Femoral Nerve Block as an Alternative to Parenteral Narcotics for Pain Control After Anterior Cruciate Ligament Reconstruction

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Summary: Anterior cruciate ligament (ACL) reconstruction is associated with signiticunt postoperative pain, usually requiring parenteral narcotics A prospective study of arthroscopically assisted autograft patellar tendon XCLR was initiated using Winnie's "three-in-one" femoral nerve block (FNB) as the primary means of postoperative pain control. Patient satisfaction and absence of parenteral narcotic use indicated clinical success. Of 24 patients studied, 92% had no parenteral narcotics administered following FNB. Ninety-live percent of patients believed FNB was beneficial and would request another. The average duration of pain control was 29 hours and the majority of patients (79%) believed discharge was possible within 23 hours. There were two patients who failed to respond to FNBs (8%) and no major complications. FNB is a safe. reliable. and effective form of analgesia following ACLR, eliminating the need for parenteral narcotics. **Key Words:** Femoral nerve block-Anterior cruciate ligament reconstruction—Pain—Narcotics—Ketorolac.

The methods of controlling pain following anterior cruciate ligament (ACL) reconstruction are quite varied and include the following: narcotic or anesthetic infusion via epidural catheter, patient-controlled analgesia pumps (PCA) using narcotic agents, peripheral nerve blocks, local anesthetic infiltration, cryotherapy, and oral or parenteral narcotics alone or in combination with the above techniques. The recent release of the parenteral nonsteroidal anti-inflammatory agent ketorolac tromethamine has had widespread use and clinically appears to be an effective supplemental analgesic to the above techniques.

Several authors have reported favorable results using femoral nerve block (FNB) with bupivicaine in various clinical situations including the following: in the acute management of femoral shaft fractures in adults and children,[1-4] for perioperative analgesia[5] and anesthesia[6] for femoral neck fractures, and for the postoperative management of pain following open knee surgery.[7-13] This article reports significant variation in the technique, as well as in the agent administered.

In 1973, Winnie et al.[14] presented a description of the "three-in-one block" technique for providing anesthesia to the lower extremity. The femoral sheath is instilled with an anesthetic agent in sufficient volume (>20 mL) to block the femoral, lateral femoral cutaneous and obturator nerves are injected. Although there is some controversy in the literature as to whether this technique reproducibly anesthetizes the obturator[15] and lateral femoral cutaneous nerves, it does appear to provide significant analgesia following specific lower extremity procedures.[6-13]

No previous study has evaluated the effectiveness of FNB using a single injection paravascular technique following arthroscopically assisted anterior cruciate ligament reconstruction with autograft patellar tendon. We prospectively evaluated FNB in this setting using

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parenteral narcotic administration as an indicator of clinical efficacy. In addition, a retrospective questionnaire was administered after the perioperative period to evaluate individual patient experience with this technique. Because only the femoral nerve distribution was specifically assessed for anesthesia following block placement (i.e., obturator and lateral femoral cutaneous distributions were not tested), we elected to use the term femoral nerve block (FNB), rather than "three-in-one" nerve block, in this study.

MATERIALS AND METHODS

Twenty-five consecutive primary arthrocopically assisted ACL reconstructions using autograft middle one-third patellar tendon grafts were performed on 25 patients by a single surgeon (K.P.S.) between 12/15/92 and 7/19/93. One patient. who preferred to use his intraoperative epidural for postoperative analgesia, was excluded from the study. The remaining 24 patients comprised the study group where follow-up was obtained. There were 9 female and 15 male subjects between the ages of 16 and 41 years. Seventeen of the injuries were considered acute (operation within 3 months of injury) and 7 chronic. Ten meniscal procedures (I medial meniscus repair, 5 partial lateral meniscectomies, 2 partial medial meniscectomies, and 2 combined partial medial and lateral meniscectomy) were performed coincident with ACL reconstruction. The patients were anesthetized by general endotracheal anesthesia (21 patients), general mask (2 patients). and epidural (1 patient). No procedures were "same day surgery."

After appropriate anesthesia was administered, anteromedial and anterolateral portals were fashioned for arthroscopy after injection with a 1:1 mixture of 0.25% bupivicaine without epinephrine and 1% lidocaine with epinephrine (1:100,000). Fifty milliliters of this mixture was injected intraarticularly before the incision was made as described by Weiker et al.[9] All patients had an autogram middle-third patellar tendon XCL reconstruction with a two-incision technique using an Acufex (Acufex Microsurgical, Inc.. Mansfield, CIA) rear-entry guide system. A medial parapatellar skin incision was used for isolation of the middle-third patellar tendon graft, and a small lateral incision was used for drilling the femoral tunnel using "outside-in" technique. A tourniquet was used in all cases and two drains were placed at the end of each procedure. Upon completion of the operation, all operated knees were placed in an Air Cast cryocuff (Air Cast. Summit. NJ) and knee immobilizer before transfer to the recovery room.

