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Comparative study between the analgesic efficacy of adductor canal block alone and adductor canal with IPACK (interspace between popliteal artery and capsule of the knee) block for knee surgeries

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ABSTRACT

Background: Knee surgeries are needed in a wide range of patients, from young athletes with anterior cruciate ligament injuries up to old patients with comorbidities presenting for arthroscopy up to total knee replacement procedures. The trend is fast track knee surgery with early ambulation and hospital discharge, so analgesic options of neuraxial blocks and main nerve blocks are less attractive due to the unavoidable muscle weakness. In this study, the benefit of pure sensory nerve block could be reached.

Aim of the study: To compare the postoperative range of motion and the analgesic efficacy of adductor canal block (ACB) alone against adductor canal with IPACK (interspace between popliteal artery and capsule of the knee) block in knee surgeries.

Patients and methods: The study is a randomized, prospective, comparative study where 50 patients subjected to knee surgeries were randomized into two groups: **Group (A)**: patients in this group received ultrasound-guided ACB only; **Group (AB)**: under ultrasound guide, patients in this group received a combined ACB and IPACK block at the start of surgery.

Results: Regarding pain control over the first 24hours following surgery, range of motion and walking distance; there were statistical differences between both groups.

When demographic information such age, sex, BMI, and ASA scores were examined between the two groups, there was no statistically significant difference between them (p-value > 0.05). Additionally, there was no statistically significant difference between groups in terms of opioid needs or consumption.

Conclusion: Regardless of the good analgesic effect of ACB, patients who received a combination of ACB and IPACK blocks have experienced a better pain control, a wider range of motion and a longer walking distance following surgery when compared to patients who received ACB alone.

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KEYWORDS
Adductor canal; IPACK; knee surgeries

1. Background

Patients who undergo total knee arthroplasty (TKA) often have comorbidities that affect anaesthesia care, including osteoarthritis and rheumatoid arthritis, along with comorbidities that accompany advanced age. The use of multimodal, opioid-sparing strategy for perioperative pain control and postoperative management is mandatory, which often includes a single injection technique, continuous nerve block, periarticular injection (PAI) of local anaesthetics (LAs), non-opioid analgesics, along with prophylaxis for postoperative nausea and vomiting, all of these allow early mobilization [1].

Nerves to the vastus medialis, intermedius, and lateralis, as well as the medial and intermediate femoral cutaneous and saphenous nerves, supply the majority of the knee joint's innervation. The sciatic nerve provides a smaller but still significant amount of innervation through the peroneal and tibial nerves, and the lateral femoral cutaneous and posterior obturator nerves provide even less. The sensory portion of the femoral nerve is the saphenous nerve [2].

Adductor canal block (ACB) is a peripheral nerve block that can effectively relieve knee arthroplasty patients' pain, especially in the peripatellar and intra-articular regions where there is little to no motor affection on the quadriceps muscle's motor activity. ACB, however, does not effectively relieve the moderately painful posterior aspect of the knee [3].

The small sensory branches of the sciatic nerve that run through this area, known as the interspace between popliteal artery and posterior capsule of the knee (IPACK), can be blocked without affecting the motor function.

Although this technique is being performed at many institutions, yet there are very limited data on its efficacy. This block alone is insufficient for postoperative analgesia; therefore, it is often combined with ACB in a multimodal analgesic pathway [4].

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1.1. Aim of work

To compare the postoperative range of motion and the analgesic efficacy of ACB alone against adductor canal with IPACK block in knee surgeries.

Secondary outcomes include assessment of postoperative narcotic consumption and number of steps walked after surgery.

2. Methodology

Between April 2021 and April 2022, a randomised, prospective, double-blinded, comparative study was conducted. 50 patients of American Society of Anesthesiologists (ASA) physical status I to III of both genders, aged between 21 and 70 years, undergoing elective knee surgeries under spinal anaesthesia, were included in this study after receiving the approval of the departmental ethical committee, ethical committee at faculty of medicine Ain Shams university, clinical trials registration number: NCT04995861, and after obtaining written informed consent from the patients. Two groups of patients, each with 25 patients, were randomly assigned by computer to one of the following:

• Group (A): received ACB only under ultrasound guide by injection of 15 ml bupivacaine 0.25% and 25 ml of saline in the IPACK before skin incision.

