

Femoral Nerve Block versus Intra-Articular Infiltration: A Preliminary Study of Analgesic Effects and Quadriceps Strength in Patients Undergoing Arthroscopic Anterior Cruciate Ligament Reconstruction

Arissara Iamaroon MD*,
Suwittha Tamrongchote MD*, Busara Sirivanasandha MD*,
Pathom Halilamien MD*, Pisit Lertwanich MD**,
Sudkanoung Surachetpong BSc*, Paweenus Rungwattanakit BSc*

* Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

** Department of Orthopedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

Background: Adequate analgesia and early rehabilitation is necessary for arthroscopic anterior cruciate ligament reconstruction (ACLR) surgery.

Objective: To compare analgesia and quadriceps strength after femoral nerve block (FNB) with intra-articular infiltration (IA) using 0.25% bupivacaine for ACLR with patella tendon graft.

Material and Method: Forty patients were randomized to receive FNB under ultrasound guidance with 20 mL of bupivacaine or IA with 15 mL of bupivacaine into the knee joint and 5 mL infiltrated along the incision sites including portal sites at the end of surgery. All patients received intravenous ketorolac at wound closure. Data regarding demographic, time to first pain, time to first morphine requirement, morphine usage, pain scores and quadriceps strength were recorded.

Results: Significant difference in quadriceps strength was shown. Ninety percent of patients in Group IA and fifty-five percent of patients in Group FNB had good ability to extend knee at 24 hours after surgery ($p = 0.013$). No differences were found in demographic data, time to first pain, time to first morphine requirement, post operative pain scores and morphine consumption.

Conclusion: The preliminary results demonstrated that IA has an effect on quadriceps strength less than FNB while provide comparable postoperative analgesia after patellar tendon graft ACLR.

Keywords: Femoral nerve block, Intra-articular infiltration, Arthroscopic anterior cruciate ligament reconstruction (ACLR)

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ACLR often results in significant pain. The intra-articular structures of the knee including the anterior synovial tissues, fat pad, and joint capsule are sensitive to painful stimuli and can produce severe pain⁽¹⁾. Adequate pain relief facilitates early rehabilitation and reduces hospital stay including costs. FNB provided excellent analgesia but accompanied with quadriceps weakness leading to delayed mobilization and increased fall risk⁽²⁻⁶⁾. Furthermore, recent studies^(7,8) showed that FNB is associated with isokinetic deficits in knee extension and flexion strength

at 6 months after ACLR. Intra-articular local anesthetics have also been shown to be effective for analgesia after knee surgery^(9,10). Several studies compared FNB and IA for post operative pain control after knee arthroscopic surgery, but the results are contradictory⁽¹¹⁻¹⁴⁾. Therefore, this prospective, randomized controlled study was designed to compare the analgesic effect and the preservation of quadriceps strength after ACLR in patients who received either FNB or IA after completion of the surgery.

Material and Method

After Institutional Review Board approval and written informed consent, a single-blinded, randomized, controlled trial was conducted in patients scheduled for elective ACLR with bone-patellar tendon-bone autograft. Forty American Society of Anesthesiologists (ASA) physical status I-II patients, aged 18 years or

Correspondence to:

Iamaroon A, Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Wanglang Road, Bangkoknoi, Bangkok 10700, Thailand.
Phone: +66-2-4197991, Fax: +66-2-4113256
E-mail: arisa21@gmail.com

older, weight 50 kilograms or more, were prospectively enrolled into the study. Exclusion criteria included patients with previous knee surgery, preexisting neurologic deficit, allergy to study medications and contraindication to regional anesthesia. The trial was registered at Thai Clinical Trials Registry (TCTR20150408001).

On preoperative visit, each patient was instructed to use a numeric rating scale (NRS) scores, in which 0 = “no pain” and 10 = the “worst pain you can imagine” and record the first time they feel pain and need the analgesic drug after surgery.

All patients received oral acetaminophen 1,000 mg as premedication 1-2 hour before surgery. Non-invasive monitors, including electrocardiography, non-invasive blood pressure and pulse oximeter, were used. After sedation with intravenous (IV) midazolam 2 mg and fentanyl 50 micrograms, oxygen via facemask was applied and spinal anesthesia was performed with 15 mg of 0.5% hyperbaric bupivacaine. IV ketorolac was given at wound closure.

