

Femoral Nerve Block With 0.25% or 0.5% Bupivacaine Improves Postoperative Analgesia Following Outpatient Arthroscopic Anterior Cruciate Ligament Repair

Michael F. Mulroy, M.D., Kathleen L. Larkin, M.D., Manbir S. Batra, M.D., Peter S. Hodgson, M.D., and Brian D. Owens, M.D.

Background and Objectives: Femoral nerve block is effective in reducing postoperative pain after inpatient knee surgery. We studied its efficacy compared with standard analgesia following outpatient anterior cruciate ligament repair, including the duration of analgesia and the effect of different concentrations of bupivacaine.

Methods: After Institutional Review Board approval and informed consent, we prospectively randomized patients to receive, in a blinded fashion, either a sham block, a femoral nerve block with 25 mL 0.25% bupivacaine, or with 25 mL 0.5% bupivacaine after anterior cruciate ligament repair under epidural anesthesia. Verbal analog pain scores were evaluated by a blinded observer at 20 and 40 minutes after injection. Patients with pain >4 (out of 10) were assessed for the presence of a block and offered a supplemental block if no anesthesia was present at either evaluation. By prospective agreement, any study group with 6 failures was excluded from further recruitment. After discharge, patients recorded pain scores and analgesic consumption in a diary, and estimated the time at which they perceived that analgesia and sensory block from the femoral nerve block resolved, based on an increase in pain, sensation, and strength in the leg.

Results: In the sham block group, 6 of 12 patients reported inadequate analgesia in the postanesthesia care unit (4 at 20 minutes, 2 at 40 minutes; greater than other groups, $P < .003$) and were excluded from further study. Patients with sham blocks had higher pain scores 20 minutes after the block, and requested intravenous analgesia more often. Bupivacaine 0.25% and 0.5% provided 23.2 ± 7 and 25.7 ± 11 hours of analgesia, respectively.

Conclusions: Femoral nerve block with 0.25% bupivacaine contributes significantly to multimodal postoperative analgesia in the immediate postoperative period following outpatient anterior cruciate ligament repair. Both doses of bupivacaine studied provided analgesia for the first night after surgery. *Reg Anesth Pain Med* 2001; 26:24-29.

Key Words: ACL repair, Ambulatory anesthesia, Arthroscopy, Bupivacaine, Femoral nerve block, Postoperative analgesia.

Arthroscopically assisted repair of the anterior cruciate ligament (ACL) of the knee has become standard orthopedic treatment for ACL disruption. The use of a patellar tendon graft and intensive multimodal analgesia has allowed this

procedure to be performed on an outpatient basis.¹ Intraarticular local anesthetic, systemic nonsteroidal anti-inflammatory drugs (NSAIDs), continuous external cold irrigation (cryotherapy), and oral opioids have been used to provide pain relief to facilitate hospital discharge. Despite aggressive analgesic interventions, postdischarge verbal analog pain scores (VAPS) range from 4 to 8 on a 10-point scale in reported series.^{2,3} Even with sustained-release oral opioids, patients report scores ranging from 3 to 6 in the first 24 hours postoperatively.²

Femoral nerve block (FNB) has been shown to provide improved analgesia after inpatient surgical reconstruction of the knee⁴⁻⁶ and for ACL repair when performed on an inpatient basis.⁷⁻¹⁰ FNB has been advocated for analgesia following outpatient

From the Department of Anesthesiology, Virginia Mason Medical Center, Seattle, Washington.

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Reprint requests: Michael F. Mulroy, M.D., Department of Anesthesiology, B2-AN, 1100 Ninth Ave, PO Box 900, Seattle, WA 98111. E-mail: anemfm@vmmc.org

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ACL repair¹¹ and has been used to reduce discharge time and the frequency of hospital admission for pain control after outpatient ACL reconstruction.^{12,13}

The efficacy of FNB in the outpatient setting, the total duration of analgesia provided, and the appropriate type and dose of local anesthetic have not been clearly documented in a prospective, randomized, blinded comparative study. We performed such a comparison between a sham FNB and FNB performed with 0.25% and 0.5% bupivacaine.

