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Original article

Evaluation of Either Ultrasound Guided Adductor Canal Block or Femoral Nerve Block for Enhansed Recovery in Arthroscopic Anterior Crutiate Ligament Repair

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ABSTRACT

Objectives: Evaluation of ultrasound-guided (USG) adductor canal block (ACB) or femoral nerve block (FNB) for enhanced recovery in arthroscopic anterior cruciate ligament (ACL) repair, and their analgesic efficacy post-operatively.

Background: USG ACB and USG FNB are getting more consideration for enhanced recovery in arthroscopic ACL repair.

Methods: A prospective randomized double-blind work was performed on eighty adult individuals assigned into two equal groups scheduled for elective arthroscopic ACL repair using spinal anesthesia. Group A (n=40): obtained USG ACB with bupivacaine 0.125% in total volume of 20 ml. Group B (n=40): received USG FNB with bupivacaine 0.125 in total volume of 20 ml. The role of those blocks in enhanced recovery after arthroscopic (ACL) repair is assessed by the length of the patient's hospital stay as a primary outcome. The analgesic efficacy of those blocks was assessed by visual analog scale (VAS), time for the postoperative first analgesic requirement, total opioid consumption as post-operative additional analgesia, and post-operative hemodynamics (mean blood pressure and heart rate) as a secondary outcome.**Results:** Hospital stay was substantially decreased in group A contrasted to in group B (*P* value = 0.001). VAS score was decreased in group A contrasted to group B with statistical significance on 4, 8, and 12 hours postoperatively with *P* value = 0.001, 0.026, 0.031 respectively. It was statistically insignificantly between both groups on admission at the post-anesthesia care unit (PACU), 16, 20, and 24 hours postoperatively with *P* values = 0.254, 0.074, 0.114, and 0.725 respectively. Time to first analgesic request was substantially prolonged in group A contrasted to group B (P value <0.001). Total consumption of morphine was substantially decreased in group A contrasted to group B (P value < 0.001).

Conclusion: Our findings revealed that USG ACB provides better post-operative enhanced recovery as shown by a lower hospital stay and superior post-operative analgesic effects via lower VAS score, time for the postoperative first analgesic requirement, total opioid consumption, patients' vital parameters and satisfaction in first 24h post-operative than USG FNB in arthroscopic ACL repair.

Keywords: Adductor canal, Femoral nerve, Ultrasound-guided, Enhanced recovery, Visual analog score.

INTRODUCTION

Enhanced recovery refers to the provision of pain medication after surgery, early mobilization of patients, and reduction in the duration of hospitalization. [1] Arthroscopic ACL repair can cause a considerable range of discomfort in certain individuals after the surgery, which might prolong their hospital stay and hinder their ability to move and receive proper physical rehabilitation. [2] Regional analgesic treatments have gained extensive approval. They play a crucial role in multimodal analgesia. [3] The Adductor canal block (ACB) offers pain relief to most of the front and middle parts of the knee joint. [4] Femoral nerve block (FNB) provides pain relief for the entire knee region but can impact the strength of the quadriceps muscle. [5] Ultrasound improves the efficacy of the blocks and reduces the likelihood of any negative consequences. [6] This study aims to compare the use of an ultrasound-guided adductor canal block (USG ACB) and an ultrasound-guided femoral nerve block (USG FNB) in enhancing postoperative recovery after arthroscopic ACL repair. The assessments were based on the duration of the patient's hospitalization.

PATIENT AND METHOD

Following approval of the work protocol by the Research Committee and Ethical Committee of the Faculty of Medicine, Menoufia University (IRB number: 2/2020ANET10), and after obtaining written informed consent from all participants, this prospective randomized open-label work was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans, and was performed in the surgical operating rooms of Menoufia University hospitals from March 2020 to December 2022.

Sample size: Based on **Tan Zhen et al** [7] study, the sample size calculated was 80 adult patients, admitted for elective arthroscopic ACL repair, divided into two groups at random utilizing a closed envelope method in sequentially numbered opaque envelopes opened by an anaesthesiologist not participated in the work. *P* value ≤ 0.05 is deemed statistically significant.

Group A (n=40): obtained USG ACB with bupivacaine 0.125% in overall volume of 20 ml. **Group B (n=40):** obtained USG FNB with bupivacaine 0.125 in total volume of 20 ml.

