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The Effect of Adductor Canal Block or Interspace between the Popliteal Artery and Posterior Capsule of Knee and Periarticular Block (Ipack Block) on Postoperative Analgesia after Knee Arthroscopy: Prospective Randomized Study

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ABSTRACT

Background: Pain control after knee arthroscopy (KA) includes multiple modalities including systemic analgesics including narcotic and non-narcotic analgesics or regional blockades as neuraxial blockade including spinal anesthesia and epidural catheters or peripheral nerve blocks as adductor canal block (ACB) and interspace between the popliteal artery and posterior capsule of knee (IPACK) block and periarticular block and local infiltration analgesia (LIA).
Objective: This work aimed to evaluate the efficacy of the ultrasound-guided IPACK versus ACB in patients planned for KA. **Methods:** This prospective randomized double-blind study involved 90 patients, from the ages of 21 to 65, males and females, who were scheduled for KA under spinal anesthesia. Patients were classified into two groups: Group I: IPACK block and periarticular block and Group II: ACB group.
Results: Both groups didn't differ significantly with respect to the numerical rating score (NRS) at rest and during movement, the time taken to request rescue analgesia, or the total dose of morphine utilized. Neither the heart rate nor the mean arterial pressure varied significantly among both groups at baseline, after block, 2, 4, 8, 16, or 24 h.
There was no significant difference between the two groups with respect to patient satisfaction, hypertension, or bradycardia. Systemic toxicity from local anesthetics did not occur in both groups.
Conclusions: Anaesthetic efficacy in KA is equivalent when ACB and IPACK blocks are combined with periarticular blocks regarding pain alleviation, hemodynamic measurements, opioid intake, and patient satisfaction.
Keywords: Adductor canal block, Interspace between the popliteal artery and posterior capsule of knee, Knee arthroscopy, Periarticular block.

INTRODUCTION

Knee arthroscopy (KA) is a common minimally invasive orthopaedic surgical procedure that can be used for both diagnosis and treatment [1]. KA is now considered the most effective method for detecting and treating meniscal and ligamentous injuries as well as osteoarthritis and degenerative knee disease [2, 3].

Pain is common after KA, in the soft tissues below the kneecap, over the arthroscopy wounds and occasionally the whole knee. For patients to recuperate from surgery, postoperative pain management is crucial [4]. Pain control after KA includes multiple modalities including systemic analgesics as narcotic and non-narcotic analgesics or regional blockade as neuraxial blockade including spinal anaesthesia and epidural catheters or peripheral nerve blocks as adductor canal block (ACB) and interspace between the popliteal artery and posterior capsule of knee (IPACK) block and periarticular block and local infiltration analgesia (LIA) [5]. The use of systemic opioids may include some adverse effects. Prolonged use of systemic analgesics may even cause systemic toxicity and neuraxial blockage may cause epidural bleeding and hematoma. There are a few potential complications that might arise with peripheral nerve blocks. These include: Infection, hematoma, failure of the block, quadriceps weakness due to local anaesthetic spreading within the femoral triangle in ACB and saphenous nerve injury in IPACK block, along with other possible side effects [6].

ACB offers adequate patient management after KA. To prevent sensation from reaching the knee, ACB blocks the saphenous nerve as well as the obturator nerve's branches to the vastus medialis and articular areas. However, the block is located far from the majority of the quadriceps' efferent branches, which means that the strength of this muscle is mostly preserved, leading to improved ambulation following surgery [7]. In 2014, Sanjay Sinha introduced a new nerve block technique called IPACK block. This technique blocks various branches of the obturator nerve in the popliteal region. It can alleviate pain at the back of the knee without weakening the muscles or causing the foot to drop since it avoids the motor branches of the tibial nerve and the common peroneal nerve [8].

This work aimed to assess the efficacy of the ultrasound (US)-guided IPACK block versus ACB in patients scheduled for KA.

