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Adductor canal block vs. femoral nerve block in patients undergoing arthroscopic anterior cruciate ligament reconstruction using levobupivacaine: a comparative randomized controlled double-blind study

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Abstract

Background: The aim of this study was to compare the efficacy of ultrasound-guided adductor canal block versus femoral nerve block in postoperative analgesia, as well as their effect on quadriceps muscle strength.

Results: The study included 66 patients who were underwent arthroscopic anterior cruciate ligament reconstruction under general anesthesia. They were randomly divided into 2 groups; A and F, of 33 patients in each. Patients in group A received an adductor canal block, while patients in group F received a femoral nerve block. The primary outcome was the total morphine requirements in the first 24 h after the procedure. Secondary outcomes included time to first analgesic request and the patients' ability to perform straight leg raise in the post-anesthesia care unit and 2 h later. The straight leg raise was impaired in group F compared with group A both in the post-anesthesia care unit (p value = 0.017) and 2 h postoperatively (p value = 0.020). While there was no differences between both groups regarding time to first analgesic request, and total morphine requirements.

Conclusions: Compared with femoral nerve block, the adductor canal block may be an effective analgesic alternative with the advantage of sparing the quadriceps muscle strength in anterior cruciate ligament reconstruction surgeries.

Keywords: Adductor canal block, Femoral nerve block, Anterior cruciate ligament reconstruction, Quadriceps muscle strength

Background

ACL (anterior cruciate ligament) injuries are one of the most common knee injuries, with an estimated incidence 85 per 100,000 in patients aged 16 to 39 years (Bram et al. 2021). ACL reconstruction is a common outpatient orthopedic surgical intervention. Regional anesthesia has been proven to reduce unplanned hospital admissions, delay to discharge, and opioid administration when used to provide postoperative analgesia in the outpatient setting of this intervention (Edwards et al. 2020).

Femoral nerve block (FNB) is commonly used to provide analgesia after ACL reconstruction (Lynch et al. 2019). Unfortunately, FNB causes motor blockade of the quadriceps muscle, which can delay postoperative mobilization and increase the risk of a fall (Min et al. 2020). The adductor canal block (ACB) is becoming a preferred

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choice for knee procedures (Faiaz and Kamath 2019). Unlike knee arthroplasty, in ACL reconstruction, there is a scarcity of data comparing these two blocks (Sehmbi et al. 2019).

The aim of this study was to compare the efficacy of ultrasound-guided adductor canal block versus femoral nerve block in postoperative analgesia, as well as their effect on quadriceps muscle strength.

Methods

This randomized prospective double blind comparative clinical study was conducted at Ain Shams University hospitals after obtaining its Research Ethics Committee approval (# FMASU M D 138/2019) and patients' written informed consent. This study adheres to CONSORT guidelines. Sixty-six patients were randomly divided, using a computer generated list, into two equal groups: A and F.

Patients with an ASA grade I or II, 18–50 years old and a body mass index (BMI) less than 35 who were underwent ACL reconstruction between June 2019 and June 2020 were eligible. Exclusion criteria were patient refusal, significant psychiatric or mental disorders, baseline neuropathy or neurological deficits involving the lower extremities, infection at the block site, coagulopathies, pregnancy, systemic infection, or known allergy to local anesthetic agents.

ASA standard monitoring in the form of pulse oximetry, non-invasive automated blood pressure, and ECG were applied. All patients were given sedation prior to the block in the form of fentanyl 25 µg IV and/or midazolam 1 to 4 mg IV as required. Irrespective of group assignment, the patient was placed for application of the block in the same position. The operative limb was externally rotated at the hip while the patient was laying supine. All patients' block sites were similarly sterilized using povidone-iodine solution swabs.