Methods

After Institutional Review Board (IRB) approval and informed consent, we randomized by sealed envelopes 60 consecutive patients undergoing ACL repairs under epidural anesthesia at our outpatient surgical center to receive either a sham FNB or an FNB with either 0.25% or 0.5% bupivacaine with 1:200,000 epinephrine (20 patients in each group). Successful pain relief was defined as a VAPS of 4 or less. By prior agreement for ethical considerations, if there were 6 treatment failures at any time (a projected failure rate of 30% or more) in any of the 3 groups, that group was excluded from further enrollment. All subjects were between 18 and 70 years of age and weighed less than 110 kg. Patients allergic to NSAIDs, or who could not cooperate with pain evaluations or follow-up, were excluded. Epidural anesthesia was performed in a standard fashion, using 15 to 20 mL of 2% lidocaine initially with a 5- to 10-mL reinjection through a continuous catheter if needed to prolong duration. Intravenous propofol sedation was provided as requested by the patient. At the beginning of surgery, 50 mL of 0.25% bupivacaine was instilled into the knee joint. At the conclusion of surgery, patients received intravenous ketorolac 30 mg. When the patient first began to perceive pain in the recovery room, the anesthesiologist was called to perform a block. If the pain was >4, a dose of 25 to 50 μ g fentanyl or 25 mg meperidine was administered by the postanesthesia care unit (PACU) nurse. When the anesthesiologist arrived, a sheet was extended across the stretcher to obstruct the patient's view, and he or she received either a sham or actual FNB. In the sham group, the groin was palpated and prepared with betadine solution, and all equipment for a block, including the nerve stimulator, was assembled. The operator then shook the thigh to mimic a nerve stimulator response to femoral nerve stimulation (quadriceps contraction). In the 2 groups assigned a block, FNB was performed by the anesthesiologist using a nerve stimulator to document location of the femoral nerve with a quadriceps

contraction achieved with a current of 0.5 mA or less, then by injecting 25 mL of either 0.25% bupivacaine or 0.5% bupivacaine, both with 1:200,000 epinephrine. The patient was blinded as to which drug was used. At 20 and 40 minutes following the injection, each patient was asked by a blinded observer to rank his or her pain on a verbal pain scale, grading from 0 to 10. If the pain score was greater than 4 at either time interval, the thigh was evaluated with a blunt 25-gauge needle for sensory analgesia. If there was no evidence of analgesia to pinprick, the patient was considered a treatment failure and dropped from further study. Further analgesia was provided with an unblinded FNB.

If the pain score was ≤ 4 , the patient was discharged from the unit with standard oral analgesic medication. Standard multimodal therapy included the use of intravenous ketorolac as described at the end of the operation, and the instillation of 50 mL 0.25% bupivacaine in the knee joint at the beginning of surgery and the use of a cryotherapy unit on the knee starting in the PACU. Patients complaining of pain in the PACU were treated with intravenous fentanyl or meperidine.

On a data sheet, all patients documented their pain scores at rest and the use of oral analgesics every 4 hours while awake in the postoperative period for the first 36 hours. They were also asked to record the time at which they believed there was a significant increase in discomfort in the knee in conjunction with a return of quadriceps strength and sensation. Scoring was confirmed by a follow-up phone call from the blinded observer at 24 to 36 hours.

Two primary variables were compared—the success of pain relief in the PACU (pain score ≤ 4) and the perceived duration of analgesia in the groups receiving effective blocks. The success of the sham versus actual block was compared by chi-square analysis and Fisher's exact test. Duration of analgesia was compared by analysis of variance among the groups. Power analysis required a sample of 20 patients in each group to show a 12-hour difference between 2 of the groups at the $P < .05$ level with 80% power. Average pain scores at each of the time intervals and the consumption of oral analgesics in the first 36 hours were also compared among the 3 treatment limbs using the Kruskal-Wallis test.

Results

Fifty-five patients were enrolled. Twenty-three received 0.25% bupivacaine blocks, with 2 block failures (pain scores >4 associated with absence of sensory analgesia on the thigh) who were excluded

Table 1. Demographics

	Groups (no.)		
	Sham (12)	0.25 Bupivacaine (21)	0.5 Bupivacaine (20)
Age	38 ± 11	36 ± 11	38 ± 11
Weight (kg)	83 ± 11	81 ± 19	78 ± 12
Gender (M/F)	11/1	15/8	12/8
ASA (1/2)	12/0	17/6	16/4
Graft:			
Auto/Semi/Allo	10/1/1	22/0/1	19/1/0

Abbreviations: Auto, autograft; Semi, semitendinosus; Allo, allograft.

from analysis. Twenty patients received 0.5% bupivacaine. In the sham group, 6 of 12 patients had pain scores of 5 or more and were excluded. The other 6 were discharged with pain scores <4, and were followed for pain scores and pain pill consumption. The groups were similar in age, weight, and surgical procedure (Table 1).

