Femoral nerve block versus adductor canal block for postoperative pain control after anterior cruciate ligament reconstruction: A randomized controlled double blind study

Mohamed Sayed El Ahl,

Lecturer of Anesthesia, Ain Shams University, Cairo, Egypt

Address for correspondence:
Dr. Mohamed Sayed El Ahl, Department of Anesthesia, Ain Shams University, Cairo, Egypt.
E-mail: mibraheem_ellaahl@med.asu.edu.eg

ABSTRACT

Background: The objective of this study was to evaluate the reliability of the postoperative pain control using adductor canal block (ACB) compared that using the femoral nerve block (FNB) in patients with anterior cruciate ligament reconstructions (ACLR). **Materials and methods:** One hundred and twenty-eight patients who had been scheduled to patellar graft ACLR were included in this double blind study, and were randomly allocated into two groups; group ACB and group FNB (64 patients each). All patients received general anesthesia. At the end of the surgery, patients in group FNB received a FNB and those in group ACB received an ACB. The postoperative pain (visual analog scale [VAS]) and muscle weakness were assessed in the postoperative care unit and every 6 h thereafter for 24 h. The total morphine requirements were also recorded. **Results:** Patients in group ACB had significantly higher VAS (at 18 h and 24 h), higher morphine consumption, but significantly less quadriceps weakness than those in group FNB. **Conclusion:** In patients with patellar graft ACLR, the ACB can maintain a higher quadriceps power, but with lesser analgesia compared with the FNB.

Key words: *Anesthetic techniques, anesthetics local, equipment, femoral, regional, ropivacaine, ultrasound machines*

INTRODUCTION

The anterior cruciate ligament injury is a common athletic injury and one of the most commonly treated conditions of the knee.[1] Approximately, 60,000-175,000 anterior cruciate ligament reconstructions (ACLR) procedures are performed annually in the United States (US).[2,3] The ACLR is widely accepted as the treatment of choice for individuals with functional instability due to anterior cruciate deficiency.[4] Femoral nerve blocks (FNB) have been shown to significantly improve postoperative analgesia compared with systemic opioid therapy, and it may even reduce hospital length of stay after knee procedures.[5-7] Therefore, FNB was commonly added to general or centroxial anesthesia to achieve adequate pain control after ACLR.[8] Recently, the adductor canal block (ACB) has been described and used frequently as postoperative analgesia after total knee arthroplasty,[9-12] where it was shown to provide a reliable postoperative pain control with less quadriceps weakness compared with that of using the FNB. However, the analgesic effectiveness of the ACB after ACLR surgeries has not yet been adequately studied. The objective of this study was to evaluate the reliability of the postoperative pain control using ACB compared that using the FNB in patients with patellar graft ACLR.

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MATERIALS AND METHODS

This prospective controlled randomized double-blind study was approved by the Research and Ethical Committee of Burjeel Hospital, Abu Dhabi, UAE, and was conducted between January and July 2014. One hundred and twenty eight patients (American Society of Anesthesiologist [ASA] I or II, aged 18-45years) who were scheduled for patellar graft ACLR were included in this study and their written informed consents were obtained. Patients with ASA class III or IV, body mass index >35, patients with additional complex knee procedure or known allergies to ropivacaine were excluded. The patients were randomly allocated into two groups (64 patients each); group ACB and group FNB. At the end of the surgery, the patients received FNB (in group FNB) or ACB (in group ACB).

In the operating room, standard monitors were applied, and an intravenous line was inserted. After preoxgenation, general anesthesia was induced using 2 mg/kg of propofol, 1 mcg/kg of fentanyl. After loss of consciousness, 0.6 mg/kg of rocuronium was injected. The laryngeal mask airway (LMA) was then placed and inflated. The patients were mechanically ventilated (to adjust the $EtCO_2$ level between 35 and 40 mmHg). The anesthesia was maintained using 2% sevoflurane diluted in 3 L of 50% oxygen mixed with air. Increments of fentanyl (0.5 mcg/kg) and rocuronium (10 mg) were used whenever required.

