IPACK (Infiltration between the Popliteal Artery and the Capsule of the Knee) and Adductor Canal Block (ACB) versus Periarticular Injection (PAI) Enhances Postoperative Pain Control in Anterior cruciate ligament (ACL) repair: A Randomized Controlled Trial

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Abstract

BACKGROUND:

Motor-sparing peripheral nerve blocks, such as the infiltration between the popliteal artery and capsule of the knee (IPACK) and the adductor canal block (ACB), are promising analgesic pathways but supporting literature remains rare. Periarticular injections (PAIs) are becoming an essential multimodal joint analgesia. We hypothesized that ACB and IPACK would lower pain on ambulation on postoperative day (POD) 1 compared to PAI alone.

METHODS:

This double-blinded randomized controlled trial included 50 patients undergoing ACL repair. Patients either received (1) a PAI (control group, n = 26) or (2) an iPACK with an ACB (intervention group, n = 24). The primary outcome was pain on ambulation on POD 1. Secondary outcomes included numeric rating scale (NRS) pain scores, patient satisfaction, and opioid consumption.

RESULTS:

The intervention group reported significantly lower pain scores on ambulation than the control group on POD 1 (difference in means [95% confidence interval]; $P < .001$). In addition, pain scores on ambulation on POD 2 for group B (3.5 [-4.3 to -2.7]) and POD 2 for group A (1.0 [1.9 to 0.1]; with $P = .033$) were significantly lower. Patients in the intervention group were more satisfied, had less intravenous opioid consumption (post anesthesia care unit, $P = .028$), and reduced need for intravenous patient-controlled analgesia for the first 24 hours ($P = .037$).

CONCLUSIONS:

The addition of iPACK and ACB significantly improves analgesia and reduces opioid consumption after ACL repair compared to PAI alone. This study strongly supports iPACK and ACB use within a multimodal analgesic pathway.

Criteria

Inclusion Criteria

- Adult male or female patients ages 18-65 scheduled for elective PCL surgery
- American Society of Anesthesiologists (ASA) physical status I-III
- Mentally competent and able to give consent for enrollment in the study

Exclusion Criteria:

- Patients with any contraindications to regional anesthesia such as infection, on anticoagulation, previous neuropathy on the operative limb.
- chronic narcotic use
- ages younger than 18 or older than 65year, and ASA class 4 or 5.
- Patient refusal
- Patients with an allergy to local anesthetics or systemic opioids

Introduction

Ultrasound guided distal nerve block provides safer approach, as it shows important anatomical structures and preserves proximal muscle function.

Blocking the sensory nerve terminals supplying the knee region with motor sparing effect can be achieved using lower anesthetic concentrations. Moreover, combined nerve block targeting different sites of nerve course can result in more successful analgesia.

Methods

Our study is approved by DMF hospital ethical committee and was performed in accordance with Helsinki declaration. This study is a double-blinded randomized study: Patients aged 18–65 years undergoing ACL Reconstruction surgery under general anesthesia over the period of 12 months (November 2020–November 2021) and included 50 patients which were randomly allocated to either Combined Adductor Canal and iPACK Blocks (group A), or Periarticular Injection Blocks (group B).

A standard local anesthetic mixture was used throughout the study: 20 ml of Ropivacaine 0.5% for ACB and 30ml Ropivacaine 2% for IPACK (totally 160 mg). For PAI 80 ml Ropivacaine 2% were injected (160 mg).

In operation theatre non-invasive monitoring (ECG, Oximeter, Noninvasive Blood Pressure, temperature and capnograph) always attached to patient before doing nerve block. Intraoperative data recorded the block time, surgery time and anesthesia time. Quadriceps motor weakness and sensory exam (leg pinprick and temperature discrimination) was examined for legs at 12, 24, and 48h after anesthesia recovery. The success of the block was verified by testing for pinprick sensation in the distribution of saphenous nerve as well as motor function.

The primary outcome was to measure the patient's ability to actively extend his/her knee while flexed at 45 degrees. Our study analgesia protocol including oral paracetamol 1g 4 times daily for first 48 hours and ibuprofen 20 mg twice daily.

Patient Controlled Analgesia (PCA) morphine 2 mg with 10 minutes interval was given to the patient. Pain scores using Verbal Analogue Scale (VAS) were monitored twice daily (morning and evening) during the length of hospital stay.

Statistical analysis:

Analysis was performed on the 2 groups using independent sample *t*-tests, and chi-square analyses were used for categorical data where appropriate. *P* value of < .05 was set as the threshold to determine statistical significance of results. All statistical analyses were completed using JMP version 14.