In group A (adductor canal block), a high-frequency linear array transducer (6 to 13 MHz; SonoSite M-Turbo; SonoSiteTM, USA) was placed in a transverse plane on the medial side of the mid-thigh to visualize the sartorius muscle, the underlying pulsating femoral artery. An insulated 5-cm 22-gauge needle (B. Braun Medical Inc., USA) was inserted in plane with the ultrasound probe and advanced from lateral to medial until the needle tip was visualized between the femoral artery and the sartorius muscle. Twenty milliliters of 0.5% levobupivacaine was administered after negative aspiration. An adhesive tape was placed in the femoral nerve location to simulate a real block procedure for ensuring patient blindness.

In group F, a high-frequency linear probe was placed parallel and slightly distal to the inguinal crease and adjusted as needed to visualize the femoral nerve in short axis. The femoral nerve was detected within a triangular hyperechoic area lateral to the femoral artery, superficial to the iliopsoas muscle and deep to the fascia iliaca. A 5-cm 22-gauge insulated needle was placed in plane with the ultrasound probe and advanced from lateral to medial until the needle tip was adjacent to the femoral artery. After negative aspiration, 20 ml of 0.5% levobupivacaine was administered to produce a spread above the femoral nerve and below the fascia iliaca. An adhesive tape was placed in the adductor canal block location to simulate a real block procedure for ensuring patient blindness.

General anesthesia was induced using 1 to 2 $mg.kg^{-1}$ propofol and 1 to 3 $mcg.kg^{-1}$ fentanyl. A laryngeal mask was placed and 1–1.2% isoflurane was given in oxygen/air mixture. All patients were monitored in case apnea or hypercarbia occurred, mechanical ventilation would be started.

The primary outcome measure was assessment of analgesic effect in the form of total narcotic needs in the first 24 h. This measure was assessed every 2 h using visual analog score (VAS, 0–10, 0 = no pain, and 10 = most intense possible pain). Assessment was done by an investigator blinded to the group assignment. Whenever VAS more than 4, patient was given 3 mg IV morphine and repeated as needed. The secondary outcome measures involved time to first analgesic request and assessing the patients' ability to perform straight leg raise (SLR) in the PACU and 2 h postoperatively after discharge from the PACU. The ability to perform SLR was graded from 0 to 5 (0, paralysis; 1, muscle twitch; 2, able to extend knee with gravity removed; 3, able to perform SLR against gravity; 4, able to extend the knee against gravity and some resistance and 5, full quadriceps power).

Statistical analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23. The continuous variables were presented as mean, standard deviations and ranges when parametric, and presented as median, inter-quartile range (IQR) when

Table 1 Demographic data

	Group A No. = 33	Group F No. = 33
Age (years) [mean (SD)]	32.18 (8.19)	33.30 (8.67)
Gender (male/female)[%]	69.7%/30.3%	69.7%/30.3%
BMI ($kg.m^{-2}$) [mean (SD)]	25.94 (4.80)	25.45 (4.09)
ASA I/II [%]	(87.9%)/(12.1%)	(90.9%)/(9.1%)
Time of operation in minute [mean (SD)]	138.18 (33.35)	129.39 (36.18)