Inclusion criteria: Age ≥19 and ≤65 years old, body mass index (BMI) ≤ 35 kg/m2, American Society of Anesthesiologists (ASA) physical status I or II, and elective arthroscopic ACL repair with spinal anesthesia.

Exclusion criteria: Refusal of giving consent, skin infection at the puncture site, pre-exciting neurological or anatomical deficit on the side of the block, coagulation disorders, allergy or intolerance to anesthetic drugs, established chronic hepatic failure (Child B, C), chronic kidney failure stages IV and V, opioid intake for chronic illness.

Primary outcome: the length of the patient's hospital as an indicator for enhanced recovery.

Secondary outcome: The analgesic efficacy of ACB and FNB was assessed by visual analog scale (VAS), time for the postoperative first analgesic requirement, total opioid consumption as post-operative additional analgesia, and post-operative hemodynamics (mean blood pressure and heart rate).

Preoperatively, all patients were provided with explanations regarding spinal anesthetic, peripheral nerve block procedures (ACB and FNB), and the use of VAS. Preoperative comprehensive evaluation and standard anesthesia-related studies were conducted for all patients. During the surgery, all patients were observed for their oxygen saturation, mean arterial blood pressure (MAP), and heart rate (HR). The administration of spinal anesthesia was standardized. **After arthroscopic ACL repair was completed by the surgeon,** The USG ACB or FNB procedures were carried out with meticulous attention to cleanliness, utilizing a short-beveled needle (22 gauge, 80mm) and a linear multifrequency 10-14 MHz probe. A 0.125% solution of bupivacaine was injected in a total volume of 20 ml, with a maximum dose of 0.3 ml/kg, and frequent aspiration was performed.

Group A of USG ACB (40 patients): The participant was positioned in a supine posture with the knee slightly bent and turned outward. The ultrasound probe was positioned horizontally at the midpoint between the inguinal recess and medial condyle of the femur until the femoral artery was visible. The needle was entered parallel to the plane of the skin, moving from the outside side to the inner side, at a sharp angle until it reached the adductor canal. Then, the administration of the local

anesthetic started on the outer or superficial side of the artery. Administer the entire amount of local anesthetic (bupivacaine 0.125%) in a total volume of 20 ml, while regularly aspirating to ensure that there is no injection into the blood vessels.

- **Group B of USG FNB (40 patients):** The patient was positioned in a supine posture to expose the anterior inguinal area where the block would be administered. The ultrasound probe was used to examine the front part of the groin area at the fold of the thigh, where the femoral artery was identified. Following that, the probe was directed to the side to detect the triangular-shaped femoral nerve, which appeared brighter on the ultrasound image. The needle was inserted parallel to the plane, moving from the side to the center, and advanced towards the femoral nerve. After positioning the needle point into close contact with the nerve (either above, below, or to the side), a local anesthetic was administered to displace the femoral nerve from the injection site. An injection of local anesthetic (bupivacaine 0.125% in the overall volume of 20 ml) was administered, with a regular aspiration to verify that there was no intravascular injection.
- **Postoperatively:** Participants were admitted to the PACU for 1 hour before being sent to the ward. The VAS had been assessed at 4h and every 4h in the first 24h postoperatively starting from patient arrival to the PACU and employed to evaluate postoperative discomfort. The scale spans 0 to 10, where 0 represents an absolute lack of pain and 10 represents the utmost intensity of suffering that can be imagined. The patients received an intravenous injection of 3 mg morphine as a rescue analgesia when the VAS score was 4 or higher thus suggesting the need for analgesia. The time of administration was documented and the interval to first rescue analgesia was calculated with the zero-point starting when the patient arrived at the PACU. The total amount of morphine used throughout the initial 24-hour period was also calculated. The mean arterial blood pressure and heart rate were documented at the time of the block as baseline, time of arrival at PACU, and every 30 minutes in the first 24h postoperatively. The duration of hospitalization was documented as a measure for promoting early mobilization and facilitating the patient's recovery.

Statistical Analysis:

The statistical analysis was conducted utilizing SPSS v27 (IBM©, Chicago, IL, USA).

The normality of the data distribution was assessed utilizing the Shapiro-Wilks test and histograms.

The quantitative parametric variables were expressed as the mean and standard deviation (SD) and were analyzed utilizing an ANOVA (F) test with a post hoc test (Tukey).