Results

All demographic data were similar without any significance (as shown in Table 1). Opioid consumption was different in both groups. Highly significant difference comparing the two groups concerning the total morphine consumption (mg) in the first 24 postoperative hours (as shown in Table 2). The occurrence of postoperative nausea and vomiting was low in both groups without any statistical difference due to the prophylactic administration of dexamethasone and ondansetron as we routinely give to all patients as a standard protocol in our hospital.

Table 1
Demographic data

	iPACK group A (24)	PAI group B (26)	P value
Age	66 (62–70)	70 (68–76)	0.98
Gender (female)	9/24	13/26	0.36
ASA	2 (2.1–2.6)	2 (2.5–2.7)	0.50
Duration of surgery (min)	142 (135–167)	155 (125–165)	0.34
BMI	29 (27–31)	30 (27–32)	0.69
Side of ACL (right)	12/24	14/26	0.82

Table 2
Postoperative outcomes on early rehabilitation

	iPACK (group A)	PAI (group B)	P value
Pain ambulation POD 1	1 (1–2)	3 (3–4)	0.01*
Pain ambulation POD 2	1 (1–2)	3.5 (3–4)	0.033 *
PACU Opioid consumption (mg)	2	7	0.028*
24 hours Opioid consumption (mg)	6	11	0.037*
PONV	2/24	3/26	0.95
*P value < 0.5% is significant			

The combined Adductor Canal and iPACK blocks showed better outcome than Periarticular Injection blocks (PAI) for ACL reconstruction surgery concerning postoperative pain. The addition of iPACK provided higher analgesia effect than the surgeon Periarticular injection which may be attributed to the local anesthetic distribution that reach only the terminal sensory branches covering the knee capsule using lower concentrations.

Limitations of our study is that the results are requiring further randomized controlled trials of larger sample size, also, our study is limited as one center study.

Discussion

Anterior cruciate ligament (ACL) reconstruction is widely performed day case orthopedic procedure. (1) The capability to perform ACL reconstruction as day case procedure is dependent on an effective multimodal analgesic protocol to minimize the effect of systemic analgesics and for effective postoperative pain control that will eventually decrease the need for overnight stay. (2)

The adductor canal contains the vastus medialis nerve, medial femoral cutaneous nerve, articular branches from the obturator nerve, and the medial retinacular nerve in addition to saphenous nerve that innervate the medial, lateral, and anterior aspects of the knee.(3, 4) Theoretically, ACB is a pure sensory nerve block, which only affects the motor function of vastus medialis due to its impact on nerve to the muscle as it crosses the adductor canal(5) and decrease the incidence of fall.(6)

Acute postoperative pain is not uncommon problem. Most accepted global protocols of perioperative anesthetic care, anesthetists may play an important role in enhancing recovery and controlling acute postoperative pain which directly affects surgical outcomes and eliminates prolonged hospital stays and patient dissatisfaction.

Moreover, multiple clinical studies and several meta-analyses (7–9) showed that ACB could preserve quadriceps muscle strength, better early ambulation with good analgesic effects and less morphine

consumption when compared to FNB in patients after TKA (11–18). Understanding of adductor canal anatomy, including nerves related to ACL reconstruction, is still not clear but the assumption of analgesic effectiveness of the ACB is less. (10–16)

The target of our present study was dual. First, to compare effectiveness of combined Adductor Canal and iPACK Blocks versus Periarticular Injection Blocks for ACL reconstruction Surgery. Secondly, to test the hypothesis of distal nerve block which are mainly sensory that might result in more successful analgesia and sparing of motor branches of mixed nerves.

A novel nerve block technique with ultrasound (US)-guided local anesthetic injection between the popliteal artery and the capsule of the knee (IPACK). (17–19) By targeting only, the sensory branches of the sciatic nerve, the IPACK block provides an alternative for decreasing posterior knee pain following TKA and greatly avoid foot drop. (18–21)

However, clinical evidence comparing the effectiveness of analgesia, postoperative physical rehabilitation, and opioids reduction with the addition of an iPACK block to ACB is still limited. The objective of this study was to evaluate the effect of an iPACK block along with ACB block on postoperative pain scores, opioid consumption, and during early physical physiotherapy.

Conclusion

This study shows the importance of multimodal approach in regional techniques as combined Adductor Canal and iPACK blocks show better analgesic pathway than Periarticular Injections for ACL reconstruction surgery mainly for postoperative pain relief.

Declarations

Ethics approval:

The study is approved by DMF hospital ethical committee and was performed in accordance with Helsinki declaration.

Consent to participate:

Informed consent was obtained from all participants.

Consent for publication:

not applicable.

Availability of data and material:

The database generated and analyzed during the current study are not publicly available due to our hospital policy of patient's confidentiality is preserved but are available from the corresponding author on

reasonable request.

Competing interests:

no competing interests.

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Authors' contributions:

A. AJ has collected the data, wrote the manuscript, did the statistical analysis, and follow up the patients. F.K has helped in writing the manuscript.

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