PATIENTS AND METHODS

This prospective randomized double-blind study involved 90 patients between 21 to 65 years of age, both genders, with American Society of Anesthesiologists (ASA) classification I-III and planned for KA under

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spinal anesthesia. The research was conducted through the period from May 2023 to May 2024.

Exclusion criteria: Language barrier, a neuropsychiatric disorder, a bleeding diathesis (diagnosed or suspected), anticoagulant medication use, history of adverse reactions to local anesthetics or opioids, injection site infection, being pregnant or nursing, taking gabapentin or pregabalin, or having uncontrolled condition affecting the liver, kidneys, or heart.

Randomization and blindness: Using computer-generated numbers, two groups of patients were randomly assigned, and an opaque sealed envelope was utilized to store each patient's code: Group I (IPACK block and periarticular block) where patients received unilateral US-guided interspace between the IPACK block and periarticular block on the side of the operation at the end of the procedure and Group II (ACB): Patients were given unilateral US-guided ACB on the side of the operation at the end of the procedure.

Before surgery, all patients underwent a thorough medical history, physical examination, and laboratory tests. These investigations encompassed complete blood count, renal function, liver function, and coagulation studies, among others. Following their surgery, all patients were instructed on the utilization of the numerical rating scale (NRS) to assess their pain (0 represents no pain, and 10 represents the most severe pain experienced).

Intraoperatively, all patients were connected to standard monitoring, which includes electrocardiography, non-invasive arterial blood pressure, oxygen saturation using pulse oximetry, and temperature probe. An intravenous cannula (18 gauge) was placed (in the upper limb contralateral to the surgical site) with starting preload 7 mL/kg of lactated ringer solution. The patient was positioned in a sitting position and thoroughly aseptically prepared before the intervertebral space between L3-L4 or L4-L5 was discovered. An infiltration of local anesthetic containing three milliliters of 2% lidocaine was performed. Following the acquisition of cerebrospinal fluid flow, a 22-G spinal needle was put and a mixture of 2.5 ml of hyperbaric bupivacaine 0.5 % (12.5 mg) and 0.5 ml of fentanyl (25 ug) was slowly injected. The patient was turned to supine position with an assessment of the level of sensory block every 3 minutes using pinprick test. Additionally, the motor block underwent evaluation every 5 minutes using the modified Bromage score. The surgery started after reaching sensory block of L3-L4 and motor block of Bromage II at least. If the destined sensory and /or motor block level were not obtained after 20 minutes, the patient received general anesthesia and was rolled out from the study. All intervention was performed by the same experienced anesthesiologist. The area was sterilized with a skin antiseptic solution. All peripheral nerve blocks were given postoperative.

Technique of adductor canal block: In frog leg position, the patient laid on his back with his knee slightly bent and leg twisted outward. Povidone iodine was utilized to prepare the thigh. Philips Healthcare's high-frequency linear US transducer was positioned transversely on the medial thigh, halfway between the inguinal crease and the medial condyle of the femur, to see the femoral artery, which is deep to the sartorius muscle. A local anesthetic solution containing 15 ml of 0.25% bupivacaine was administered under US-guidance with the needle tip positioned slightly deeper than the artery and anterolateral to the sartorius muscle's fascia.

Technique of IPACK block: The patient was laid on his side with his knees slightly bent. The popliteal fossa was prepared with povidone iodine and Curvilinear US transducer Philips healthcare was placed on popliteal fossa until femoral condyles were visible at a depth of about 3.5 to 4.5 cm, the transducer was then advanced cephalad until the condyles were no longer visible, and the femoral axis was visible. Now, positioning the needle 1 to 2 cm from the popliteal artery's lateral edge, it was placed in a plane running from the anteromedial to the posteromedial direction, between the popliteal artery and the femur, 15 ml of bupivacaine 0.25% was administered under US-guidance.

