Will the Addition of a Sciatic Nerve Block to a Femoral Nerve Block Provide Better Pain Control Following Anterior Cruciate Ligament Repair Surgery?

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Two common forms of postoperative analgesia used in patients following an anterior cruciate ligament repair (ACLR) are the femoral nerve block (FNB) and the combined femoral-sciatic nerve block (FSB). The purpose of this study was to determine if the addition of the sciatic nerve block to the FNB is truly beneficial in ACLR patients requesting regional anesthesia for postoperative pain control.

All subjects scheduled for an ACLR, requesting general anesthesia and preoperative placement of a peripheral nerve block (PNB), were randomized to receive an FNB or an FSB. Analgesic requirements, pain scores, and overall postoperative analgesic satisfaction were the primary outcomes measured.

The data for 56 subjects (FNB, 27; FSB, 29) were used in analysis. Significantly higher analgesic requirements, pain scores, and lower satisfaction scores were noted in the FNB group compared with the FSB group (P < .05). No other differences were noted between groups in demographic data.

Based on this investigation, we concluded that the FSB, compared with FNB alone, provides superior postoperative analgesia in patients receiving an ACLR and should be included in the anesthetic care plan in which a PNB is planned to facilitate postoperative analgesia.

Keywords: Analgesia, anterior cruciate ligament repair, femoral nerve block, peripheral nerve blocks, sciatic nerve block.

An anterior cruciate ligament (ACL) injury is traumatic and debilitating and is typically repaired using an arthroscopic surgical technique performed as an outpatient surgical procedure. However, many patients complain that the postoperative pain is severe for the first 24 to 48 hours following the ACL repair (ACLR), and the analgesics prescribed by their attending orthopedic surgeons are less than adequate.[1] In addition to the incomplete level of analgesia reported, the side effects reported from the analgesics prescribed can be troublesome, thereby compounding the overall level of dissatisfaction with the postoperative analgesic treatment regimen.[1] As a result, anesthesia providers are continually seeking alternative methods of analgesia that can provide intense, prolonged levels of analgesia, with minimal to no side effects.

One method that possibly meets this criterion is the femoral nerve block (FNB). Investigations have shown that in patients who have undergone a surgical procedure to the knee, the performance of an FNB results in a significant reduction in overall postoperative analgesic requirements for the first 24 to 48 hours following surgery.[2-8] However, the FNB provides analgesia to the anterior portion of the knee, and many patients who undergo an extensive surgical procedure to the knee complain of pain in the posterior portion as well, thereby necessitating supplemental analgesia to achieve postoperative comfort.[1,9-12] To address this incomplete analgesia, many practitioners advocate that in addition to an FNB, a sciatic nerve block (SNB) should be performed to provide analgesia to the posterior portion of the knee.[1,9-12] The femoral-sciatic nerve block (FSB) has been shown to decrease postoperative pain scores in patients who have undergone total knee reconstruction, but there is little evidence to indicate whether using this combination of nerve blocks would be beneficial in patients undergoing an ACLR.[13,14] Therefore, the purpose of this investigation was to determine the analgesic efficacy of an FNB or an FSB placed preoperatively to facilitate postoperative analgesia in groups of patients undergoing ACLR and administered general anesthesia for the surgical procedure.

Patients and Methods

Following institutional review board approval, a prospective, randomized, quasi-experimental investigation was conducted at a large military medical treatment facility.

ASA physical status I and II patients scheduled for an ACLR were given informed consent and randomized by using a computer-generated process to receive an FNB (control group) or an FSB (experimental group). Patients were excluded from participation for pregnancy, history of long-term opioid use of more than 3 months, history of neuropathological disease, documented allergies to any medication used in this study, or evidence of a coagulation disorder at the time of the surgical procedure.