Informed consent was obtained by the anesthesia Acute Pain Service for FNB placement. Following completion of the reconstructive procedure, the groin region of the operative side was prepared with betadine and draped with sterile linen. The femoral artery was palpated just inferior to the inguinal ligament and a 22-gauge insulated needle (Stimex: Becton, Dickinson, and Co., Franklin Lakes, NJ) was inserted lateral to the arterial pulse. Nerve stimulation was used to elicit a strong quadriceps twitch at a level of 0.5 mA or less, confirming needle placement within the femoral sheath. An injection of 0.5% bupivicaine with epinephrine (1:200,000) was administered in a dose ranging from 2 to 3 mg/kg.

All patients were placed on a similar postoperative analgesia protocol. Standard postoperative pain orders included "as needed" administration of intramuscular ketorolac tromethamine (Toradol; Syntex Laboratories, Inc., Palo Alto, CA) and oral narcotic preparations (acetaminophen with hydrocodone or oxycodone). Parenteral narcotics were to be used only in cases of failure of the nerve block and supplemental analgesia. The time, route, and dose of all analgesics administered were recorded. Prcoperatively, patients were counseled in general terms regarding the use of FNB as an analgesic supplement. To avoid the introduction of potential biases, no formal discussion was made with patients regarding alterations in postoperative analgesic protocols or expected patterns of analgesic usage. The patients were mobilized within 24 hours of surgery and were instructed in the USC of crutches and a standard set of exercises by the physical therapy staff. No attempt was made to standardize the time of discharge. Upon discharge. the patients were given a prescription for an acetaminophen/hydrocodone oral preparation.

RESULTS

Twenty-three nerve blocks were placed postoperatively in patients who were awake in the Post Anesthesia Care Unit (PACU) and one in the operating room upon completion of the operation. The average time from the end of the operation to placement of the block was 50 minutes (range, 10 to 104 minutes). Parenteral analgesic use in the PACU before and after FNB is compared in Table I Nine patients required narcotics or ketorolac before block placement. No parenteral narcotics were administered in the PACU following placement of the block. Five (21%) patients received

TABLE 1. *Postoperative Anesthesia Care Unit Parenteral Medications Administered Pre- and Post-Femoral Nerve Blockade*

	Pre-FNB		Post-FNB	
	Narcotics	Ketorolac	Narcotics	Ketorolac
Yes	6 (25%)	5 (21%)	0 (0%)	5 (21%)
No	18 (75%)	19 (79%)	24 (100%)	19 (79%)

ketorolac following block placement. including one patient who had received narcotics before FNB. Forty-six percent of patients required no supplemental analgesia in the PACU before or after block placement.

All patients were admitted to the orthopaedic ward postoperatively. Only two patients 18%) received parenteral narcotics after transfer from the PACU. The first patient, although documented as initially receiving significant relief following FNB, required multiple injections of morphine sulfate and meperidine beginning 3 hours postoperatively. A second patient received morphine sulfate by patient controlled analgesia pump (PCA) for approximately 7 hours. beginning 16 hours after block placement. He was discharged home on an oral narcotic preparation the morning following surgery

Pain in the remainder of patients was adequately controlled with combinations of parenteral ketorolac and ral narcotic derivative/APAP preparations (Table 2). Twenty-five percent of patients required only oral preparations (oxycodone/APAP or hydrocodone/APAP) after discharge from the PACU. An additional four patients received only a single dose of parenteral ketorolac in addition to oral preparations following discharge from the PACU (Table 3). Thus. 42% of patients required zero or one dose of non-narcotic analgesic via a parenteral route after leaving the recovery room

Blood levels of bupivicnine following FNB placement were observed in a small sample of our patient population (n = 3; 1 2%). Peak serum levels averaged 1.04 μg/mL (range. 0.884 to 1.20) and were seen between 1 and 1.5 hours post injection. It has been suggested that toxicity occurs in milder forms with serum levels as low as 1.6 μg/mL,[17] with more severe side effects at levels exceeding 2.3 μg/mL[17] and 4 μg/mL. [23] However, several studies have reported levels between these values without toxic symptoms."[23]

All patients were contacted by phone regarding their postoperative experience. Data collected from the telephone interview is summarized in Table 3. The average perceived duration of significant relief from FNB was 29 hours (range, 0 to 3.5 days). Twenty-three of 24 patients (95%) believed FNB to be "very" (n = 21) or "somewhat" (n = 2) beneficial and would request another nerve block if undergoing a similar surgical procedure in the future. The only patient who declined was considered to have a "failed" block attempt, having required significant doses of parenteral narcotics beginning approximately 3 hours from the time of FNB placement. Interestingly. one patient who responded "somewhat beneficial" to this question used no supplemental pain medications during the entire hospital course.