Patients were randomized into two groups by block randomization generated by a random number table. Allocation concealment with opaque sealed envelopes was used. At the end of surgery, patients in Group FNB received FNB under ultrasound guidance with 20 mL of 0.25% bupivacaine. The senior residents performed FNBs under supervision of the same three anesthesiologists. Patients in Group IA received IA with 15 mL of 0.25% bupivacaine into the knee joint and 5 mL infiltrated along the incision sites including portal sites. The injection was applied 10 min before tourniquet release and no drainage tube was used. The same two orthopedists performed all surgical procedures and IA. For pain control after surgery, oral acetaminophen 500 mg every six hours and celecoxib 400 mg once a day were given. IV morphine 3 mg was given every three hours as needed for a NRS pain score 3 or above.

The assessors blinded to group assignment collected the data. Time from end of surgery to first pain and first requirement of morphine were recorded by the patients and confirmed by the assessors. The NRS pain scores were noted every six hours and cumulative doses of morphine were recorded at 12, 24 and 36 hours after surgery. The strength of quadriceps muscle was evaluated as ability or inability to extend the operated leg against gravity with the hip passively flexed at 45 degrees compared with the contra-lateral leg^(6,15) at 24 and 36 hours after surgery. The adverse events, including paresthesia, residual numbness or

motor weakness, were reported.

Data were analyzed using PASW Statistics for windows version 18. Categorical data was presented as number (%), continuous data as mean (SD), median and range. Differences in demographic, anesthetic and post operative data were tested by independent t-test or Mann-Whitney U test for continuous data and Chi-square test or Fisher’s exact test for categorical data. Cumulative morphine consumption was analyzed by Mann-Whitney U test. Friedman test was used for difference in NRS. Time to first pain and time to first morphine requirement were analyzed using log-rank test and Kaplan-Meier curve. Statistical significance was accepted at *p*-value of less than 0.05. Preliminary data with a small sample size were early reported. To complete the study, a sample size of 50 in each group would provide 80% power to detect a difference in duration of analgesia means of four hours assuming that the common standard deviation is 7 with a 0.05 two-sided significance level^(6,16).

Results

Forty patients were enrolled in the study, with 20 patients in each group. No patient was excluded from the study. As shown in Table 1, there were no significant differences between the groups according to sex, age, body mass index, ASA physical status classification, operation time, tourniquet time and meniscus repair. Time to first pain and time to first morphine requirement did not differ significantly between the two groups. Median (95% CI) time to first pain was 5.9 hours (5.2-6.6) in Group IA and 6.7 hours (5.6-7.8) in Group FNB (*p*=0.20). Median (95% CI) time to first morphine requirement was 9.9 hours (6.5-13.3) in Group IA and 9.6 hours (0-34.4) in Group FNB (*p*=0.68) as shown in Fig. 1. The numbers of patients requiring morphine were similar. The cumulative morphine consumption at 12, 24 and 36 hours after surgery were not significantly different between the groups (Table 1). Regarding NR Scores (Fig. 2), no significant differences between the groups were found at any time point (*p*>0.05). Fig. 3 showed effects of FNB and IA on quadriceps muscle strength. FNB significantly reduced quadriceps strength more than IA when assessed at 24 hours after surgery (*p*=0.013). Ninety percent of patients in Group IA had good ability to extend knee compared with only fifty-five percent of those in Group FNB. When assessed at 36 hours after surgery, all patients in both groups had good ability to extend knee. Patient’s satisfaction was similar in both groups (*p*>0.05).