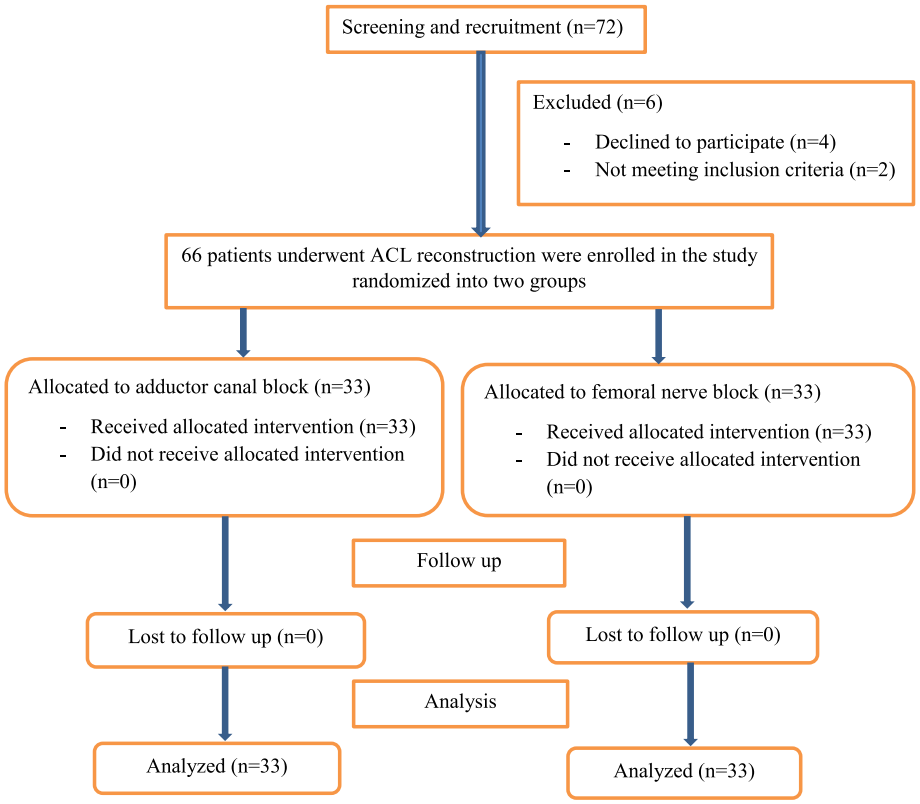

Fig. 1 Consort diagram showing selection and randomization of patients

data found non-parametric. Also, categorical variables were presented as number and percentages. The comparison between groups regarding categorical variables was done by using *chi-square test* when the expected count in any cell was found less than five. The comparison between two independent groups with continuous variables and parametric distribution was done by using *independent t test* while with non-parametric distribution were done by using *Mann-Whitney test.* The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the *p* value was considered significant when p value < 0.05.

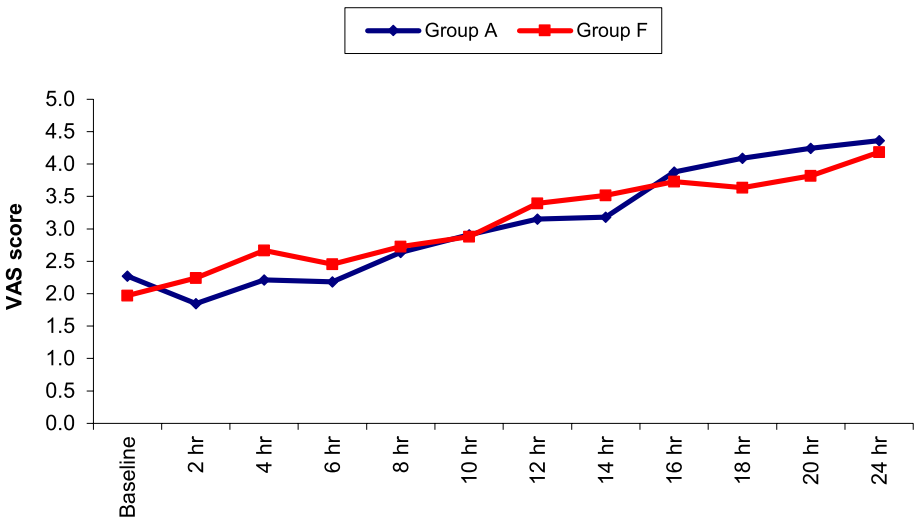

Fig. 2 Comparison between group A and group F according to VAS score

Table 2 Comparison between group A and group F according to time to first analgesic request and total morphine needed in 1st 24 h