Data collection consisted of demographic information, including gender, age, height, weight, and race. Before placement of the nerve block(s), baseline pain and motor assessments were performed and documented on a data collection sheet. Pain assessments were performed by using a 0 to 10 verbal numeric rating scale (VNRS) in which a score of "0" indicated "no pain" and a score of "10" indicated "the worst pain imaginable." Degree of motor blockade to the lower extremity was analyzed by using the modified Bromage scale (MBS). The MBS was modified according to the block placed. Assessment of the degree of FNB was determined by using a 2-point ordinal scale in which a "0" indicated ability to extend extremity at the knee and a score of "1" indicated an inability to extend the knee. Sciatic nerve motor blockade was determined by using a 4-point ordinal scale, so that determination of common peroneal and tibial nerve motor block could be ascertained before surgery. A score of "0" indicated an ability to extend hip and flex knee; a score of "1" indicated an inability to extend hip but an ability to flex the knee; a score of "2" indicated an inability to flex knee but an ability to flex ankle; and a score of "3" indicated an inability to flex the knee or ankle.

Following baseline assessment, an intravenous (IV) infusion of lactated Ringer's solution was initiated for all subjects, and they were given preoperative anxiolysis and sedation using midazolam (0-5 mg IV) and fentanyl (0-250 µg IV). All preoperative medications administered were recorded on a data collection sheet. All subjects were monitored (electrocardiogram, Sao_2, noninvasive blood pressure) in the preoperative block area before block placement and continuously during the procedure.

For subjects randomized to the FSB group, the SNB was placed before placement of the FNB. To facilitate placement of the SNB, all FSB subjects were positioned laterally with the operative limb placed in a nondependent position (classic LaBat approach). The operative leg was flexed approximately 90° at the hip joint, with moderate flexion of the knee to facilitate block placement. A triangulation technique of 3 intersecting lines of the anatomical landmarks was used to identify the injection site. The first line was drawn from the posterior superior iliac spine to the greater trochanter of the femur, the second line from the sacral hiatus to the greater trochanter, and the third line perpendicular to, and inferiorly from, the midpoint of the first line. The point at which the third line and the second line intersected was the point of injection (Figure 1).

The injection site was cleansed with povidone iodine solution and subcutaneously infiltrated with 2 to 3 mL of 1% lidocaine. A 10- to 12-cm, 22-gauge Stimuplex needle (B. Braun Medical, Bethlehem, Pennsylvania) was inserted at the injection site and advanced following a plane that was perpendicular to the skin. Immediately following skin penetration, the needle was attached to a peripheral nerve stimulator (PNS), emitting a pulsatile frequency of 2 Hz with an intensity of 1.0 mA and advanced along this perpendicular plane until dorsiflexion of the ankle was noted. Once the desired motor response was observed, the PNS stimulation intensity was reduced incrementally to less than 0.5 mA. If at less than 0.5 mA the dorsiflexion motor response was retained, a total of 20 mL of 0.25% bupivacaine with 1:200,000 epinephrine was injected in 5-mL increments. The syringe was aspirated immediately before injection of each 5-mL increment to ascertain if intravascular migration had occurred. Following injection of the local anesthetic solution, the needle was removed and digital pressure applied to the injection site for 5 minutes. Subjects in the FSB group were then repositioned supine for placement of the FNB.

All subjects received an FNB using the classic approach with nerve stimulation. All subjects were positioned in the supine position, and anatomic localization of the femoral nerve was performed by palpation inferior to the inguinal ligament, 1 cm lateral to the femoral artery (Figure 2). The site was cleansed with povidone iodine solution, and 2 to 3 mL of 1% lidocaine solution was injected subcutaneously for local anesthesia. Following aseptic technique, femoral artery pulsation was palpated, and a 22-gauge, 4-cm Stimuplex needle was advanced perpendicular to the skin into the area of the femoral nerve. Nerve stimulation was emitted with a 2-Hz frequency and 1.0-mA intensity signal, and the needle was advanced until a quadriceps extension motor response was elicited. Stimulator intensity was reduced incrementally until a motor response less than 0.5 mA was obtained; then, 30 mL of 0.25% bupivacaine with 1:200,000 epinephrine was administered in 5-mL increments, with frequent aspirations on the syringe to ascertain if inadvertent intravascular migration had occurred. On completion of the administration of local anesthetic solution, the needle was withdrawn, and distal digital pressure was applied to the needle insertion site for 5 minutes.