At the end of the surgery, under aseptic conditions, all patients received FNB (in group FNB) or ACB (in group ACB) using an S-nerve machine (SonoSite Inc., Bothell, WA, USA), a linear US probe (HFL 38, 13-6 MHz, SonoSite Inc., Bothell, WA, USA), a 5-cm needle (21G, Locoplex from Vygon, France) and 15 ml of ropivacaine 05% (Naropin®, AstraZeneca, AB, Sweden). For the ACB, the US probe was placed at the mid-thigh level. The superficial femoral vessels were identified; deep to the sartorius muscle. The needle was advanced (using the in-plane technique from lateral to medial) toward the adductor canal where the local anesthetic was injected. For FNB, the US probe was placed on the inguinal crease, with a slight cephalic tilt, to identify the femoral artery and nerve. The needle was advanced (via the in-plane approach from lateral to medial) towards the femoral nerve where the local anesthetic was slowly injected. Adequate local anesthetic spread was confirmed in both techniques. For the emergence from general anesthesia, sevoflurane was discontinued, and rocuronium was reversed using 2.5 mg of neostigmine and 2 mg of atropine after return of adequate muscle power. The LMA was removed fully awake.

Postoperatively, all patients received 1 g Perfalgan every 6 h and 30 mg ketorolac every 12 h. The postoperative pain, muscle weakness, and the total morphine requirement were evaluated and recorded by nurses who were unaware of the used block technique. The postoperative pain was assessed using the visual analog scale (VAS; 0 no pain while 10 is the maximum pain). If the VAS was 4 or more, a morphine increment (2 mg) was added. To assess the quadriceps muscle power, the patients (in the supine position) were asked to perform a straight leg raise. The motor block was graded as follows: Grade 0, normal muscle power; grade I, motor weakness; grade II, complete motor paralysis.[13] The assessment started in the postoperative care unit (0 h) and every 6 h thereafter for 24 h. Neurological assessment was performed in all the patients before hospital discharge, and also during the physiotherapy visits for 3 weeks after surgery.

Statistical analysis

Based on the previous study,[14] 128 patients were required to detect a 5% difference between the two groups with a power of 80% and an α error of 0.05. The sample size was calculated using G* power 3.1.9.2 (Department of Psychology, Heinrich-Heine-University, Dusseldorf, Germany). The patients' allocation was performed by block randomization using the package "blockrand" in R (R foundation for statistical computing, Vienna, Austria). Opaque sealed envelopes were used for concealment of randomized allocation. Six patients were excluded and replaced in this study (two had failed block and four required a complex procedure rather than ACLR). All other data were analyzed using Graph Pad InStat, version 3.00 for Windows (Graph Pad Inc., CA, USA). The unpaired *t*-test, Fisher's exact and Chi-square for trend test were used to analyze the continuous, categorical and ordinal data respectively. Significance was determined by a $P < 0.05$.

RESULTS

Patients in both groups had comparable characteristics [Table 1]. Patients in group ACB had significantly higher VAS at 18 h and 24 h [Figure 1], but significantly less quadriceps weakness than those in group FNB [Figure 2]. The total morphine consumption was statistically higher in ACB group than FNB group (18 mg [6] vs. 12 mg [4], P-0.0001*). No complications were recorded in both groups.

DISCUSSION

The clinical objective for this study was to render patients pain-free, with otherwise minimal effect on muscle power. The main finding of this study was the ACB resulted in a

Table 1: Patient's characteristics

Variables	Group FNB (*n* = 64)	Group ACB (*n* = 64)	*P*
Age (year) mean (SD)	28 (12)	27 (13)	0.651
Gender (male/female)	58/6	53/11	0.297
ASA (I/II)	52/12	55/9	0.633
BMI (kg/m²) mean (SD)	27.5 (3.9)	26.7 (3.6)	0.230
Duration of surgery (min) mean (SD)	118 (36)	105 (48)	0.085

ASA: American Society of Anesthesiologist; BMI: body mass index; SD: Standard deviation; FNB: Femoral nerve block; ACB: Adductor canal block