	Group A No. = 33	Group F No. = 33	*P* value
Time to first analgesic request (h) [mean (SD)]	14.42 (5.47)	14.06 (5.93)	0.796
Total morphine needed in 1st 24 h (mg) [mean (SD)	5.55 (2.39)	5.45 (2.65)	0.884

Sample size calculation

Sample size was calculated using PASS® version 11 program. Result from previous study (Abdallah et al. 2016) showed that among FNB patients the cumulative oral morphine equivalent consumption for the first 24 h postoperatively was 44.4 ± 20.4 mg. Considering a non-inferiority margin (Δ) of 30% (i.e., 13 mg morphine), and assuming that the true difference in 24-h oral morphine equivalent consumption between the ACB and FNB treatment groups is 0%, a power analysis using a type I error estimate of 5% ($\alpha = 0.05$),a power (1-β) of 80% indicated that a sample of 33 patients per group would be needed with taking in consideration 10% drop out rate.

Results

Sixty-six patients completed the study (Table 1) (Fig. 1). There was no statistical differences between both groups regarding VAS score (Fig. 2), time to first analgesic request, and total morphine needed in first 24 h postoperative (Table 2). The mean SLR was higher in group A relative to group F both in PACU and 2 h postoperatively (Fig 3).

Discussion

The purpose of this study was to compare the FNB and ACB regarding the analgesic efficacy and quadriceps motor strength after arthroscopic ACL reconstruction. Our findings showed that ACB provided similar analgesia to FNB but with a better SLR.

Many studies showed no difference in pain scores, time for rescue analgesia, or total analgesic consumption between the ACB and FNB (Ghodki et al. 2018; Bailey et al. 2019). Faiaz and Kamath (2019) showed that both blocks provided similar analgesia after ACL reconstruction. Ogura et al. (2021) found no differences between FNB and ACB in VAS scores or diclofenac sodium intake.

On the oth1-er hand, Lynch et al. (2019) found that ACB group had less morphine requirement in the first 4 h after surgery. Yet later, there were no differences in opioid requirements or pain levels. Seangleulur et al. 2019 reported significant higher pain score after the ACB only after 24 h at rest.