• Group (AB): prior to skin incision, patients received ACB under ultrasound guide by injection of 15 ml bupivacaine and IPACK block under direct visualization of ultrasound of 25 ml bupivacaine 0.25%.

N.B Patients distribution according to type of surgery has been considered; as group (A) included 10 patients who underwent total knee replacement and 15 patients who underwent knee arthroscopy. Whereas group (AB) included 11 patients who underwent total knee replacement and 14 patients who underwent knee arthroscopy.

2.1. Selection criteria for cases

2.1.1. Inclusion criteria

- Patients undergoing knee surgery i.e., arthroscopy, total knee replacement, ACL repair.
- ASA physical status I to III.
- Sex (males and females).
- Age 18–70 years.

2.1.2. Exclusion criteria

- Hypersensitivity to local anesthetics.
- Preexisting peripheral neuropathy.
- Infection near site of infections e.g., osteomyelitis, septic knee joint, etc.
- Patient refusal.
- Any contraindications for spinal anesthesia. (e.g. coagulopathy, use of anticoagulants or antiplatelets).

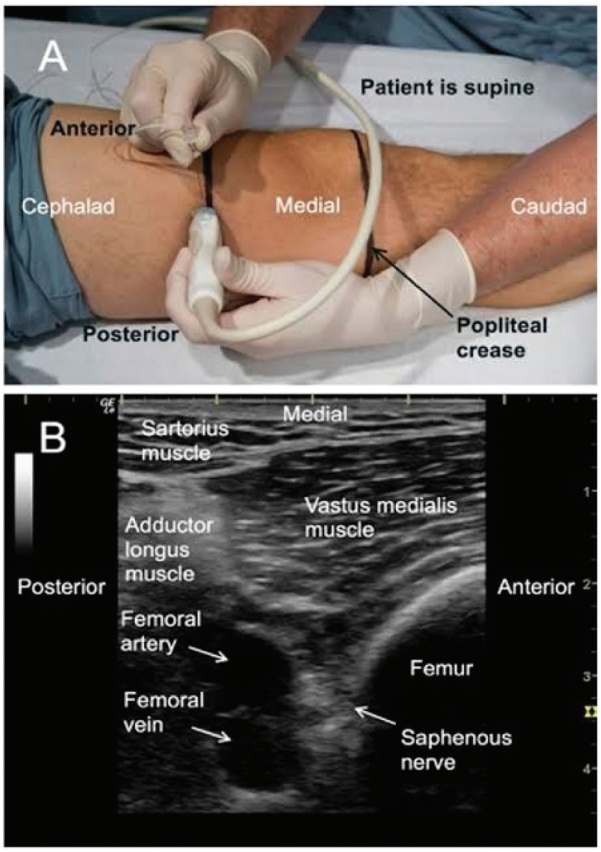
2.2. Sample size calculation

PASS 11 program was used for sample size calculation, setting power at 80%, alpha error at 5% reviewing results from previous studies showed that the VAS in the first day after surgery for ACB technique was 3± 0.83 (Thobani, et al,2017) vs 1.5 + 1.63 for ACB plus IPACK technique (W. Kampitke et al,2018). Based on these results, a sample size of at least 50 patients (25/group) will be needed.

2.3. Study procedure

- All patients underwent a history taking, physical examination, and tests including complete blood count (CBC), prothrombin time (PT), and partial thromboplastin time (PTT).
- Prior to surgery, all trial participants were instructed to discontinue oral intake of fluids and meals for 2 hours and 8 hours, respectively.
- In the operating room, standard monitoring tools such as temperature, noninvasive blood pressure (NIBP), electrocardiography (ECG), and pulse oximetry (SpO2) were used.
  - Patients received spinal anesthesia in the sitting position at the level of L3–L4 or below; using 4 ml heavy bupivacaine 0.5% with 12.5 mcg fentanyl as additive.
  - Baseline HR, SpO2, and blood pressure readings were taken and nasal prongs were applied.
  - In event of hypotension (< 25% of the basal mean arterial blood pressure), patient received ephedrine 10 mg by slow titration.
  - After 5 minutes, adequacy of spinal anesthesia was assessed by motor Bromage scale (scale 0 to 3 where 0 = full flexion of knees, 1 = partial; able to move knees, 2 = almost complete; able to move only feet, 3 = complete; unable to move knees or feet) and sensory examination of the level of the block by cold sensation test; adequate spinal blockade was considered when sensory block was above L1 (groin) level. (NB. temperature and pain sensation are not transferred by the same fibres and are not blocked on the same level. We used cold sensation test instead of pin prick for the risk of infection.)
  - The **(A) group**: received ACB only under ultrasound guide by injection of 15 ml bupivacaine 0.25% at the start of surgery.