The quantitative non-parametric variables were reported using the median and interquartile range (IQR).

For comparing each group, the data were analyzed utilizing the Kruskal-Wallis test with the Mann-Whitney test.

The qualitative parameters were shown as frequencies and percentages (%) and were examined utilizing the Chi-square test.

A two-tailed *P* value < 0.05 was considered statistically significant.

RESULTS

Demographic data and duration of surgeries had been insignificantly different between the two groups (table 1)

Hospital stay had been substantially lower in group A than in group B (P value = 0.001). (Table 2)

VAS score had been decreased in group A contrasted to group B with statistical significance on 4, 8, and 12 hours postoperatively with *P* value = 0.001, 0.026, 0.031 respectively and was statistically insignificantly between both groups on admission at PACU, 16, 20, and 24 hours postoperatively with *P* value = 0.254, 0.074, 0.114, 0.725 respectively. (Figure1)

Time to first analgesic request had been substantially prolonged in group A contrasted to group B (P value <0.001). Total morphine consumption had been substantially decreased in group A than in group B (P value < 0.001). (Table 3)

The postoperative heart rate measurements at baseline, PACU, 30 min, 60 min, 90 min, 2h, 2.5h, 3h, 3.5h, 12.5h, 13h, 13.5h, 14h, 14.5h, 15h, 15.5h, 16h, 16.5h, 17h, 17.5h, 18h, 18.5h, 19h, 19.5h, 20h, 20.5h, 21h, 21.5h, 22h, 22.5h, 23h, 23.5h and 24h were insignificantly different among the two groups (P value >0.05). They had been significantly lower at 4h, 4.5h, 5h, 5.5h, 6h, 6.5h, 7h, 7.5h, 8h, 8.5h, 9h,

9.5h, 10h, 10.5h, 11h, 11.5h and 12h in group A contrasted to group B (P value <0.05). (Figure 2)

The postoperative mean arterial blood pressure measurements at baseline, PACU, 30 min, 60 min, 90 min, 2h, 2.5h, 3h, 3.5h, 12.5h, 13h, 13.5h, 14h, 14.5h, 15h, 15.5h, 16h, 16.5h, 17h, 17.5h, 18h, 18.5h, 19h, 19.5h, 20h, 20.5h, 21h, 21.5h, 22h, 22.5h, 23h, 23.5h and 24h were insignificantly different among the two groups (P value >0.05). They were significantly lower at 4h, 4.5h, 5h, 5.5h, 6h, 6.5h, 7h, 7.5h, 8h, 8.5h, 9h, 9.5h, 10h, 10.5h, 11h, 11.5h and 12h in group A contrasted to group B (P value <0.05). (Figure 3)

Considering postoperative complications, Bradycardia was reported in 3 cases in group A and 5 instances in group B (P = 0.456). Hypotension was reported in 5 cases in group A and 6 participants in group B (p = 0.745). Postoperative nausea and vomiting (PONV) had been reported in 6 instances in group A and 9 instances in group B (P = 0.390).

Table1: Demographic data and duration of surgery of the studied groups

		Group A (n=40)	Group B (n=40)	P value
Age (years)	**Mean ± SD**	32.45 ± 8.27	35.48 ± 8.21	0.105
Sex	**Male**	25 (62.5%)	22 (55%)	0.496
	Female	15 (37.5%)	18 (45%)	
ASA physical status	**I**	29 (72.5%)	25 (62.5%)	0.340
	II	11 (27.5%)	15 (37.5%)	
Weight (kg)	**Mean ± SD**	69.68 ± 8.06	70.08 ± 8.13	0.826
Height (m)	**Mean ± SD**	1.69 ± 0.08	1.7 ± 0.07	0.422
BMI (kg/m^2)	**Mean ± SD**	24.65 ± 4.08	24.37 ± 3.81	0.750
Duration of surgery (min)	**Mean ± SD**	73.88 ± 7.64	75.5 ± 7.91	0.353

BMI: Body mass index. Statistical insignificance *P* value > 0.05

Table 2: Hospital stay of the studied groups

		Group A (n=40)	Group B (n=40)	P value
Hospital stay (days)	Mean ± SD	1.45 ± 0.5	1.98 ± 0.86	**0.001***

*: Significantly different as *P* value ≤0.05.