The frequency of successful analgesia was significantly higher in both bupivacaine treatment groups ($P < .003$). Pain scores in PACU were not different between the groups before the block, but were higher in the sham group 20 minutes after the block ($P = .03$). After the 20-minute interval, only 8 patients remained in the sham group. The frequency of analgesic requests and doses in the PACU was not different between groups before the FNB, but the frequency of requests for medication was higher in the sham group following the block ($P =$

.04, Table 2). At the time of discharge, 6 patients remained in the sham group.

The pain scores at each of the measurement points for 36 hours tended to be higher in the sham group (Fig 1), but the differences were not significant. Similarly, pain pill consumption during each interval in 36 hours and total pain pill consumption tended to be higher in the sham group (Fig 1).

All patients were successfully discharged on the day of surgery, and there were no adverse effects associated with the blocks. The average duration of analgesia was equivalent in the 2 bupivacaine groups (0.5% 25.7 ± 11 hours ν 0.25% 23.2 ± 7 hours).

Discussion

Our report is a prospective, blinded, randomized confirmation of the efficacy of femoral nerve block as part of a multimodal regimen for postoperative analgesia after outpatient patellar-tendon graft ACL repair. We found that the frequency of successful postoperative analgesia (VAPS <5) was higher with the femoral nerve block compared with the sham block group, and that the frequency of requests for analgesia was also lower with the femoral nerve block compared with the sham block patients. Sham block patients also tended to have higher pain scores in the first 24 hours and more oral analgesics in the first 36 hours, but the small number of patients successfully discharged after sham blocks precludes identifying these trends as signifi-

Table 2. PACU Pain Scores, Analgesic Use

	Group (no. subjects)		
	Sham (12)	0.25% Bupivacaine (21)	0.5% Bupivacaine (20)
Pain score			
Baseline average	2.5	2.9	2.7
Median	2	3	2
20 min post block			
Average	3.8*	2.6	2.3
Median	2.5	1	0.5
40 min post block			
Average	3.5 (8 patients)	2.3	2.4
Median	2 (8 patients)	0	1
Analgesics in PACU:			
None (no. patients)	5†	13	12‡
Fentanyl			
Average μ g before FNB	50 ± 35 (5)	50 ± 38 (8)	45 ± 33 (4)
Average μ g after FNB	46 ± 58 (4 of 6§)	5 ± 9 (2)	15 ± 22 (2)
Average no. pain pills in 36 h	12 ± 9 (6 subjects)	9.7 ± 4	9 ± 6

NOTE. Numbers in parentheses = number of patients. Two patient data points missing (one each, 0.5 and sham groups).

* $P = .03$ compared with bupivacaine groups.

†3 discharged with sham block and 2 sham failures.

‡2 patients received meperidine before FNB.

§ $P = .04$ compared with bupivacaine groups.

