without IPACK block after total knee arthroplasty

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## ABSTRACT

**Background & objectives:** Ensuring adequate post-operative pain management, especially after orthopedic procedures, is a crucial component of patients' well-being. Following total knee arthroplasty (TKA), the degree of pain underscores the need for effective analgesic measures to alleviate the adverse effects of pain. Utilizing multimodal analgesia has been recognized as an ideal approach for managing acute pain following TKA. This approach encompasses various strategies, including preemptive analgesia, neuraxial blockade, peripheral nerve blocks, as well as narcotic and non-narcotic analgesics.

This prospective research compared the efficacy of the combination of IPACK (Interspace between Popliteal Artery and the Capsule of the Posterior Knee) block and Adductor Canal Block (ACB) for postoperative pain following TKA, with a particular focus on posterior knee pain. The study compared the effectiveness of this technique with opioid analgesics administered after spinal anesthesia alone or with ACB used independently.

**Methodology:** The research was a prospective, double-blinded, randomized controlled trial, comprising 60 patients undergoing knee surgeries. The patients were assigned into three groups at random: Group A received solely spinal anesthesia without any peripheral nerve blocks; Group B underwent ultrasound guided ACB after spinal anesthesia, and Group C was administered a blend of ACB and IPACK block under ultrasound guidance at the commencement of the surgery. Postoperatively, pain levels were evaluated using VAS scores. If the VAS score exceeded 4, 50 mg of intravenous pethidine was used as a primary rescue analgesic to lower the VAS score to below 3.

**Results:** Demographic data and preoperative hemodynamic parameters (heart rate and mean arterial blood pressure) were equivalent in both groups. Postoperatively, HR at 4, 8, 12 and 24 h and MAP at 12 and 24 h were significantly different ( $P < 0.001$ ). Time to first rescue analgesia, total narcotics intake and VAS scores were significantly different at 4, 8, 12 and 24 h ( $P < 0.001$ ).

**Conclusion:** In patients undergoing TKA, postoperative analgesia of combined ACB and IPACK was more effective than that of ACB block alone regarding hemodynamic changes, pain scores, doses of pethidine required for pain relief and postoperative mobilization.

**Keywords:** Adductor Canal Block; IPACK; Knee Arthroplasty; Knee Capsule; Nerve Block

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## 1. INTRODUCTION

Pain relief following orthopedic surgeries is often not adequate with non-opioid analgesics alone. Opioids, on the other hand, are typically not administered in optimal dosages due to concerns about their side effects, e.g., nausea, vomiting, respiratory depression, and the potential for addiction. Inadequate pain management can also result in extended hospital stays and rehabilitation periods, as well as the potential to develop into chronic pain. Multimodal analgesia regimens use both regional anesthesia and systemic analgesics, and are commonly employed in orthopedic patients.

The quadriceps muscle plays a key role in walking after total knee arthroplasty (TKA). Its strength can be impacted by various factors, such as surgical trauma, pain, and the use of peripheral nerve blocks (PNBs). While PNBs are effective in controlling postoperative pain after TKA, they can lead to reduced muscle strength. Femoral nerve block (FNB) is known for providing good relief from pain following TKA, but it weakens the muscle and might make falls more likely. In contrast, adductor canal block (ACB) tends to preserve muscle strength more effectively than FNB, while offering similar pain relief. As a result, it has been investigated to use ACB instead of FNB, targeting the saphenous nerve in the adductor canal in the thigh's medial area.<sup>1</sup>

Although the ACB efficiently offers pain relief to the peripatellar and intra-articular areas of knee joint, it does not address moderate to severe pain of the posterior knee.<sup>2</sup>

One common challenge is achieving sufficient anesthesia of the posterior knee using regional methods for managing pain after surgery. A method known as 'Interspace between Popliteal Artery and the Capsule of the Posterior Knee' (IPACK) block was created to deal with this, it entails injecting a local anesthetic between the popliteal artery and the posterior knee capsule. By focusing on this particular region, IPACK block helps to minimize discomfort during knee surgery while maintaining motor function.<sup>3</sup>

Combining IPACK block with ACB allows sensory nerve blockade of the anterior, medial, and posterior knee, while maintaining motor power to facilitate early mobilization and hasten recovery.<sup>4</sup>

We conducted this study in patients undergoing TKA, to compare the efficacy of adductor canal block with combined adductor canal block and IPACK block, regarding postoperative pain scores, doses of pethidine required for pain relief, hemodynamic changes, and postoperative mobilization.

## 2. METHODOLOGY

The study included 60 male patients fulfilling the inclusion criteria. All patients were instructed about the research protocol and after getting signed agreement with full knowledge from the participants, they were preoperatively evaluated for their medical status and were educated about visual analogue score. They were randomized into three equal groups by a random numbers table, each consisting of 20 patients; Group A patients received spinal anesthesia only. Group B patients received spinal anesthesia followed by ultrasound guided ACB before start of operation, and Group C patients received spinal anesthesia followed by ultrasound guided ACB with IPACK block before the start of operation.