Table 1. Patient characteristics and perioperative data

Variables	FNB (n = 20)	IA (n = 20)	p-value
Sex: male	18 (90%)	20 (100%)	0.49
Age (year)	27.3±5.9	28.2±6.6	0.64
BMI (kilogram per square meter)	24.3±4.3	24.6±3.6	0.82
ASA physical status I	19 (95%)	19 (95%)	1.00
Meniscus: repair	4 (20%)	3 (15%)	1.00
Operation time (minute)	114.2±27.5	114.5±18.0	0.97
Tourniquet time (minute)	111.9±18.0	109.8±19.7	0.73
Patients requiring MO	12 (60%)	14 (70%)	0.51 [#]
Cumulative MO requirement (milligram)			
12 hours	3 (0, 3)	3 (0, 3)	0.74 ^{##}
24 hours	3 (0, 6)	3 (0, 6)	0.25 ^{##}
36 hours	3 (0, 6)	3 (0, 9)	0.24 ^{##}

FNB = femoral nerve block; IA = intraarticular infiltration; BMI = body mass index; ASA = American Society of Anesthesiologists; MO = morphine

[#] Adjusted p-value with Chi-square test, ^{##} Mann-Whitney U test and adjusted p-value with exact sig

Data are presented as numbers (%), means ± SD or median (min, max)

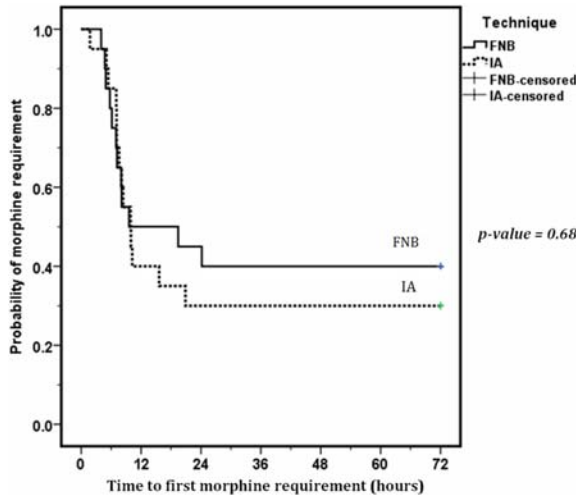
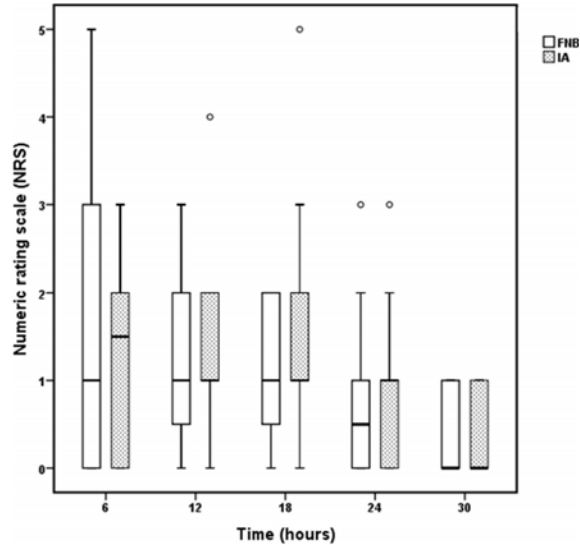


Fig. 1 Kaplan-Meier curve showed no significant difference in the time to first morphine requirement. Median time to first morphine requirement was 9.6 hours in Group FNB and 9.9 hours in Group IA ($p = 0.68$).

Discussion

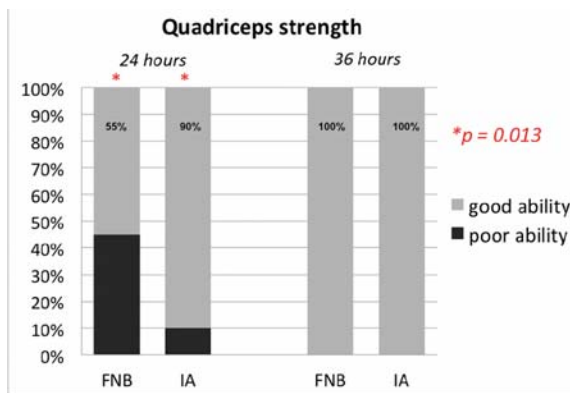
In the present study, intra-articular 0.25% bupivacaine provided comparable postoperative analgesia and had less effect on quadriceps strength when compared to FNB with 0.25% bupivacaine. The study showed that both FNB and IA provided effective pain relief at least 6 hour after ACLR. Patients reported