Following placement of the FNB or FSB, all subjects were evaluated for level of sensory and motor blockade every 5 minutes for a period of 30 minutes. Sensory level was assessed with tactile stimulation, and the MBS was used to determine degree of motor blockade. All MBS and sensory assessments were noted on a data collection sheet, and blocks were considered successful if a lack of

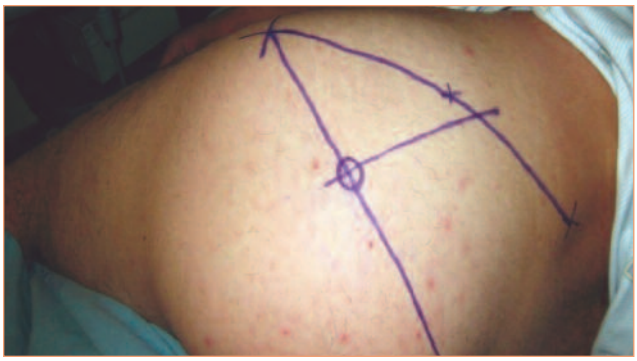

Figure 1. Landmarks for Sciatic Nerve Block: Classic LeBat Approach

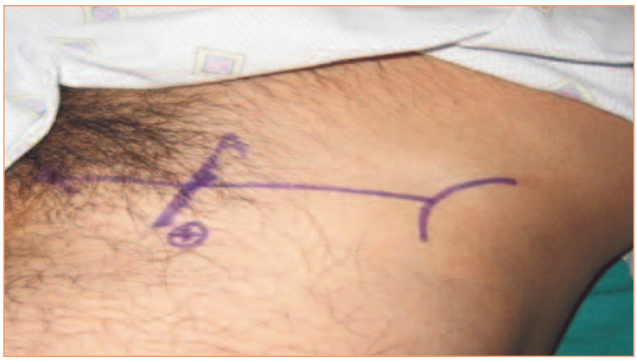

Figure 2. Landmarks for Femoral Nerve Block: Classic Approach

motor strength and no sensation was noted along the femoral and sciatic nerve distributions in the FSB group and along the femoral nerve distribution in the FNB group. If sensory or motor blockade changes had not occurred within 30 minutes following block placement, the block was determined to be a failure.

Following block placement, all subjects were transported to the operative suite and transferred to the operative table where standard monitors were reapplied and 100% oxygen was administered via facemask. General anesthesia was then administered according to the following induction protocol to facilitate tracheal intubation: propofol, 2.0 to 2.5 mg/kg IV; 1% lidocaine, 20 to 40 mg IV; fentanyl 2 to 3 µg/kg IV; and rocuronium, 0.6 to 1.2 mg/kg IV, or succinylcholine, 1.5 to 2.0 mg/kg IV. Anesthesia was maintained with a volatile anesthetic chosen by the anesthesia provider (sevoflurane, isoflurane, or desflurane) in combination with 50% nitrous oxide and 50% oxygen. Perioperative opioid administration was left to the discretion of the anesthesia provider. All perioperative medications and the ACLR graft source were recorded on the data collection sheet. All preoperative, intraoperative, and postoperative analgesics administered were later converted to morphine equivalents for analysis. On completion of the ACLR procedure, all subjects were extubated and transferred to the postanesthesia care unit (PACU).

The times of entry to and discharge from the PACU were recorded on a data collection sheet. All subjects had PACU orders written for nausea and for breakthrough pain. Nausea was treated with ondansetron, 4 mg IV, every 15 minutes up to a total of 8 mg, and pain was treated with morphine sulfate, 1 to 3 mg IV, every 5 minutes up to a total of 0.15 mg/kg. Postoperative shivering was treated with meperidine, 12.5 to 25 mg IV, every 15 minutes up to a total of 50 mg. All medications administered were recorded, and all subjects were observed for time of return of motor and sensory function in the PACU. A 0 to 10 VNRS score for pain was assessed on every subject on entry to and discharge from the PACU and immediately before and 30 minutes following the administration of any analgesic. Sensory and MBS scores were assessed on entry to and discharge from the PACU. Once PACU discharge criteria were met, subjects were transferred to the same-day surgery unit (SDSU).