Table 3: Time to first analgesic request and total morphine consumption of the studied groups

		Group A (n=40)	Group B (n=40)	P value
Time to first analgesic request (h)	**Mean ± SD**	10.8 ± 2.21	7.73 ± 1.58	**<0.001***
Total morphine consumption (mg)	**Mean ± SD**	6.3 ± 1.32	7.88 ± 1.76	**<0.001***

*: Significantly different as *P* value ≤0.05.

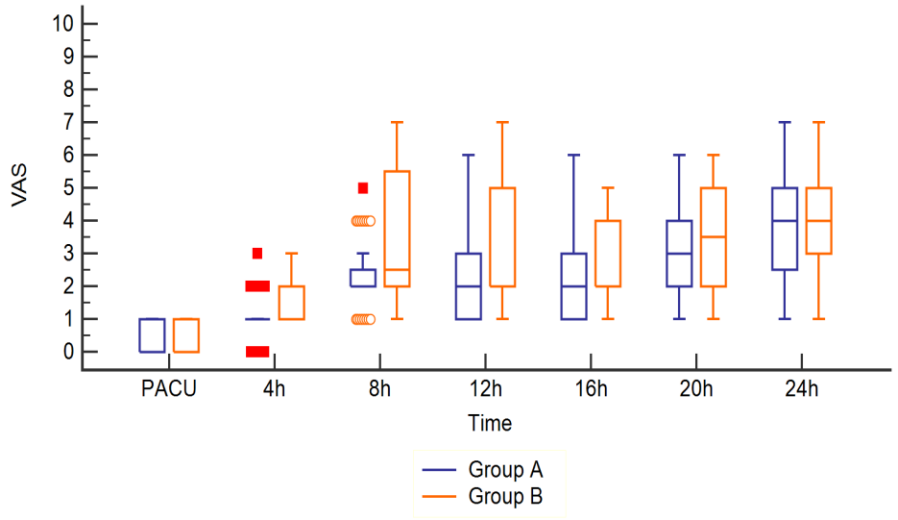

Figure1: VAS score measurements of studied groups

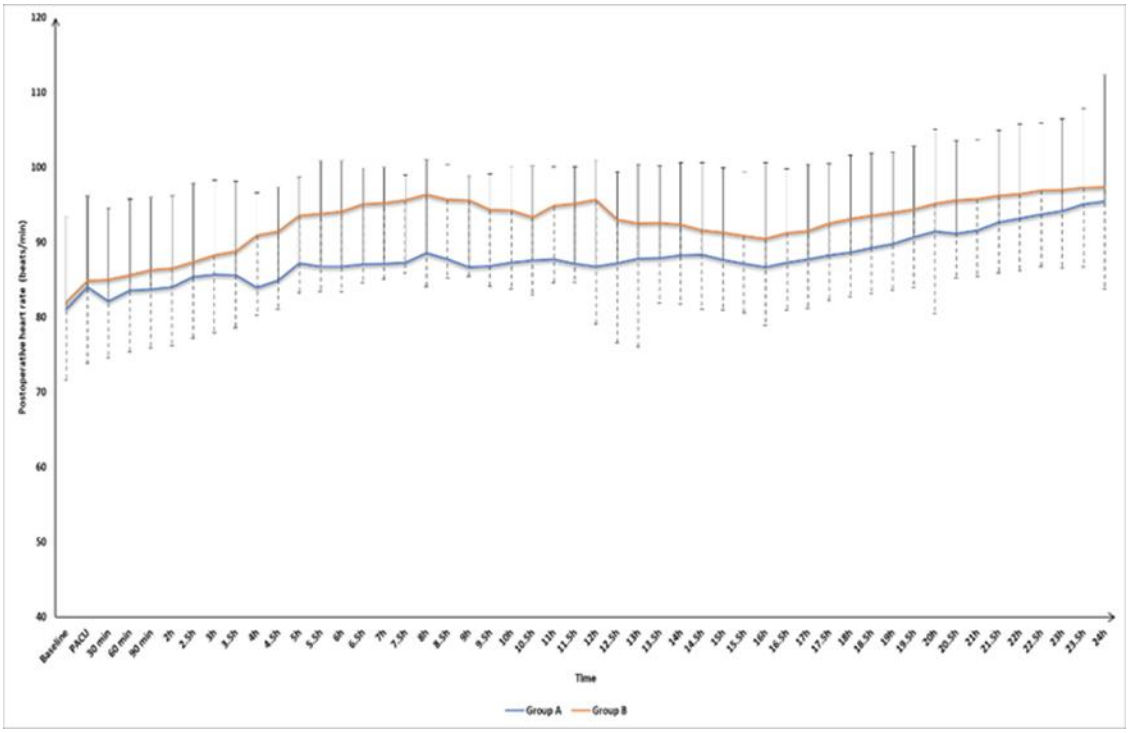

Figure 2: Postoperative heart rate of studied groups

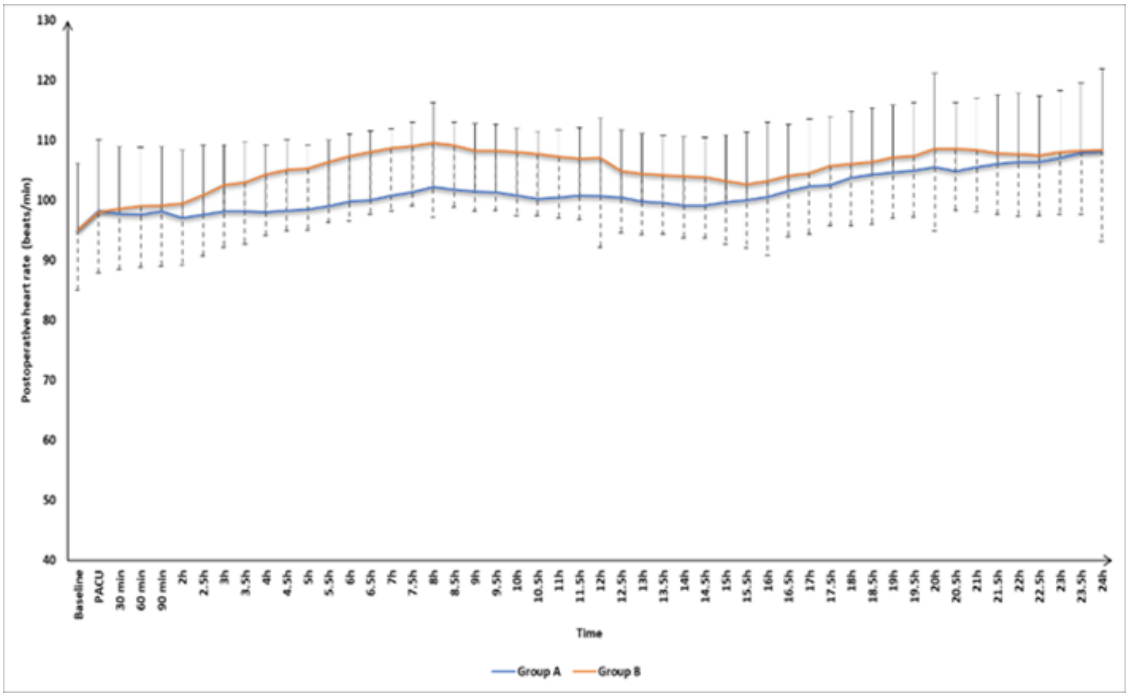

Figure 3: Postoperative mean arterial blood pressure measurements of studied groups

DISCUSSION

Cruciate ligament problems are commonly treated through the regular performance of knee arthroscopic procedures. Although the operation is classified as minimally invasive, it is correlated with a substantial spectrum of pain in certain patients. There has been an increase in the number of individuals receiving ACL reconstruction surgery in the last ten years. [2] USG ACB and USG FNB are efficacious for providing pain relief after surgery. [2]

In our investigation, the patient's demographic characteristics, including sex, age, ASA physical status, weight, height, BMI, and duration of surgeries, were comparable amongst the groups. These similarities were not statistically significant. (Table 1)

The duration of hospitalization was markedly shorter in group A contrasted to group B (P value = 0.001). The findings of our study were corroborated by **Tan et al**. [7] in a previously published study, where they conducted a double-blind, prospective, randomized, and controlled study including 200 participants who received unilateral total-knee arthroplasty. The patients had been divided into the ACB or the FNB groups at random. It was discovered that the ACB group had shorter durations of hospitalization after surgery in comparison to the FNB group.