* Extreme value, ° Outlier

Fig. 2 Numeric rating scale scores at different times after surgery. No significant differences were found between the groups ($p > 0.05$). Data are shown as median (horizontal bar) with 25th-75th (box) and 10th-90th (whiskers) percentiles.

pain scores not more than 3 and morphine dosages for rescue pain were not more than 6 mg for the first 24 hours after surgery. Furthermore, eight patients in Group FNB and 6 patients in Group IA did not need



FNB = femoral nerve block; IA = intraarticular infiltration

Fig. 3 Effects of FNB and IA on quadriceps muscle strength. Muscle strength was assessed as ability to extend knee. FNB significantly reduced quadriceps strength more than IA when assessed at 24 hours after surgery ($p = 0.013$).

any morphine supplementation. Similarly, Mehdi et al⁽¹³⁾ found that FNB had no advantage over IA after ACLR. They concluded that IA combined with oral analgesia could provide adequate pain control. Matava et al⁽¹⁴⁾ compared pre-emptive FNB or placebo in addition to IA and IV ketorolac at wound closure in patients undergoing ACLR. They found that a preemptive FNB did not provide significant clinical improvement over IA and IV ketorolac. In contrast, Iskandar et al⁽¹¹⁾ found that FNB provided superior analgesia as compared with IA after ACLR. Dauri et al⁽¹²⁾ found that continuous FNB after ACLR provided better analgesia compared with continuous IA and patellar tendon wound infusions. However, the present study results, according to analgesic effects, are not strong enough due to small sample size. Further study should be continued.

In addition to adequate pain control after surgery, successful rehabilitation, improved knee function and return to sports are the important issues. FNB provides effective pain relief but is associated with quadriceps weakness and fall risk⁽²⁻⁸⁾. The present study showed that IA had less effect on quadriceps strength than FNB. However, some degree of quadriceps weakness was also observed in Group IA. The possible etiologies may be muscle strength reduction before operation, patient positioning during operation, long tourniquet times and inadequate postoperative pain control^(17,18). Therefore, a comparable pain relief between FNB and IA suggests

that IA has benefit in concern of quadriceps weakness. In addition, it is easy to perform by surgeon.

Regarding local anesthetic chondrotoxicity, two studies showed chondrotoxic effects of bupivacaine on human articular cartilage in vitro^(19,20). The contributory factors for chondrotoxicity included anesthetics containing epinephrine⁽²⁰⁾ and prolonged exposure to high local anesthetic concentrations⁽²¹⁾. Breu et al⁽²²⁾ concluded that local anesthetics are chondrotoxic in a time-dependent, concentration-dependent, and drug-dependent manner. However, in the present study, single-dose intra-articular 0.25% bupivacaine without epinephrine was used. No chondrotoxicity was found. Further studies to determine the risk were needed.

Regarding local anesthetic systemic toxicity, it can occur after using an excessive dose or accidental IV injection. Convery et al⁽²³⁾ recommended a 100 mg intra-articular bupivacaine should be a safe dose because its plasma concentration is lower than the threshold of systemic toxicity. In the present study, a 50 mg bupivacaine was used on completion of surgery. No patient in the study showed any sign or symptom of local or systemic toxicity.

The present study has some limitations. First, a small sample size was unable to show statistical differences in time to first analgesic requirement, pain scores and morphine usage. Further study should conduct an adequate sample size. Second, various residents performed FNB under supervision of three anesthesiologists. Therefore, the findings are likely not anesthesiologist-specific. Third, the plasma concentration of bupivacaine is not measured. However, the dose of bupivacaine in the study was low and within the therapeutic levels.

In conclusion, the preliminary results demonstrated that IA has less effect on quadriceps strength while provide comparable postoperative analgesia after patellar tendon graft ACLR, compared with FNB. Concerning quadriceps weakness, IA showed potential benefit for early ambulation and rehabilitation.

What is already known on this topic?