Times of entry to and discharge from the SDSU were recorded, and on admission, all subjects had a 0 to 10 VNRS score for pain performed immediately before and 30 minutes following the administration of any analgesic. Breakthrough pain was treated using the prescribed oral analgesic and/or anti-inflammatory medication ordered by the attending orthopedic surgeon for all subjects. An admission and discharge MBS and sensory level were assessed and recorded on an SDSU data collection sheet. Before discharge from the SDSU, all subjects were provided with a home data collection tool and were instructed to document the dose and time of any analgesic required within the first 24 hours following discharge and the 0 to 10 VNRS score for the amount of pain experienced immediately before and 30 minutes following the administration of any analgesic. In addition, all subjects were instructed to rate their overall level of satisfaction using a 5-point Likert scale for 3 global areas of assessment. These 3 global areas included overall satisfaction with the leg block procedure, willingness to have the leg block performed if lower extremity surgery was required again, and overall pain control during the first 24 hours following surgery. Satisfaction with the leg block procedure and overall pain control was analyzed by using the following scale: 1, extremely satisfied; 2, satisfied; 3, somewhat satisfied; 4, dissatisfied; and 5, extremely dissatisfied. All subjects were contacted by one of the investigators approximately 24 hours following surgery to obtain these postdischarge data. The duration of analgesia in both groups was defined as the time from placement of the FNB to the first request for analgesic medication.

Before initiation of the study, a power analysis was performed in which we estimated that a 35% reduction in postoperative opioid requirements would be demonstrated between the FNB and FSB groups. By using an α of .05 and a β of .20, we estimated that a sample size of 27 subjects per group would be required to show a difference

Demographics/study variables	FNB group (n = 27)	FSB group (n = 29)	P*
Gender (no.)			
Female	5	2	.189
Male	22	27	
Age (y) (mean ± SD)	28.7 ± 7.8	27.1 ± 5.9	.378
Race (no.)			
Caucasian	19	20	
African American	6	5	
Hispanic	0	2	.496
Pacific-Islander	1	0	
Asian	1	2	
Height (cm) (mean ± SD)	173.9 ± 7.8	176.1 ± 10.6	.406
Weight (kg) (mean ± SD)	86.8 ± 16.9	83.6 ± 11.6	.405
Volatile agent used (no.)			
Isoflurane	16	18	.677
Desflurane	7	5	
Sevoflurane	4	6	
Time (min) (mean ± SD)			
Operative time	220.19 ± 59.1	232.6 ± 69	.473
PACU time	89.3 ± 41	67.4 ± 32.5	.030
SDSU time	144 ± 56	149 ± 93.4	.790
Type of graft used (no.)			
Patellar tendon	1	8	
Semitendinosis	9	9	.071
Donor graft	7	3	
Other	10	9	

Table. Demographics and Variables of Interest
FNB indicates femoral nerve block; FSB, femoral-sciatic nerve block; PACU, postanesthesia care unit; SDSU, same-day surgery unit.
* Significance indicated by a value < .05.

between the groups Factoring in an attrition rate of 10%, this increased our sample size requirements to a total of 60 subjects (30 per group). Data analysis was conducted by using SPSS version 14.0 statistical software (SPSS Inc, Chicago Illinois). Descriptive and inferential statistics were used to analyze data. Demographic data were analyzed by using χ^2 analysis and a Fisher exact test. A Student *t* test was used to analyze for continuous data, VNRS scores, and opioid requirements. A Mann-Whitney *U* test was used to measure MBS ordinal scores and satisfaction scores. A χ^2 analysis was used to measure all binary scores and type of graft used for the ACLR. A Pearson correlation was used to determine if the source of graft correlated with increased pain. A *P* value of less than .05 was considered significant.