The inclusion criteria included; male patients, ages from 45 to 70 y, ASA I, II and III, undergoing unilateral total knee arthroplasty. Written informed consent was taken from all patients.

Exclusion criteria included; refusal of the patient, inability to cooperate, neuromuscular pathology, opioids or steroids intake within the last 4 weeks or any analgesics during the last 48 h, and coagulopathies and severe aortic stenosis.

During the preoperative assessment in the anesthesia clinic, patients were taught about Visual Analogue Score (VAS score). History and general examination were completed from all patients and routine investigations were done preoperatively.

Inj. Ringer solution 500 mL was given as co-load together with spinal block. Then the patient was prepared for spinal anesthesia, in sitting position. The local skin was infiltrated with lidocaine 2%. Spinal anesthesia was given with 4 mL of 0.5% hyperbaric bupivacaine at L3/4 interspaces with a 25G spinal needle. The patient was then made to lie supine, anesthesia level and hemodynamics parameters were monitored.

In Group B and Group C patients, ACB was performed by abducting and rotating the thigh to access the medial thigh. The transducer was positioned anteromedially at

**Table 1: Comparison between groups as regard demographic data**

Parameter	Group A	Group B	Group C	f/X <sup>2</sup>	P-value
Age (y)	52.6 ± 7.5	55.30 ± 10.7	57.45 ± 5.7	1.8 <sup>f</sup>	0.182
ASA I	9 (45)	8 (40)	3 (15)	6.5 <sup>x2</sup>	0.313
II	10 (50)	8 (40)	12 (60)		
III	1 (5)	4 (20)	5 (25)		

*Data presented as mean ± SD or n (%); P < 0.05 considered as significant*

**Table 2: Comparative hemodynamic data between the three groups**

Parameter	Group A	Group B	Group C	F	p-value
HR PACU	67.65 ± 8.0	72.15 ± 5.6	68.75 ± 7.32	2.2	0.117
HR 4 h	72.55 ± 9.4 <sup>a</sup>	72.70 ± 8.8 <sup>a</sup>	66.3 ± 3.20 <sup>b</sup>	4.5	<b>0.015</b>
HR 8 h	81.3 ± 10.9 <sup>a</sup>	80.45 ± 9.5 <sup>a</sup>	70.85 ± 5.58 <sup>b</sup>	8.4	<b>&lt; 0.001</b>
HR 12 h	102.6 ± 11.4 <sup>a</sup>	91.00 ± 16.6 <sup>b</sup>	78.8 ± 10.05 <sup>c</sup>	16.8	<b>&lt; 0.001</b>
HR 24 h	101.25 ± 14.3 <sup>a</sup>	95.90 ± 9.5 <sup>a</sup>	76.35 ± 13.37 <sup>b</sup>	21.8	<b>&lt; 0.001</b>
MAP PACU	61.25 ± 5.5	61.60 ± 5.2	62.7 ± 5.48	0.4	0.675
MAP 4 h	65.15 ± 5.4	66.90 ± 10.1	64.45 ± 4.22	0.6	0.53
MAP 8 h	72.9 ± 10.7	68.90 ± 12.7	67.65 ± 7.52	1.4	0.264
MAP 12 h	90.25 ± 13.2 <sup>a</sup>	86.45 ± 15.9 <sup>a</sup>	73.75 ± 11.58 <sup>b</sup>	7.98	<b>&lt; 0.001</b>
MAP 24 h	87.8 ± 11.8 <sup>a</sup>	94.15 ± 8.2 <sup>a</sup>	78.05 ± 14.80 <sup>b</sup>	9.3	<b>&lt; 0.001</b>

*Data presented as mean ± SD; P < 0.05 considered as significant*

the thigh intersection, and the needle was progressed towards the femoral artery. A 22G, 3.5-inch spinal needle guided by ultrasound was progressed above the artery and after cautious aspiration, 15 mL of 0.25% bupivacaine was injected.

Patients in Group C underwent IPACK block after ACB, placing the transducer on the lower part of the inner thigh to capture images of the femur and femoral arteries. The area above the femoral condyles was visible by moving the transducer. After negative aspiration, same dose of bupivacaine was gradually administered, and the needle was removed.

After completion of the surgery, the patient was monitored in the Post Anesthesia Care Unit to ensure hemodynamic stability before being transferred to the ward, provided no pain was reported. All patients received the same postoperative analgesic regimen: 1 gm of intravenous paracetamol every 6 h for 3 days, followed by 1 gm of oral paracetamol every 8 h for 2 weeks.