Before surgery, all patients underwent ultrasound-guided ACB (using a linear high frequency probe from SonoSiteTM, Inc., Bothell, WA 98021, USA), during which the adductor canal is seen just below the sartorius muscle and 15 ml of 0.25% bupivacaine is injected into it using a 22-gauge 100-mm short-bevelled regional block needle (In-plane technique technique).



- Patients had the same preoperative pain management protocol, which included administering 1 g of paracetamol intravenously every 8 hours for 3 days. In case of break through pain (VAS score above 4), patient received 3 mg morphine sulfate intravenously as a rescue analgesia.
- **In (AB) groups**: Before beginning surgery, patients in this group had a 15 ml bupivacaine injection into the adductor canal and a 25 ml bupivacaine 0.25% IPACK block under direct ultrasound observation.

The patients in Group AB got ACB as previously described, and then IPACK block was administered using the same methods as Elliott et al. [3], with the patient lying supine on their back with their knee flexed to 90 degrees. A spinal needle was inserted from the medial side of the knee directed from anteromedially to posterolaterally in a plane between the popliteal artery and the femur, along with a curved low-frequency ultrasonography probe in the popliteal fossa. The tip of the needle was positioned almost 1–2 cm away from the lateral border of the artery, and 25 ml of 0.25% bupivacaine was injected after negative aspiration.

Nerve blocks were given by a third person (anaesthesiologist who is competent in regional anaesthesia) and blind for the researcher who will do the postoperative visits and collect the data. Also it was blind for patients.

Assessment of pain after completion the surgical procedure and wear off of spinal analgesia were confirmed by Bromage scale and cold sensation.

The primary outcome of the study was the assessment of pain using the visual analogue scale (VAS), where 0 indicates no pain and 10 indicates the most excruciating pain imaginable. This was done postoperatively at 4 hours, 8 hours, 12 hours, and 24 hours postoperatively.

At the time of enrolment in the trial, the VAS score for patients' self-assessment of pain was explained to every patient.

Additionally, the total cumulative dose of morphine utilised to manage pain within the first 24 hours following surgery was computed.

The extent of knee extension one day after surgery was used to quantify the range of motion (ROM), and the number of steps the patient took after surgery was used to estimate the ambulation distance.

2.4. Statistical analysis

The Statistical Package for Social Science (SPSS) version 22.0 was used to analyze the data. Quantitative data were expressed as mean, standard deviation (SD), or median (IQR), as appropriate. Frequency and percentage were used to express qualitative data.

The tests used are as follows:

-When comparing two means, the independent samples' t-test of significance was applied.

-The proportions between two qualitative measures were compared using the Chi-square (X2) test of significance.

-For two group comparisons in non-parametric data use the Mann–Whitney U-test.

-The allowable margin of error was set at 5%, while the confidence interval was set at 95%. The p-value was, therefore, deemed significant as follows:

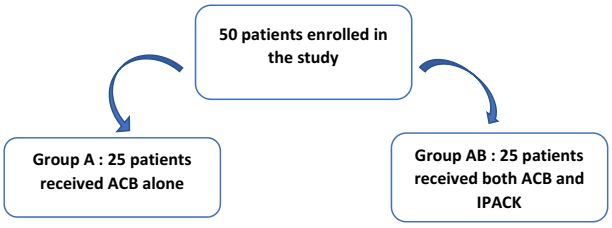
-The likelihood (P-value):

A P-value of 0.05 or higher was deemed significant.

P-values below 0.001 were deemed to be very significant.

A P-value of 0.05 or higher was deemed non-significant

3. Results



FLOW CHART OF THE STUDY

A. Demographics

In the study, there were 50 patients. There are 25 patients per group. In terms of age, sex, BMI, and ASA, both groups were comparable, and there was no

Table 1. Comparison between groups as regard demographic data.