The average time of hospitalization was 1.8 days with 7 discharges on postoperative day one, 14 on day two, and 3 on day three. All patients were retrospectively questioned regarding the possibility of earlier discharge. A majority of patients believed that they could have comfortably been discharged earlier (Table 3). Three of the five patients declining early discharge reported pain as a factor in their decision. The two who did not have significant pain cited a general feeling of "weakness" and "dependence" as the main factors. Most patients experienced adequate pain relief from oral narcotic preparations following discharge (Table 3).

Two minor complications occurred, with no apparent evidence of more serious local or systemic side effects. Two patients developed a mild contact dermatitis at the site of injection, presumably secondary to the local preparation in the groin region. Two patients (both of whom underwent general anesthesia) experienced urinary retention requiring limited catheterization in the immediate postoperative period.

DISCUSSION

FNBs and three-in-one nerve blocks have been used for lower extremity anesthesia and analgesia under a variety of operative and nonoperative conditions. Although a majority of reports in the literature have described favorable results, variability in operative/injury site. operative procedure. technique of FNB administration, type and concentration of anesthetic. and fixed

TABLE 2. *Inpatient Pain Control Medications*

	Parenteral		
	Narcotics	Toradol	Oral Narcotics
Yes	2 (8%)	18 (75%)	22 (92%)
No	22 (92%)	6 (25%)	2 (8%)

TABLE 3. *Subjective Analysis of Femoral Nerve Block*

Another*	Beneficial†	Possible D/C‡	Oral Meds§	Duration//
Yes = 96%	Very = 88%	SD = 33%	None = 13%	Avg = 29 h
No = 4%	Somewhat = 8%	ND-AM = 46%	Adequate = 71%	Range = O-84 h
	Not = 4%	Other = 21%	Marginal = 8%	
			Inadequate = 84	

Abbreviations: SD. same day; ND. next day: AM, other.
* would you have another FNB?
† Is the FNB beneficial?
‡ When would you be able to be discharged'?
§ Efficacy of oral meds following discharge.
// Recall of subjective duration of pain relief.

versus per weight dosing make it difficult to extrapolate data and compare results. However, these reports have provided us with useful information regarding the general effectiveness, or ineffectiveness, of' various methods and means of FNB administration.

Lynch et al.' studied 208 patients who received intermittent femoral nerve blockade using an indwelling catheter following ACL reconstruction (operative technique not specified). They concluded that this technique provide; ''safe and reliable analgesia, improves patient mobility. has a high patient acceptance and [reduces: systemic analgesic demand following [ACL] repair." Edwards and Wright' reported similar results using continuous bupivicaine infusion via an indwelling catheter following total knee replacement, reporting decreased opiate requirements and lower pain scores in the first 24 hours. Hord et al.[8] reported significantly &creased pain scores in the first 24 hours following continuous block administration after primary total knee arthroplasty. Total morphine use by PCA. as well as pain scores on the second postoperative day. did not differ- significantly when compared with controls. Ringrose and Cross"' prospectively compared "blocks:" and "unblocked" patient groups following ACL reconstruction (unspecified operative procedure) and found a significant difference in narcotic use among patients receiving FNB. A study by Matheny et al.[13] comparing PCA and continuous lumbar plexus block LPB) following ACL reconstruction, found that patients receiving LPB used "dramatically" less parenteral narcotic and had significantly fewer narcotic-associated side effects.

In contrast to these positive results, Tierney et al." used 20 mL of 0.25% plain bupivicaine to effect an FNB following "knee ligament reconstruction" (unspecified procedure). They found that narcotic requirements were reduced in the recovery room and that time to first narcotic dose was prolonged in the study group. However, they did not find a significant difference in the total dose of narcotic used by the FNB group overall. No serious complications were reported in these series, as in our series.