Adequate analgesia, successful rehabilitation, recovery of knee function and return to sports are important for ACLR. FNB provides good postoperative pain but accompanied with quadriceps weakness. IA is effective in reducing postoperative pain but with question of chondrotoxicity. Comparing FNB and IA has conflicting results.

What this study adds?

IA, compared with FNB, has less effect on quadriceps strength while it provides comparable post operative analgesia after patellar tendon graft ACLR. Further studies on chondrotoxicity were suggested.

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Potential conflicts of interest

None.

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การศึกษาเบื้องต้นถึงผลการระงับปวดและความแข็งแรงของกล้ามเนื้อ quadriceps ภายหลังการผ่าตัดส่องกล้องสร้าง anterior cruciate ligament เปรียบเทียบระหว่างการทำ femoral nerve block กับการฉีดยาชาในข้อเข่า

อริศรา เอี่ยมอรุณ, สุวิชาธารังโชติ, บุศรา ศิริวันสามท, ปฐม หัสละเมียร, พิสิฏฐ์ เลิศวานิช, สุกคณิง สุรเชษฐพงษ์, ปวีณัส รุ่งวัฒนะกิจ

ภูมิหลัง: การระงับปวดที่เพียงพอและการฟื้นฟูสมรรถภาพโดยเร็ว เป็นสิ่งจำเป็นสำหรับการผ่าตัดส่องกล้องสร้าง anterior cruciate ligament (ACL)

วัตถุประสงค์: การศึกษานี้ต้องการเปรียบเทียบผลการระงับปวดและผลต่อกำลังกล้ามเนื้อ quadriceps ระหว่างการทำ femoral nerve block (FNB) กับการฉีดยาชาในข้อเข่าโดยใช้ยาชา bupivacaine 0.25% สำหรับการผ่าตัดส่องกล้องสร้าง ACL โดยใช้ patellar tendon graft

วัสดุและวิธีการ: ผู้ป่วย 40 คน จะถูกแบ่งออกเป็นจำนวนเท่าๆ กัน เมื่อเสร็จผ่าตัดกลุ่มหนึ่งจะได้รับการทำ FNB โดยอัลตราซาวด์และใช้ยาชา bupivacaine จำนวน 20 มิลลิตรอีกกลุ่มหนึ่งจะได้รับการฉีดยาชา bupivacaine จำนวน 15 มิลลิตรในข้อเข่าและ 5 มิลลิตรบริเวณแผลผ่าตัดและบริเวณที่ใส่กล้อง ผู้ป่วยทุกคนจะได้รับการฉีด ketorolac ทางหลอดเลือดดำเมื่อเย็บแผลเสร็จ ข้อมูลเกี่ยวกับผู้ป่วย เวลาที่ปวดแผลครั้งแรก เวลาที่ขอยามอร์ฟีนครั้งแรก จำนวนมอร์ฟีนที่ใช้ทั้งหมด คะแนนความปวด และกำลังของกล้ามเนื้อ quadriceps จะถูกบันทึกไว้

ผลการศึกษา: พบว่ามีความแตกต่างกันอย่างมีนัยสำคัญในเรื่องกำลังของกล้ามเนื้อ quadriceps ผู้ป่วยจำนวน 90% ในกลุ่มฉีดยาชาในข้อเข่า และผู้ป่วยจำนวน 55% ในกลุ่ม FNB สามารถยกขาได้ในระดับที่เวลา 24 ชั่วโมงหลังผ่าตัด ($p = 0.013$) นอกจากนี้ไม่พบความแตกต่างกันในลักษณะของประชากร เวลาที่ปวดแผลครั้งแรก เวลาที่ต้องขอยามอร์ฟีนครั้งแรก คะแนนความปวดและจำนวนยามอร์ฟีนที่ใช้ทั้งหมด

สรุป: การศึกษาเบื้องต้นแสดงให้เห็นว่าการฉีดยาในข้อเข่ามีผลต่อกำลังของกล้ามเนื้อ quadriceps น้อยกว่าการทำ FNB โดยให้ผลการระงับปวดที่ใกล้เคียงกันภายหลังการผ่าตัดส่องกล้องสร้าง ACL ด้วย patellar tendon graft