Technique of peri-articular injection block: The peri-articular (cocktail) injection technique was performed intra-operatively by a single surgeon. The peri-articular cocktail injection consisted of 90 ml of normal saline, 15 mL of 0.25% bupivacaine, the total volume of the cocktail was 110 ml. The infiltration was injected using a 21-gauge needle dividing the volume between the quadrants and the rest of the local anesthesia was administrated at the end of the procedure in skin and subcutaneous tissue [9]. Injecting the cocktail into specific areas allowed for localized distribution: The medial compartment (the medial retinaculum, medial collateral ligament and medial meniscus capsular attachment), the posterior capsule, the anterior compartment, which includes the patellar tendon, fat pad, cut ends of the quadriceps muscle and tendon, subcutaneous tissue and the lateral compartment (the lateral retinaculum, lateral collateral ligament, and lateral meniscus capsular attachment.)

Postoperatively, the patient was discharged to the post-anesthesia care unit. Every patient who had surgery was prescribed a standard postoperative pain medication regimen consisting of 1 gm of IV paracetamol every six hours and 30 mg of IV ketorolac every eight hours.

Postoperative pain was assessed by NRS. Patients received 3 mg morphine slowly intravenous when their pain score reached more than 3 that can be repeated provided that total daily morphine consumption does not exceed 20 mg/day. In cases of hypotension, which is defined as a drop in mean arterial pressure (MAP) of 20 mmHg or more from the first measurement or a drop of 65 mmHg or more, the patient was given an IV bolus

of vasopressor (Ephedrine 10 mg) and may be given another dose if necessary. In cases of bradycardia, which is defined as HR less than 50 b/min, the patient was given an IV atropine as treatment (0.02 mg/kg), which may be repeated if needed.

The primary outcome was postoperative pain assessment at rest and on moving was performed using the NRS score. The secondary outcomes were postoperative morphine consumption in the first 24 hours after surgery and time for the first rescue analgesic request.

Sample size calculation: Epi-Info, a statistical application developed by the World Health Organization and the Centers for Disease Control and Prevention in 2002, was employed to determine the sample size and conduct the power analysis. This study's sample size was determined using the following criteria: 80% power, 95% confidence limit. The expected efficient pain block in the best treatment groups is at occurrence of fasciculation at 90% compared to 65% in the least favorable treatment groups. Each group had the appropriate sample size (N=44) according to the preceding criteria. For each group, the researcher used a larger sample size of 45 instances to overcome for missing data.

Ethical concerns: The study was done after approval from The Ethics Committee of the Faculty of Medicine, Tanta University Hospitals. The study adhered to the Helsinki Declaration throughout its execution. Informed signed consent was obtained from each participant.

Statistical analysis

SPSS version 27 (IBM©, Armonk, NY, USA) was employed to conduct statistical analysis. To determine if the data were normally distributed, the Shapiro-Wilks test and histograms were employed. To evaluate quantitative parametric data, the unpaired student t-test was used, with mean and standard deviation (SD) values. The Mann Whitney test was used to evaluate quantitative non-parametric data, which was presented as median and interquartile range (IQR). We utilized the Chi-square test or Fisher's exact test to assess qualitative variables, and the findings were provided as frequency and percentage. It was deemed statistically significant if the two-tailed P value was ≤ 0.05.

RESULTS

We evaluated 133 patients to see if they were eligible for this study; 12 patients refused to take part, and 31 patients did not fulfill the requirements. We divided the remaining patients evenly into two groups, each with 45 patients. We statistically examined all the allocated patients after they were followed up (Figure 1).