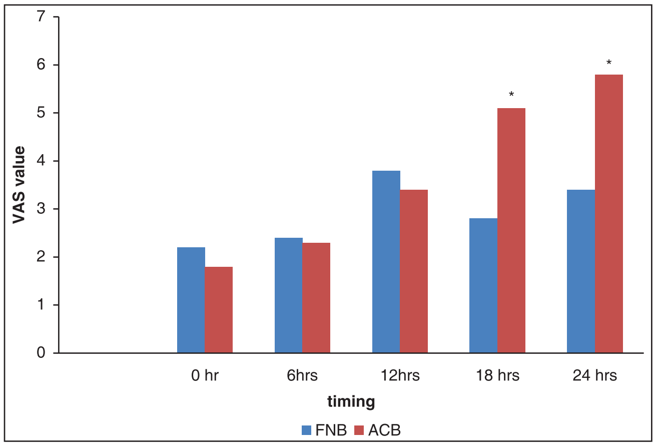

Figure 1: Visual analogue scale values. *statistically significant

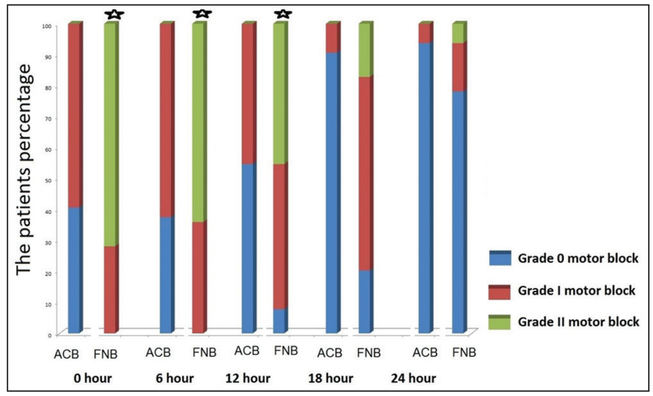

Figure 2: Quadriceps motor block. ACB: Adductor canal block, FNB: Femoral nerve block, *statistically significant

less quadriceps muscle weakness, but also in a less analgesia compared with that of the FNB.

The ACL is the most common torn knee ligament and its reconstruction is the second most common knee surgery.[15] Early ambulation after ACLR surgery is one of the most important targets of modern anesthesia. It minimizes the bed ridden related risks, improves the patient recovery and allows early hospital discharge.[16] Two main parameters can hasten or delay the early ambulation; the muscle power and the severity of pain during movements. Unfortunately, improving one of these parameters usually impairs the other. For many decades, the femoral nerve has been used to achieve analgesia after lower limb surgery.[5-7] Recently, a selective block of the femoral nerve branches within the adductor canal has been described.[9-12] The adductor canal is an inter-muscular space lying in the mid-thigh, between the adductor longus, sartorius, and the vastus medialis muscles. It contains superficial femoral vessels and only two branches of the femoral nerve; the saphenous nerve (a pure cutaneous nerve) and the nerve to vastus medialis.[9-12]

Many studies have shown that the ACB can provide adequate analgesia after knee arthroplasty comparable to that with the FNB.[9-12] Unlike the knee arthroplasty, during the ACLR, an allograft (hamstring or patellar tendon) is usually harvested. The patellar tendon (used in this study) is purely supplied by the motor fibers of the femoral nerve. This may explain the better analgesia achieved with FNB group in the current result compared with that in ACB group. In contrast, a recent study showed that both blocks had comparable postoperative analgesia after ACLR.[17]

In the current study, ACB has shown to reduce the quadriceps muscle strength in some patients, but to a limited extent compared to the FNB patients. This may be due to blocking the nerve to vastus medialis muscle that lies within the adductor canal. Jaeger *et al.*,[18] reported that the ACB can reduce quadriceps muscle strength (8%) compared with placebo, but such reduction was not considered functionally important. In comparison, the FNB reduced quadriceps strength by 49%.[18] It was also reported that both the ACB and the FNB may reduce adductor strength as the ACB may block the posterior branch of the obturator nerve while the FNB blocks the innervations of the pectineus muscle and may spread to the obturator nerve.[18,19]

All the studied patients underwent ACLR using patellar tendon graft and most of them were males. Therefore, the above result may not be applicable for other knee procedures or for the female gender.

CONCLUSION

In patients with patellar graft ACLR, the ACB can maintain a higher quadriceps power, but with lesser analgesia compared with the FNB.

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