Postoperative assessments were conducted post-surgery, focusing on pain intensity and hemodynamic parameters. Pain levels were evaluated using VAS scores. If the VAS score exceeded 4, 50 mg of intravenous pethidine was used as a primary rescue analgesic to lower the VAS score to below 3.

Our primary outcome was VAS scores in the first 24 h postoperative, and the time recorded for the first rescue analgesia, defined as the time after finishing the block till the patient's first analgesic requirement postoperative in the ward. Secondary outcomes were; total opioid (pethidine) consumption, and the degree of movement and ambulation distance evaluated based on counting the steps taken by the patient once the effects of spinal anesthesia had worn off.

#### Statistical analysis

The data were analyzed using SPSS version 27.0, with quantitative data displayed as mean ± standard deviation and qualitative data in terms of frequencies and percentages. Statistical analysis included ANOVA and

**Table 3: Comparative VAS scores at different time intervals in the groups**

	Group A			Group B			Group C			P-value <sup>k</sup>
	Range	Median	IQR	Range	Median	IQR	Range	Median	IQR	
<b>VAS PACU</b>	0-2	1	0.5-2	0-3	1	0.5-2	1-2	1	1-2	0.279
<b>VAS 4 h</b>	0-5	2 <sup>a</sup>	1-3	2-5	3 <sup>b</sup>	2-3	1-2	1 <sup>a</sup>	1-2	<b>&lt; 0.001</b>
<b>VAS 8 h</b>	2-8	3 <sup>a</sup>	2-4.5	2-5	3 <sup>a</sup>	2-3.5	1-3	2 <sup>b</sup>	2-2	<b>&lt; 0.001</b>
<b>VAS 12 h</b>	3-8	6 <sup>a</sup>	5-7	1-7	5 <sup>b</sup>	3-6	1-6	3 <sup>c</sup>	2-3	<b>&lt; 0.001</b>
<b>VAS 24 h</b>	2-7	5.5 <sup>a</sup>	3-7	3-7	5 <sup>a</sup>	3-6	1-7	1.5 <sup>b</sup>	1-5	<b>&lt; 0.001</b>

*P < 0.05 considered as significant*

**Table 4: Comparison of 1st rescue analgesia and total opioid consumption**

Variable	Group A	Group B	Group C	F	P-value
<b>Time to 1<sup>st</sup> rescue analgesia (h)</b>	2.95 ± 0.8 <sup>a</sup>	5.93 ± 0.9 <sup>b</sup>	15.95 ± 3.94 <sup>c</sup>	163.5	<b>&lt; 0.001</b>
<b>Total opioid consumption</b>	132.5 ± 29.4 <sup>a</sup>	112.50 ± 22.2 <sup>b</sup>	63.75 ± 24.97 <sup>c</sup>	37.9	<b>&lt; 0.001</b>

*Data presented as mean ± SD; P < 0.05 considered as significant*

the Kruskal-Wallis test, with a 95% confidence interval, 5% tolerance margin of error, and a P-value below 0.05.

### 3. RESULTS

Demographic data of the groups are shown as Table 1.

Hemodynamic parameters (heart rate and mean arterial blood pressure) were comparable amongst the groups and there was major difference between them regarding HR at 4, 8, 12 and 24 h post-anesthesia and MAP at 12 and 24 h ( $P < 0.001$ ).

Tukey post hoc test is done for statistically significant results (Table 2).

Groups were comparable in pain data (including time of starting analgesia and total narcotics intake at several times) and there was difference between groups at first rescue analgesia, total narcotics intake and VAS at 4, 8, 12 and 24 h.

### 4. DISCUSSION

ACB is a recognized method for providing postoperative analgesia following knee surgeries. However, it does not effectively address pain in the posterior knee capsule, which is supplied by the terminal branches of the tibial nerve as well as the posterior branch of the obturator nerve. So, extra analgesic interventions are needed to complement the ACB for comprehensive pain management in this region.<sup>6</sup>

The IPACK block, a relatively new technique, may address the limitations of analgesia in the posterior knee when using the ACB alone following knee surgeries.<sup>7</sup> Effective pain management with peripheral nerve blocks, such as IPACK in conjunction with ACB, can offer substantial analgesia, reduce the need for supplementary pain relief, facilitate early mobilization and rehabilitation, and potentially shorten the duration of hospital stay.<sup>5,8</sup>

In our research, we compared the pain-relieving impacts of ACB alone (Group B) and the combined approach of ACB with IPACK (Group C) during knee surgeries, with a third control group receiving solely spinal anesthesia (Group A).

There was statistically insignificant increase of HR in Group A and Group B than Group C ( $P < 0.001$ ). Regarding MAP, also there was statistically no difference at 12 h and 24 h postoperatively with more increase of the MAP in Group A and B than Group C ( $P < 0.001$ ).

VAS scores at fixed intervals indicated superior pain management in Group C compared to Groups A and B with  $P < 0.05$ .