On the other hand, **Laksono and his team** [8] carried out a prospective trial with 30 patients, aged between 15 and 60 years, with a BMI of 18.5 to 24.9 kg/m2, and categorized as ASA I and II. These patients had ACL restoration while under a subarachnoid block. The participants were allocated into two groups through random assignment. Group IV got analgesia through intravenous administration (n = 15), while Group ACB obtained blockage of the adductor canal (n = 15). The researchers discovered that no substantial variation existed in the duration of hospitalization among Group IV and Group ACB. The discrepancy can be ascribed to the limited size of the sample.

The VAS score measures at PACU, 16h, 20h, and 24h didn't reveal any substantial variation among both groups. However, at 4h, 8h, and 12h, the ACB group had considerably decreased scores compared to the FNB group. (Figure1). **Siddiqui et al.** [9] discovered that no statistically substantial variation existed in pain scores at 1, 2, 6, and 24 H between the ACB group and the FNB group.

The results align with the outcomes of **Bangal et al.** [10], a randomized investigation was undertaken on

a sample of 60 patients. These patients, ranging in age from 15 to 50 years, were of both sexes and had ASA physical status I and II. The study focused on individuals undergoing elective arthroscopic ACL reconstruction procedures, which were performed under spinal anesthesia. A total of 60 participants had been split at random into two groups, including 30 participants in each group. Patients in Group A had been administered ACB with a 20 ml solution of 0.2% Ropivacaine after the surgery. Following the surgical closure of the arthroscopic port sites, Group B was administered a 20 ml intra-articular injection of 0.2% ropivacaine in the knee joint. According to their statement, the pain scores in the group that obtained intra-articular infiltration increased and were considerably higher after 12 hours. However, by the conclusion of the 24th hour, the pain scores became similar to the group that received ACB.

The work performed by **Sehmbi et al.** [11] supports our findings, as they discovered that the use of ACB in minor knee arthroscopic surgeries resulted in lower postoperative resting pain levels at 0, 6, and 8 H compared to the control group. In addition, the pain scores experienced by the participants decreased at 0, 6, and 8 H, correspondingly, as contrasted to the control group.

Contrary to the findings of **Dixit et al.** [12], who revealed that the VAS score was not significant at baseline, 2, 4, 6, 8, 12, 18, and 24 hours in the ACB Group contrasted to the FNB Group.

This finding contradicts the results of **Abdallah et al.** [13], who saw a substantial decrease in pain scores in the FNB group and ACB group contrasted to the control group at 30 minutes, 1, 2, 3, 4, 5, 6, 8, 10, and 12 hours after the operation. The variation in anesthetic volume and concentration may account for this disparity.

In contrast to the findings of **EL Ahl et al.** [14], it was demonstrated that participants in the ACB group had notably elevated VAS scores at 18 hours and 24 hours.

The time at which the initial request for pain relief occurred was substantially longer in the ACB group contrasted to the FNB group in our work. The group ACB exhibited a notable reduction in overall opioid use compared to the group FNB. The information is shown in Table 3.

Consistent with our findings, **Sinha et al.** [15] conducted a randomized, double-blind, controlled clinical study including 60 individuals aged 15 to 60 years, who had ASA physical status I/II and had been planned for ACL repair using general anesthesia (GA). In Group I (ACB), a 20cc bolus of 0.5% levobupivacaine had been given to enlarge the adductor canal. In Group II (FNB), the same bolus dose was used to expand the femoral nerve. The study demonstrated that the duration it took for participants to make their first demand for postoperative pain medication was considerably longer in the ACB group compared to the FNB group. In addition, the total amount of pain medication consumed within 24 hours was notably lower in the ACB group compared to the FNB group.

In addition, **Sehmbi et al.** [11] performed comprehensive evaluations and statistical analyses, which involved 10 randomized controlled studies and a total of 714 participants, comparing the effectiveness of ACB with placebo or FNB. The researchers determined that ACB reduces the total amount of opioids consumed within 24 hours when contrasted to the control group.