Demographic data		A group (n = 25)	AB group (n = 25)	T/x2	p-value
Age (years)		50.2 ± 12.4	55.2 ± 11.6	1.4 ^{t}	0.15
ASA	I	13 (52%)	16 (64%)	0.7 ^{x2}	0.39
	II	12 (48%)	9 (36%)		
Sex	Male	17(68%)	14 (56%)	0.75^{x2}	0.39
	Female	8 (32%)	11 (44%)		
BMI		31.7 ± 2.7	32.2 ± 2.97	0.6 ^{t}	0.55
Duration of surgery (in minutes)		116.2 ± 7.8	115.3 ± 7.3	0.47 ^{t}	0.64

Data expressed as mean ± SD, proportion., t = student t test, x2 = Chi-square test, A = adductor canal block group, AB = adductor canal block Plus IPACK block group

statistically significant difference between them (p-value > 0.05). (Table 1 to 4).

B. Pain control

Visual analogue scale (VAS) measurements of pain control were made at regular intervals (4 hours, 8 hours, 12 hours, and 24 hours) and showed statistically significant differences between the groups. (Table 2)

3.1. Range of motion

After 24 hours, range of motion (ROM) was examined between the groups, and a statistically significant difference was found. See Figure 1

3.2. Distance walked after 24 hours

Groups were compared for the distance walked after 72 hours and there was statistical difference between them. See Figure 2

4. Discussion

The increase in number of knee surgeries performed around the world in the recent years has spotted the light on finding effective pain management techniques for the patients undergoing those surgeries.

A variety of pain control strategies have emerged. Peripheral nerve blockade techniques have been gaining popularity over the past years.

ACB is an effective peripheral nerve block that is widely used in knee surgeries, as it guarantees an adequate analgesic effect together with early mobilization after surgery because of its quadriceps muscle sparing effect.

However, the analgesic action of the ACB is only felt in the anterior aspect of the knee because it has no impact on the deep genicular neurons that are in charge of transmitting sensations from the posterior aspect of the knee joint.

In the IPACK approach, on the other hand, infiltration of local anesthetics into the space between the popliteal artery and the posterior capsule of the knee spares the motor branches of both the tibial and peroneal nerves. This can lead to a selective blockage of the sensory deep genicular nerves, which are responsible for the sensory nerve supply of the posterior aspect of the knee without impacting the muscle power [5].

In our study, we contrasted the analgesic effects of ACB alone and ACB in combination with IPACK in knee operations.

According to the study, there was no statistically significant difference between the two groups'

Table 2. Comparison between groups as regard VAS.

VAS	A group(n = 25)	AB group(n = 25)	z	p-value
4 hours	1 (1–1)	0 (0–1)	3.1	**0.0017**
8 hours	2 (2–3)	1 (1–2)	4.2	**<0.001**
12 hours	3 (3–4)	2 (2–3)	4.4	**<0.001**
24 hours	4 (3–4)	3 (3–3)	3.5	**<0.001**

Data expressed as median(IQR), z = Mann-Whitney test,, A = adductor canal block group, AB = adductor canal block Plus IPACK block group
Additionally, groups did not significantly vary from one another for pain control over a 24-hour period measured by total narcotic usage.

Table 3. Comparison between groups as regard opioid consumption.

	A group(n = 25)	AB group(n = 25)	z	p-value
Opioid consumption (mg)	0 (0–3)	0 (0–0.75)	0.32	0.75

Data expressed as median (IQR), z = Mann-Whitney test, A = adductor canal block group, AB = adductor canal block Plus IPACK block group

Table 4. Comparison between groups as regard opioid need postoperative.

	A group(n = 25)	AB group(n = 25)	X^2	p-value
Opioid need	7 (28%)	6 (25%)	0.1	0.7

Data expressed as proportion, x2 = Chi-square test, A = adductor canal block group, AB = adductor canal block Plus IPACK block group

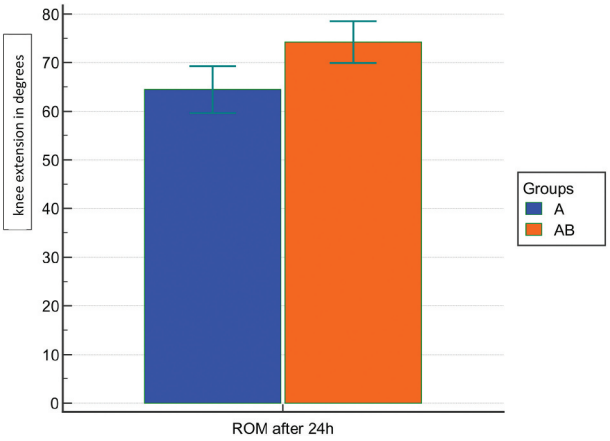


Figure 1. Bar chart comparison graph between groups as regard ROM after 24 hours.