Results

A total of 60 subjects were enrolled, but the data for 4 subjects were dropped from analysis because of a change in the surgical procedure following block placement (FNB), surgical cancellation because of surgical equipment failure after block placement (FSB), extension of the surgical procedure beyond an ACLR following entry into the operating room (FNB), and inadvertent block of the wrong extremity (FNB), leaving a total of 56 subjects (FNB, 27; FSB, 29) for analysis. A total of 6 subjects were admitted to the inpatient ward (FNB, 2; FSB, 4) for nonmedical reasons, which occasionally occurs with active duty military personnel living in the barracks or on a ship. Data collection procedures were the same for patients admitted to an inpatient ward and for patients discharged to home. On subanalysis of data for the 6 inpatients compared with patients discharged to home, there were no differences in analgesic requirements or VNRS data; hence, the data for these subjects were included in the final analysis.

There were no differences in demographic variables, graft sources used, or volatile agent used. When times were analyzed, no differences were noted in the operative or SDSU times between groups. However, in the PACU, it was noted that the FSB group required less postoperative recovery time than subjects in the FNB group (*P* = .030)

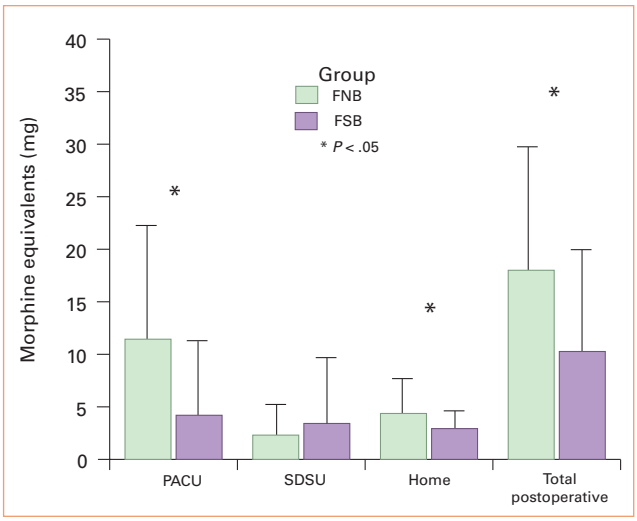

Figure 3. Postoperative Analgesic Requirements
The femoral-sciatic nerve block (FSB) group had significantly lower analgesic requirements in the postanesthesia care unit (PACU; $P = .004$) and at home ($P = .045$), but not in the same-day surgery unit (SDSU; $P = .389$). Total mean ± SD postoperative analgesic requirements were higher in the femoral nerve block group (18.1 ± 11.98 mg) compared with the FSB group (10.2759 ± 9.4657 mg) ($P = .009$).
FNB indicates femoral nerve block.

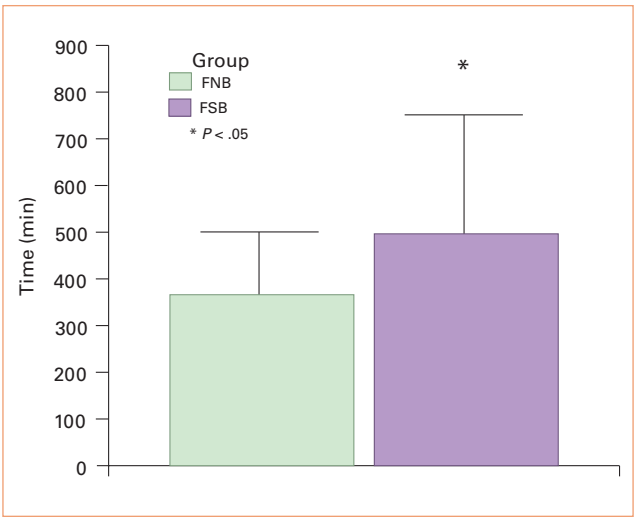

Figure 4. Time From Nerve Block Placement to First Analgesic Request
The mean ± SD time to first analgesic request was significantly longer in the femoral-sciatic nerve block (FSB) group than in the femoral nerve block group (496.5 ± 241.6 vs 366.1 ± 138.34 min; $P = .016$).
FNB indicates femoral nerve block.