The systemic toxic side effects of bupivicaine for local or regional anesthesia are well described. In addition, there have been sporadic reports of more localized complications. including transient and prolonged femoral nerve palsy following injection of "safe" doses of anesthetic for femoral and three-in-one nerve blocks.[24-27] Signs of' toxicity include central nervous system reactions (including nausea, vomiting, chills, restlessness, anxiety, dizziness, blurred vision, tremors, and seizures) and cardiovascular system reactions (including myocardial depression, diminished cardiac output, hypotension, bradycardia, heartblock, and ventricular dysrhythmias), as well as rare signs of local and systemic hypersensitivity. The more severe central nervous system and cardiovascular side effects are usually associated with higher plasma concentrations possibly related to accidental intravenous or arterial administration. unusually rapid uptake from the site of administration, decreased degradation, or excessive administration. Several studies have reported safe and effective administration for peripheral nerve block using doses that exceed the recommended 2 mg/kg[19]* Misra et al.'" administered 0.5% bupivicaine with epinephrine (1:200,000) at 3 mg/kg for Femoral three-in-one combined with sciatic nerve block for lower extremity surgery, achieving concentrations of up to 2

*In countries other than the United States. the dosage of 0.25% and 0.5% concentrations of bupivicaine is 2 mg/kg, with the maximum of 100 mg without epinephrine and 150 mg with epinephreine 1:200,000. In the United States, maximum doses of such concentrations have not been determined, and the package insert states: (a) 'Most experience to date is with single doses of Marcaine up to 225 mg with epinephrine 1:200,000, and 175 mg without epinephrine; more or less drug may be used depending on the individualization of each case;' and (b) 'In clinical studies to date. total daily doses have been up to 400 mg. Until further experience is gained, this dose should not be exceeded in 7-I hours.

μg/mL. Moore et al.[27] administered up to 400 mg (6 to IO mg/kg) bupivicaine with epinephrine (1:320,000) for sciatic. femoral, and lateral femoral cutaneous nerve blocks, achieving levels of up to 3.16 μg/mL. Robison et al." found that peak plasma concentrations were significantly diminished in patients receiving anesthetic containing epinephrine. No systemic side effects were reported in these studies.

By evaluating the available historical data, as well as our own clinical experience, we attempted to design our FNB protocol based on factors that appear to be important in obtaining consistent, effective, and durable analgesia. These include an anatomic approach to the femoral triangle, the use of a nerve stimulator to isolate the optimal injection site, and a per weight dose of a 0.5% bupivicaine preparation containing epinephrine. Previous studies. as well as our complication profile and serum level determinations, suggest that safe and effective analgesia can be achieved with up to 3 mg/kg of 0.5% bupivicaine with 1:200,000 epinephrine. Using FNB. with ketorolac tromethamine and oral narcotic analgesics as supplements, we have essentially eliminated the need for narcotic use via the parenteral route. This combination has provided a highly effective means of controlling postoperative pain following the operative procedure described. It is associated with a high degree of patient approval (95%). favorable complication profile, and low rate of failure (8%). Although not specifically evaluated in this study, there appears to be less association with the undesirable side effects of parenteral narcotics, such as sedation. nausea, and generalized malaise. In our experience, patients appear to tolerate the postoperative period better and seem to mobilize more readily than when parenteral narcotics are used as the primary means of' pain control. Subjective data collected demonstrate that patients should tolerate earlier discharge using this protocol. If effectively used in this manner, cost savings can ultimately be realized, especially with the utilization of day surgery centers for ACL reconstruction. We have subsequently evaluated these savings in a prospective study.[28]

Our use of ketorolac for breakthrough pain has probably improved our results in a favorable way: to what degree cannot be determined in this study. We will continue to use it in our protocol because it appears to provide acceptable supplemental analgesia without the undesirable side-effects of parenteral narcotics. Although no obvious toxicity resulted from our use of ketorolac, a spectrum of side effects ranging from the more common gastrointestinal complaints associated with other nonsteroidal anti-inflammatory drugs to other more severe toxicities in the gastrointestinal, cardiovascular, hematologic, nervous, renal, and hepatic systems. Hypersensitivity has also been reported. We do not regularly use parenteral ketorolac for longer than 5 days' duration or the oral preparation for larger than 1 to 2 weeks secondary to a reported increased incidence of associated side effects.

By eliminating parenteral narcotic use as an indicator of success, we have outlined a protocol for the safe, effective, and reliable administration of FNB for ACL reconstruction. We are currently using this technique with good clinical results on patients undergoing ACL reconstruction using patellar tendon or hamstring and following patellar realignment using the modified Elmslie-Trillat procedure. Prospective studies are currently underway evaluating the usefulness of FNB following outpatient ACL reconstruction, and as the primary anesthetic during routine arthroscopy.

We have shown that blockade of the femoral nerve, when administered using the described technique. can provide a reliable, safe, and effective alternative form of analgesia in the immediate postoperative period following ACL reconstruction. The complication profile and patient tolerance for this procedure are excellent. With successful FNB, parenteral narcotic administration is eliminated and patient pain relief is excellent. FNB is a valuable adjunct to ACL reconstruction surgery.

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