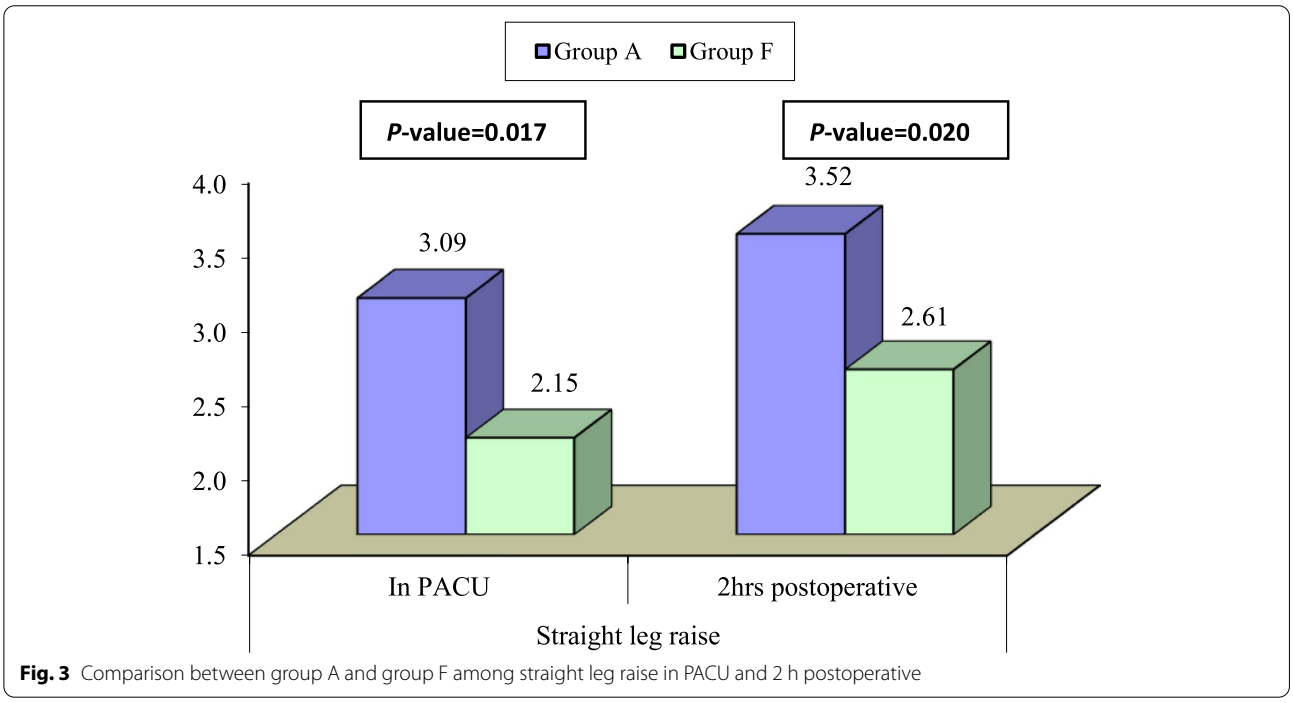

Fig. 3 Comparison between group A and group F among straight leg raise in PACU and 2 h postoperative

Faiaz and Kamath (2019) studied the effect of both blocks on quadriceps function/patient ambulation using the Medical Research Council's muscular strength grading scale (Paternostro-Sluga et al. 2008). Their results showed that ACB was associated with faster recovery of quadriceps motor power compared with FNB (12 versus 24 h). However, Lynch et al. 2019 showed no difference in straight leg lift in the recovery room between both blocks. Also, Seangleulur et al. (2019) found that ACB was associated with higher quadriceps strength only for 8 h postoperatively. They used handheld dynamometer to assess quadriceps maximum voluntary isometric contraction.

Although some of their results are not comparable to this study, Bailey et al. 2019 reported on longer-term follow-up that at 4 weeks, a higher number of patients in the ACB group met the criteria of full ambulation than in the FNB group (100 % vs 84.2 %, *p* value 001). At 6 months, there were no differences between groups; however, the rate of knee extension range of motion loss was greater in the FNB group versus the ACB group at 6 months (Bailey et al. 2019). In Ogura et al. (2021) study, both blocks had similar functional quadriceps recovery criterion. After both block, most patients could contract the vastus medialis and elevate the patella within 4–5 days after surgery. Moreover, all patients achieved safe double-crutch walking on stairs in 4–5 days.

Limitations of our study include lack of long-term follow-up. Another issue is that we did not assess motor strength using a dynamometer, which would have been more accurate.

Conclusions

Compared with femoral nerve block, the adductor canal block may be an effective analgesic alternative with the advantage of sparing the quadriceps muscle strength.

Abbreviations

ACL: Anterior cruciate ligament; ASA: American Society of Anesthesiologist; ACB: Adductor canal block; FNB: Femoral nerve block; PACU: Post-anesthesia care unit; SLR: Straight leg raise; VAS: Visual analog scale.

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Not applicable.

Authors' contributions

KS designed the study, revised the literature, performed the blocks, followed up the patients, and wrote the manuscript. GF designed the study, performed the analysis, and critically revised the manuscript. HS revised the literature, performed the analysis, and critically reviewed the manuscript. DM revised the literature, collected the data, performed the analysis, and critically reviewed the manuscript. MM revised the literature, performed the analysis, and critically reviewed the manuscript. All authors approved the final version of the manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

After approval of the ethical committee in Faculty of Medicine, Ain Shams University number FMASU M D (138/2019), this prospective randomized controlled clinical study was conducted over 66 patients for 1 year from June 2019 to June 2020. Written informed consent was obtained from patients after explaining of the procedure and its potential complications.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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