(Table). No differences in MBS or sensory scores were noted between groups. No correlation was noted between the graft source and the following variables of interest: pain data, analgesic requirements, time intervals, and satisfaction scores. In addition, no side effects occurred with any of the blocks, and no block failures (FNB or FSB) resulted. We noted that 74% (n = 20) of the FNB group required PACU analgesia compared with 34% (n = 10) in the FSB group ($P = .003$). The mean ± SD PACU analgesic requirements were also higher in the FNB group (11.4 ± 10.1 mg) compared with the FSB group (4.2 ± 6.5 mg; $P = .002$). Analgesic requirements were similar in the SDSU, but a difference was noted between groups following discharge from the SDSU for the first 24 hours (FSB, 2.9 ± 2.3 mg; FNB, 4.4 ± 2.9 mg; $P = .045$). The mean ± SD overall postoperative analgesic requirements were higher in the FNB group (18.4 ± 12.0 mg) compared with the FSB group (10.3 ± 9.5 mg; $P = .009$; Figure 3).

Significant differences in the mean ± SD time to first analgesic request following block placement were noted between groups (FSB, 496.5 ± 241.6 minutes; FNB, 366.1 ± 138.3 minutes; $P = .016$; Figure 4). In addition, the corresponding mean ± SD VNRS scores at the first analgesic request were higher in the FNB group (6.4 ± 2.3) compared with the FSB group (4.4 ± 2.7; $P = .041$). Postoperative VNRS scores were noted to be higher in the FNB group compared with the FSB group at all interval measurements except on admission to the PACU, but the differences failed to achieve statistical significance.

Furthermore, there was a significant difference between groups in overall pain control satisfaction scores (FSB, 1.0 "extremely satisfied"; FNB, 2.5 "satisfied"; $P = .001$). Both groups reported extreme satisfaction with the leg block procedure, and only 1 subject (FSB) reported that a similar block for a future procedure would not be requested.

Discussion

Significant postoperative pain and marked opioid consumption have continued to present a barrier to the performance of an ACLR as an outpatient procedure. Multiple research investigations have been conducted to evaluate the most successful postoperative pain management.

Our investigation revealed that the use of a combined peripheral nerve block approach (FSB) in the ACLR population is associated with less pain, decreased opioid use, higher patient satisfaction, and shorter PACU stays. Our data confirm that there is clearly a sciatic nerve distribution of postoperative pain in the ACLR, unrelated to the harvesting of a hamstring graft vs a patellar tendon graft. The source of the pain is thought to be related to posterior knee edema, surgical trespass, and the intraoperative use of a thigh tourniquet. The FSB provides superior pain relief because of the analgesia provided to the posterior portion of the knee. Our data confirm the conclusions made by Cook et al[13] claiming that the FSB is superior to the FNB in providing optimal pain management in "the early postoperative period" in all types of orthopedic knee surgeries and contradict the findings of Allen et al,[3] who suggested that equal analgesia is afforded by an FNB

alone or an FSB in a group of patients undergoing total knee arthroplasty.

Frost et al[9] asserted that the use of a hamstring autograft in patients undergoing ACLR was the central factor that detracted from the efficacy of the FNB in providing adequate pain control, necessitating an FSB for adequate postoperative analgesia. However, on analysis, our evidence demonstrated that the source of the graft had no clinically significant difference in any of the variables of interest. The reduced total postoperative analgesic requirements, extended period to first analgesic request, and increased patient satisfaction in the FSB group validate this conclusion. Graft source was also addressed by Williams et al,[12] who reported similar findings to our's, emphasizing that orthopedic knee surgery, especially ACLR, trespass into regions innervated by the femoral and sciatic nerve distributions.

Conclusion

Although regional anesthesia requires more preoperative time in the anesthetic regimen of these surgeries, our investigation has demonstrated that an FSB substantially reduces PACU time, which can be a significant overall cost benefit. Further investigations examining the difference in times to place the block(s) between groups vs the time reductions in certain echelons of perioperative care, namely the PACU, should be conducted to alleviate concerns of surgeons and other anesthesia providers who believe that these regional techniques will delay surgical start times and turnover rates.

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ADDITIONAL READING

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