Our study results align with those of Sankineani and colleagues, who conducted a prospective research with 120 participants split into two groups. One group underwent both IPACK and ACB, while the other received ACB only. Their results revealed that individuals who received IPACK along with ACB

exhibited notably reduced VAS scores at 8 h, 1 day, and 2 days following surgery ( $P < 0.001$ ).<sup>9</sup> A recent review carried out in Egypt demonstrated that patients who underwent ACB in conjunction with IPACK exhibited reduced VAS scores during the initial 48 h post-operation in comparison to those who solely received ACB.<sup>12</sup>

Against our research, Thobhani and colleagues conducted a study with three sets of patients undergoing TKA: one group receiving solely a FNB, another receiving FNB alongside IPACK, and a third receiving ACB with IPACK. Their results revealed that the ACB combined with IPACK provided good pain relief, with similar VAS scores evident across all three groups, as the variances were statistically insignificant.

In our research statistically significant difference was noted between groups at early rescue analgesia and total opioid intake shown as an increased pethidine consumption in Groups A and B compared to Group C ( $P < 0.001$ ).

This corresponds with the findings of Donghai and colleagues, who reported that the ACB+IPACK group encountered less levels of pain, decreased morphine usage, and prolonged analgesic effects in comparison to the ACB-only group. Additionally, they observed minimal disparity in mobility outcomes between them.<sup>10</sup>

In another research, Tayfun et al. found that patients who were given both ACB and IPACK experienced faster departure and ambulation times, reduced pain, and lower opioid requirements compared to those who received only ACB.<sup>11</sup>

Also, opioid consumption at 12 h postoperatively was shown to be statistically considerably reduced with IPACK block than with ACB alone in 2021.<sup>12</sup>

Against our work, Thobhani and his colleagues in their study, showed that opioid usage was notably lower in the FNB plus IPACK group compared to the other two. They came to the conclusion that although combining FNB with IPACK led to reduced opioid consumption, this advantage was not observed when IPACK was paired with ACB.<sup>13</sup>

Our research found that Group C had a greater walking distance and increased range of motion ( $P = 0.001$  for both outcomes), when compared to Group A or B. Group C had a median of 20 steps, while Group A had a median of 4 steps, and Group B had a median of 8 steps. This agrees with what Elliot et al. found, who illustrated that ACB + IPACK enhances the response to physical therapy, while also reducing length of stay.<sup>3</sup> Records were kept on pain levels, opioid use, physical therapy results, and the release time. In comparison to the FNB/IPACK group, the ACB/IPACK group exhibited somewhat increased opioid intake and non-inferior VAS

scores. On the other hand, in the ACB/IPACK group, more patients were discharged on the first and second post-operative days, and all the patients in this group were released on the same post-operative day. They also had a considerably superior ambulation distance.

Unlike our research, Patterson and associates,<sup>14</sup> conducted an analysis to evaluate the pain-relieving impact of IPACK in TKA patients. Two teams participated in the research: one received IPACK block and ACB together, while the other received ACB together with a placebo injection of normal saline subcutaneously given at the IPACK location. Within PACU, the IPACK group exhibited notably lower average ( $P = .0122$ ) and worst ( $P = .0168$ ) pain scores at rest. However, there were no disparities in pain scores during physical rehabilitation ( $P = .2080$ ), narcotics intake in PACU ( $P = .7928$ ), or at the 24-hour mark ( $P = .7456$ ). Moreover, there were no discrepancies in pain scores on POD 1, both morning ( $P = .4597$ ) and evening ( $P = .6273$ ), moving distance ( $P = .5197$ ), PACU length of stay ( $P = .9426$ ), or total hospital stay ( $P = .2141$ ). According to their results, using the IPACK block together with ACB improved pain ratings only during the first postoperative phase. without yielding noteworthy advantages during subsequent pain evaluations. Moreover, their research revealed no discernible variance in opioid usage, leading them to infer that the regular incorporation of the IPACK block with ACB in TKA might not offer important clinical advantages. They suggested that the IPACK block may be more appropriate in cases where standard multimodal pain management is contraindicated (such as in patients unable to take NSAIDs or acetaminophen), for chronic pain conditions, or in patients with opioid dependence.

## 5. CONCLUSION

The results of our study show that, in contrast to ACB alone, the combined use of ACB + IPACK can deliver improved analgesic outcomes following TKR surgery, leading to reduced need of narcotics and comparatively early postoperative mobility of the patients.

## 6. Data availability

The numerical data generated during this research is available with the authors.

## 7. Conflict of interest

The authors declare no conflict of interests.

## 8. Funding

The study utilized the hospital resources only, and no external or industry funding was involved.

## 10. Authors' contribution

MM: conduction of study work

MH: manuscript editing

HAE, AM: literature search

MR: statistical analysis and review

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