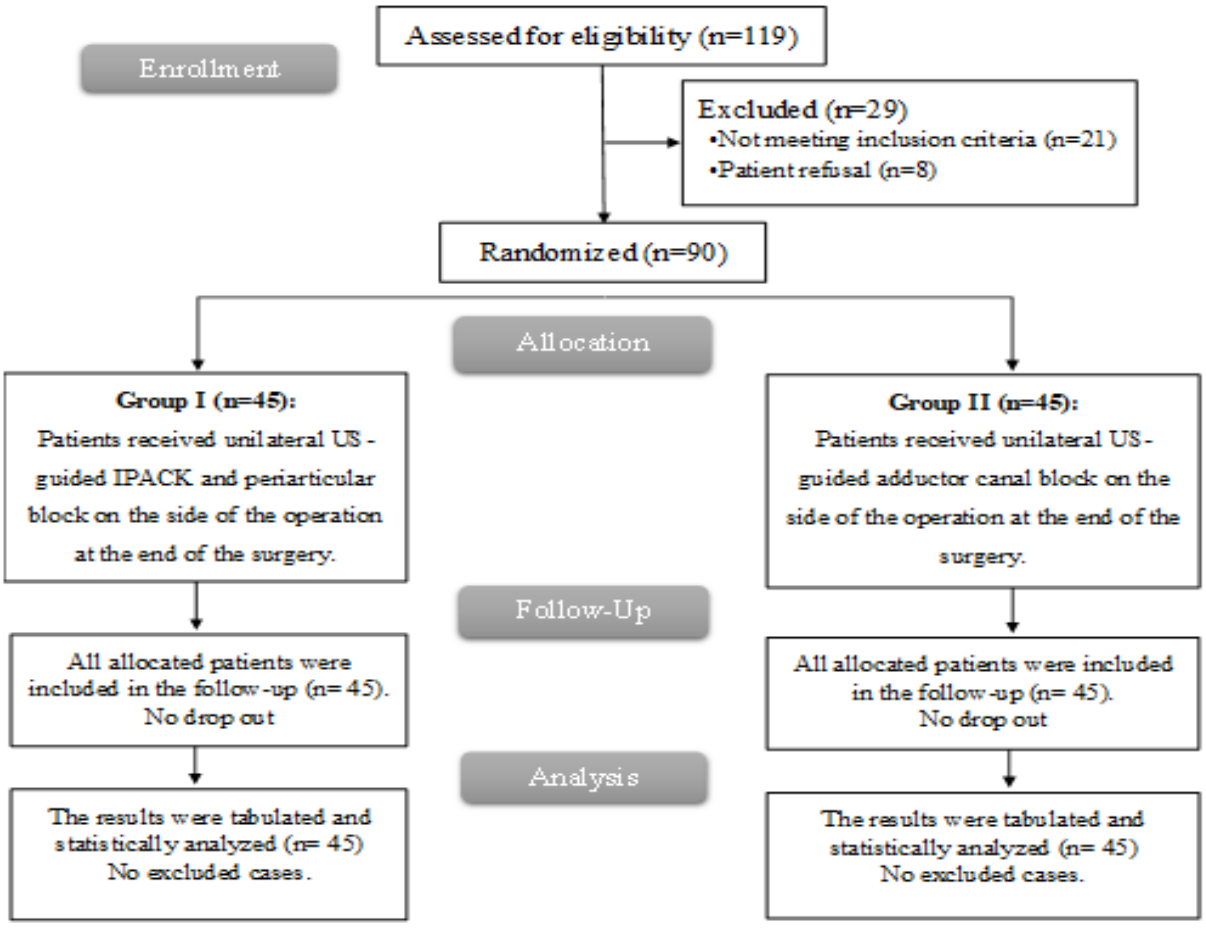


Figure (1): CONSORT flowchart of the enrolled patients.

Neither group differed significantly from the other with respect to demographic data, side, type, and duration of surgery (Table 1).