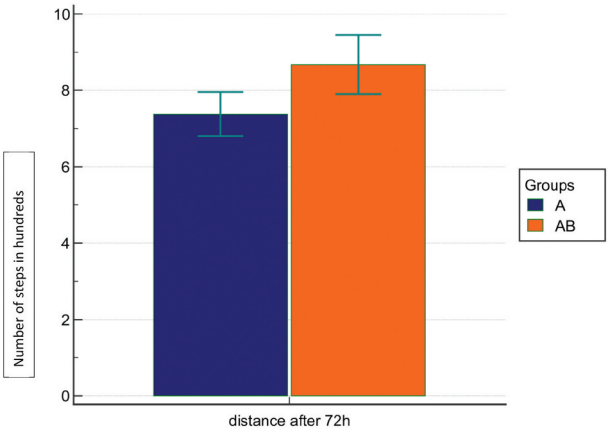


Figure 2. Bar chart comparison graph between groups as regard distance walked after 24 hours.

demographic characteristics (age, sex, BMI, and ASA score) (P-value > 0.05).

Additionally, there was no discernible difference in the two groups' use of opioids in the first 24 hours following surgery (P-value = 0.57).

Measurement of the pain score using the VAS at regular intervals (4, 8, 12, and 24 hours) showed a better pain control among the group which received a combination of both ACB + IPACK block than in the group that received ACB alone (P-values at 4, 8, 12, and 24 hours were 0.0017, <0.001, <0.001, <0.001, respectively).

The study also discovered that when compared to the ACB alone group, the group that received both ACB+IPACK had a longer walking distance and a greater range of motion (P-values were 0.001 for both outcomes).

Unfortunately, we did not come across many published studies discussing the effect of IPACK block in knee surgeries .

In agreement with our study, Sankineani et al. reported that the group which received ACB + IPACK has shown a better pain control on VAS, a better range of motion together with better ambulatory distance than in the group that received ACB alone . They also mentioned that the chief complaint of patients who received ACB only was pain limited to the posterior side of the knee on the first 24 hours following surgery [5].

According to Donghai et al., the ACB+IPACK group displayed lower pain scores, less morphine use, and a longer analgesic duration than the ACB solo group. Additionally, they claimed that there was little difference regarding the mobility between the two groups [6].

In a different study, Tayfun et al. discovered that patients who received a combined ACB + IPACK had shorter discharge and mobilization days, less pain, and less opioid demands than patients who received only ACB [7].

In a 2021 study by Singtana, it was discovered that compared to ACB alone, opioid intake at 12 hours postoperatively was statistically significantly lower with IPACK block than with ACB alone. Between the two groups, there were no statistically significant differences in the numerical pain rating scale, analgesic dosage, satisfaction ratings, or complications.

Elliot et al. stated that the combination of ACB + IPACK improves the response to physical therapy and can reduce pain scores, opioid consumption, and hospital stay. In their study, ACB+IPACK group did not show lower VAS scores. In comparison with the femoral nerve block (FNB)+IPACK group, they also displayed somewhat increased opioid demands and consumption. However, during the first 48 hours following surgery, the ACB +IPACK group demonstrated considerably longer walking distance and a greater rate of discharges [3].

Additionally, a recent study conducted here in Egypt discovered that patients who received ABC with IPACK had lower VAS scores during the first 48 hours following surgery than those who simply received ACB [8].

On contrary to the present study, a study by Patterson et al. showed that using IPACK with ACB decreased pain scores during the immediate postoperative period only and had no beneficial effect during subsequent pain assessment. Also, they found no significant difference in opioid demands. They recommended that the indications for IPACK block may be applied where there are contraindications to the standard multimodal pain management (as patients with contraindications to paracetamol or NSAIDs), in case of chronic pain, or if the patient has opioid dependence [9].

5. Conclusion

In conclusion, the combined technique of ACB + IPACK can offer better analgesic effect in the postoperative period without motor power affection of the knee joint. Subsequently, this combination can also provide a longer walking distance and a wider range of motion when compared to ACB alone.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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