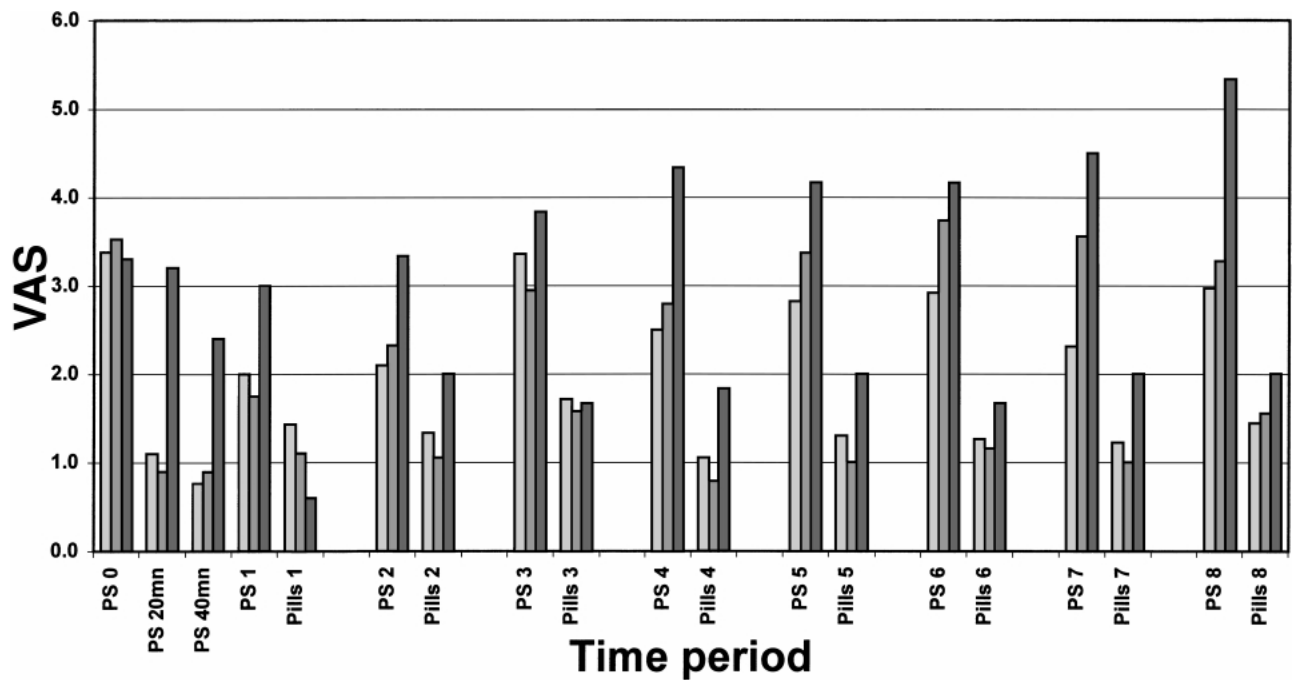


Fig 1. Average pain scores and analgesic consumption at each time interval in the first 36 hours after ACL repair. PS, average pain score; Pills, average number of oral analgesics at time period. Time Periods: 1, 8 PM day of surgery; 2, midnight; 3, 8 AM next day; 4, noon; 5, 4 PM; 6, 8 PM; 7, midnight; 8, 8 AM second day. Pain scores at 20 minutes greater in sham group ($P = .03$); no significant differences at other times. (□), .25% bupivacaine average; (▒), .5% bupivacaine average; (■), sham average.

cant. We also showed that FNB analgesia persisted overnight, but was not different between 0.25% and 0.5% bupivacaine. The average pain score reported in the first 24 hours with the FNB was in the range of 2 to 3. This contrasts with the pain scores ranging from 3 to 5 in previously reported studies with the use of oral opioid analgesia alone.²

FNBs have been shown to provide superior analgesia after inpatient knee surgery. Allen et al.⁴ showed that an FNB after inpatient total knee arthroplasty provided better pain scores in the first 8 hours and a 50% reduction in morphine requirements in the first 24 hours after surgery compared with a sham block. Others have reported similar success with continuous FNB infusions.^{5,6} FNB has also been effective after inpatient ACL repair. Lynch et al.⁸ used the femoral nerve catheter to provide intermittent boluses of bupivacaine following inpatient open ACL repair and reported good or satisfactory analgesia in 88% of patients. Tetzlaff et al.¹⁰ used continuous infusions of bupivacaine through an indwelling femoral catheter to provide postoperative analgesia and reported pain scores of 2.5 to 4 during the first 24 hours. Edkin et al.⁷ used single-injection FNB for postoperative analgesia in 24 patients following inpatient ACL repair, and found that 92% of patients required no parenteral opioids. Peng et al.⁹ reported the first blinded, randomized

comparison of FNB to a placebo block on inpatient ACL repairs. They found a decrease in pain scores and morphine consumption with the FNB alone in the first 18 hours, but did not measure actual duration of block. They believed that FNB alone did not facilitate early recovery and that further evaluation of a multimodal approach incorporating FNB was needed.