Dixit et al. [12] conducted a randomized, controlled, and double-blind trial on 90 adult patients with ASA grades I and II who were scheduled for arthroscopic ACL rupture repair procedures utilizing a subarachnoid block. However, we disagree with their conclusions. The subjects were split into three equal groups, with each group consisting of 30 individuals. Group 1, referred to as ACB, was administered a combination of 15 ml of ropivacaine 0.25% and dexmedetomidine 0.5 µg/kg. Group 2 (FNB) had been given a combination of 15 ml of ropivacaine 0.25% and dexmedetomidine at a dosage of 0.5 µg/kg. Group 3 (Control) was administered solely the conventional analgesic regimen. The group ACB had a considerably reduced overall opioid intake compared to the group FNB. The variation can be ascribed to disparities in sample sizes as well as variations in the types, concentrations, and volumes of anesthetic drugs used.

Siddiqui et al. [9] did a prospective randomized controlled trial on 50 persons, both male and female, aged 35-75 years, who were undergoing unilateral total knee replacement (TKR) surgery and had ASA grades I-III. However, their findings contradict ours. The subjects had been divided into

two groups of identical size at random (n=25). The ACB group obtained continuous ACB with infiltration between the popliteal artery and capsule of the knee (iPACK) block, while the FNB group obtained continuous FNB with iPACK block. The study revealed that no statistically substantial variation existed in the time required to administer analgesia among both groups. The variation can be ascribed to varying sample sizes and distinct processes.

In contrast to our findings, **Faiaz et al.** [16] performed a prospective, randomized controlled study on 76 individuals aged 18 to 60 years, with a BMI below 35 kg/m2, and ASA physical status class 1 and 2. These participants were planned for elective ACL procedures. The participants were categorized into two cohorts, with group A receiving a 5 mL dose of 0.125% bupivacaine and 25 mcg fentanyl by ACB, whereas group B received the same substances via FNB. They demonstrated that no substantial variation existed in the time it took for participants to request their first analgesic medication between the ACB and FNB methods.

The findings of **Abdallah et al.** [13] contradicted our results. They conducted a prospective randomized trial with 105 adult participants of both genders, which had ASA physical status I/II and were planned for knee arthroscopy utilizing general anesthesia. GA was administered with a dose of 1µg/kg of fentanyl and 2.0mg/kg of propofol. The patients were placed into three groups of similar size (N=35). Group I (control group) obtained intravenous intraoperative analgesia with paracetamol 1gm, which was repeated every 6 hours orally after the surgery, and diclofenac 75mg infusion intraoperatively, which was given orally at a dose of 25mg every 6 hours after the surgery. Group II, also known as group FNB, got FNB following the administration of GA. Group III (ACB group): got ACB following the administration of general anesthesia. The study demonstrated that no substantial variation existed in the time to first analgesic request and total opioid use between both groups. The variation in anesthetic volume and concentration, as well as the utilization of a smaller sample size, could potentially account for this discrepancy.

In contrast, **EL Ahl et al.** [14] performed a randomized double-blind trial on 128 individuals aged 18-45 years, with a BMI greater than 35 and classified as ASA class III or IV, who had been planned for patellar graft ACLR. The participants had been assigned at random to two groups, with 64 participants in each group. They either received FNB or ACB, using 5 ml of ropivacaine at a concentration of 0.05%, after the conclusion of the surgery. The researchers discovered that the overall opioid consumption was much greater in the ACB group compared to the FNB group.The current study examined the postoperative hemodynamics and observed that the HR and MAP measurements had not significantly varied among both groups at baseline, PACU, 16h, 20h, and 24h. However, at 4h, 8h, and 12h, group A had significantly lower measurements contrasted to group B (P value <0.05). The disparity in heart rate can be ascribed to multiple variables, including distinct physiological reactions to these anesthesia methods, varying levels of pain, or the degree of stress encountered by patients in the postoperative phase. A decreased heart rate in the ACB group may suggest diminished tension and pain, potentially facilitating a more seamless healing process for these patients.

The satisfaction score and occurrence of postoperative complications (bradycardia, hypotension, and postoperative nausea and vomiting) were similar among our groups.

CONCLUSION

Adductor canal block provides better post-operative enhanced recovery as shown by lower hospital stay and superior post-operative analgesic effects via lower VAS score, total opioid consumption, patients' vital parameters, and satisfaction in the first 24h post-operative.

Limitations: Lack of control group, the sample size to generalize our result, VAS is not an objective method and short follow-up for pain assessment.

Recommendations: Further studies on a larger sample size, further studies in other centers to compare findings, and additional studies are required to investigate the effect of the blocks in preventing chronic pain.

No conflicts of interest to disclose.

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Citation

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