Table (1): Demographic data, side, type and duration of surgery in the studied groups

		Group I (n=45)	Group II (n=45)	P
Age (years)		47.71±8.15	49.42±7.55	0.304
Sex	**Male**	21(46.67%)	19(42.22%)	0.671
	Female	24(53.33%)	26(57.78%)	
BMI (Kg/m^2)		29.57±3.51	29.09±3.07	0.491
ASA physical status	**I**	7(15.56%)	8(17.78%)	0.793
	II	22(48.89%)	24(53.33%)	
	III	16(35.56%)	13(28.89%)	
Side of surgery	**Right**	24(53.33%)	22(48.89%)	0.673
	Left	21(46.67%)	23(51.11%)	
	ACL	16(35.56%)	14(31.11%)	0.917
	PCL	13(28.89%)	12(26.67%)	
	Combined	10(22.22%)	11(24.44%)	
	Medial meniscus	6(13.33%)	8(17.78%)	
Duration of surgery		103.56±16.98	102.78±13.12	0.808

Data is presented as mean ± SD or frequency (%). BMI: Body mass index, ASA: American Society of Anesthesiologists.
NRS at rest and movement in the studied groups was insignificantly different between the two groups (Table 2).

Table (2): NRS at rest and movement in the studied groups

		Group I (n=45)	Group II (n=45)	P
NRS at rest	**T1**	0(0-1)	0(0-1)	0.674
	2h	1(1-2)	2(1-2)	0.074
	4h	2(1-3)	2(2-3)	0.212
	8h	3(2-4)	3(2-4)	0.905
	16h	3(3-4)	3(3-5)	0.560
	24h	4(3-4)	4(3-5)	0.764
NRS at movement	**2h**	3(2-4)	3(3-4)	0.232
	4h	3(3-4)	4(3-4)	0.211
	8h	4(3-6)	4(3-7)	0.680
	16h	5(4-6)	5(4-5)	0.181
	24h	5(4-6)	5(5-6)	0.684

Data is presented as median (IQR). NRS: Numerical Rating Scale.

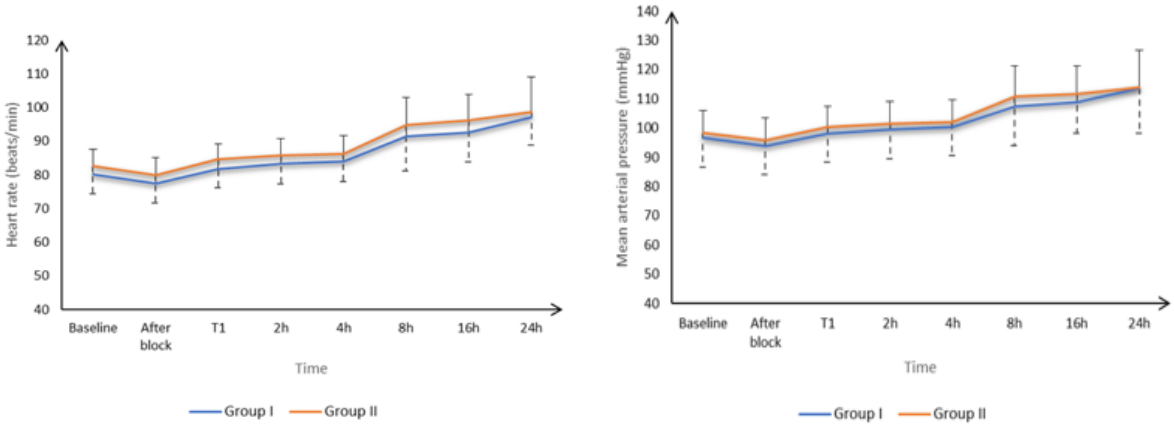
There was insignificant difference between the groups in the terms of the time to first request of rescue analgesia and total dose of morphine consumption (Table 3).

Table (3): Time to first request of rescue analgesia and total dose of morphine consumption in the studied groups

	Group I (n=45)	Group II (n=45)	P
Time to first request of rescue analgesia (h)	8.33±0.93	7.96±0.93	0.057
Total dose of morphine consumption (mg)	6.4±1.64	6.27±2.1	0.738

Data is presented as mean ± SD.

At baseline, 2, 4, 8, 16, and 24 hours after block, there was insignificant difference in heart rate or mean arterial pressure between the two groups (Figure 2).