ACL repair with a patellar tendon autograft is associated with significant postoperative pain, with 50% of patients requiring opioid analgesia in the absence of other therapy.³ This may limit the ability to perform this procedure on an outpatient basis, and explain why Peng et al. found little improvement with single-modality therapy. While oral analgesics remain a standard therapy for outpatient ACL repair, Reuben et al.² reported pain scores maintained in the 3 to 6 range with a sustained-release oxycodone preparation for this procedure, a level higher than that usually found with inpatient analgesia studies. Edkin et al.¹¹ used their experience with FNB to encourage performance of this surgery on an outpatient basis. With FNB, they could discharge 51% of their patients on the day of surgery.¹¹ Williams et al.¹³ also described single-injection FNB as part of a multimodal therapy to be helpful in providing early postoperative analgesia for outpatient surgery and reducing the rate of un-

planned admissions, but only as compared to historical controls. Urmey et al.¹² have presented a preliminary report of improved analgesia and discharge times with FNB compared with a placebo group, but have not reported the duration of analgesia following discharge. None of these reports attempted to measure the duration of FNB or to compare local anesthetic choices.

We chose to study 2 doses of bupivacaine for the single-injection FNB technique. Fanelli et al.¹⁴ have previously shown that the use of 0.5% bupivacaine for femoral nerve block provides longer duration of postoperative analgesia for lower extremity surgery than the other long-acting local anesthetics, 0.75% ropivacaine or 2% mepivacaine. Greengrass et al.¹⁵ have also shown a significantly longer duration when bupivacaine is used for lumbar plexus block, compared with ropivacaine. Although bupivacaine may exhibit a longer delay of onset of surgical anesthesia,¹⁶ our findings confirmed Greengrass's observation of a rapid onset of analgesia within 20 minutes of injection. There is concern about the use of higher concentrations of bupivacaine because of the potential for systemic toxicity with larger doses, and there is the potential for prolonged nerve block.¹⁷ The potential advantage of greater prolongation of sensory block with a higher concentration has not been evaluated compared with equal volumes of a lower concentration of bupivacaine, such as 0.25%. Our results show that the duration of analgesia is not prolonged by the use of the 0.5% concentration. We cannot explain this lack of difference, which may reflect the subjective evaluation of the duration of block in our protocol. Further study with objective criteria may identify a longer duration with the higher milligram dose.

There are several limitations to our study. The observations of pain scores and sensory analgesia in the first 24 hours were based on patients reporting their subjective observations during the time following discharge, rather than direct observation and recording. We did not test sensory analgesia with pinprick or other objective modalities because of the need to preserve the potential of a sham block in the patients' mind. Nevertheless, these subjective data were confirmed by a blinded observer who performed the phone call follow-up on the morning after surgery, and recorded the patients' observations and scores at that time.

A second limitation is that the sham group does not have an equal number of participants. Enrollment into this group was discontinued after 6 failures based on a predetermined level of ethical acceptability. The wide variability of analgesia scores in the small number of patients remaining in this group makes comparisons to the patients with

blocks difficult. A more significant difference in the sham group is the disproportionate presence of male patients. This is unfortunate, because it is known that males are less likely to report pain and to use analgesics than females¹⁸; thus our failure rate, pain scores, and analgesic use may have actually been higher in the sham group if an equal gender distribution had been attained.

We may also have achieved greater differences among groups if we had used traditional oral analgesics as the "rescue" medication in the sham group, rather than providing an FNB. However, other studies have shown high opioid requirements³ and relatively higher pain scores² in such groups, compared to the analgesia with FNB in other nonblinded descriptive reports. In consultation with our surgical colleagues and our IRB, it was decided that the best option was to provide an FNB. Our pain scores may have also been affected by the inclusion of a few patients receiving grafts other than patellar tendon, but we did not have this information before randomization and did not exclude these 4 patients.

Our numbers of observations were too small to provide adequate documentation of any risk associated with the higher doses of the local anesthetic. Our study was designed to determine whether there was a significant difference in duration between the 2 concentrations of bupivacaine, and does not justify conclusions about safety or risk with either of these doses.

In summary, we found that FNB with 25 mL of either 0.25% or 0.5% bupivacaine (as part of a multi-modality analgesic regimen including cold therapy and NSAIDs) provided a higher frequency of satisfactory analgesia in the immediate postoperative period than standard therapy alone, and provided satisfactory analgesia for the first 24 hours after outpatient arthroscopic ACL repair. The duration of analgesia did not differ with the higher concentration. We conclude that FNB with 0.25% bupivacaine is a useful adjunct to multi-modal analgesia for outpatient patellar-tendon ACL repair.

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