(A) **(B)**

Neither group differed significantly from the other in terms of patient satisfaction, hypertension, or bradycardia. No incidence of LAST was evaluated in both groups (Table 4).

Table (4): Patient satisfaction and complications in the groups studied

		Group I (n=45)	Group II (n=45)	P
Patient satisfaction	**Unsatisfied**	2(4.44%)	4(8.89%)	0.649
	Neither satisfied nor unsatisfied	7(15.56%)	8(17.78%)	
	Satisfied	36(80.0%)	33(73.33%)	
Complications	**LAST**	0(0.0%)	0(0.0%)	--
	Hypotension	6(13.33%)	5(11.11%)	0.747
	Bradycardia	4(8.89%)	2(4.44%)	0.676

Data is presented as frequency (%). LAST: Local anesthetic systemic toxicity.

DISCUSSION

KA is a surgical operation that enables orthopedic physicians to examine the knee joint without invasive skin and tissue incisions [10].

According to our study, time to first request of rescue analgesia and total dose of morphine need were not notably different in the two groups. NRS at rest was not markedly different at T1, 2, 4, 8, 16 and 24 h between both groups. Also, NRS movement was not notably different between both groups. Heart rate and mean arterial pressure were insignificantly distinguished at the beginning, after block, T1, 2 h, 4 h, 8 h, 16 h, and 24 h between both groups.

According to our findings, the two groups did not differ substantially in terms of patient satisfaction. Complications such as hypotension and bradycardia weren't notably different in both groups. Supporting our results, **Kim *et al.*** [11] found that NRS score was substantially less in ACB group than placebo group. Adverse events didn't occur in either ACB group or placebo group. Also, **Arumugam *et al.*** [12] stated that the average opioid consumption, pain score and hemodynamics stability were markedly lower in ACB group than the control group. There are no complications present in ACB group and control group. Besides, **Sim *et al.*** [13] found that the opioid utilization rate within postoperative 12 h was notably reduced in ACB group compared to placebo group. Also, after 12 h, the ACB group reported markedly less pain than the placebo group, and latter group didn't experience any systemic or localized side effects. In addition, **Lan *et al.*** [14] illustrated that the ACB group experienced substantially less pain at rest and at motion in comparison with the control group. Furthermore, **Grevstad *et al.*** [15] highlighted that the ACB markedly diminished pain scores. Also, **Ochroch *et al.*** [16] stated that patients who had the IPACK block reported decreased posterior knee discomfort when contrasted with those who underwent the sham block. On the other hand, **Aboelfadl *et al.*** [17] noticed that the IPACK group consumed much less analgesics after surgery compared to the ACB group.

In agreement with our findings, **Nader *et al.*** [18] noted that the ACB successfully decreased pain and opioid need after TKA compared to the control group. Supporting our study, **Pai *et al.*** [19] revealed that time to first opioid use and total postoperative opioid use were markedly different between IPACK and control group. **Aboelfadl *et al.*** [17] revealed that adverse effects were similar in both the IPACK and ACB groups. However, **Akesen *et al.*** [20] illustrated that heart rate and systolic and diastolic blood pressure were not distinguished statistically between the two groups. (IPACK group and genicular group). Also, **Narejo *et al.*** [21] illustrated that there was marked difference between IPACK group and control group regarding NRS pain score, MAP and heart rate. This variation in findings could be attributed to the

differences in the volume of the bupivacaine used in the IPACK (20ml) compared to our study (15 ml).

LIMITATIONS

A small sample was utilized in the study. It was a single centered study. Not comparing the blocks with different surgeries. The absence of a control group. Not comparing the blocks with other local anesthetics, doses and concentrations.

CONCLUSIONS

ACB and IPACK blocks paired with periarticular blocks showed equal analgesic efficacy in terms of pain reduction, hemodynamic measures, narcotic utilization, and patient satisfaction after arthroscopic knee surgery.

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