An Original Study

Use of Femoral Nerve Blocks in Adolescents Undergoing Patellar Realignment Surgery

Scott J. Luhmann, MD, Mario Schootman, PhD, Perry L. Schoenecker, MD, J. Eric Gordon, MD, and Charles Schrock, MD

Abstract

The purpose of this study was to analyze the efficacy of femoral nerve blocks (FNBs) in decreasing postoperative narcotic use in adolescents undergoing patellar realignment surgery (PRS). All patients who underwent PRS at 2 children's hospitals between 1998 and 2002 were included in the study. Patients were grouped according to postoperative analgesia: FNB (n = 14), as-needed intravenous morphine (PRN-IV; n = 16), or patient-controlled analgesia using morphine (PCA; n = 13). Total postoperative IV morphine use was statistically significantly different among the 3 groups: 9.0 mg for FNB, 26.43 mg for PRN-IV, and 64.7 mg for PCA. FNB use was effective in significantly decreasing postoperative IV narcotic use.

Pain management in hospital and outpatient settings has been garnering increased attention and interest over the past decade. Postoperative pain management has evolved from simple intramuscular administration of narcotics to more multimodal regimens using narcotics (intravenous [IV], oral, intrathecal, intra-articular, transdermal), nonsteroidal anti-inflammatory drugs (NSAIDs, both oral and IV), and local anesthetics (eg, subcutaneous, regional, epidural, caudal, intrathecal, intra-articular). Use of regional techniques, using narcotics and local anesthetics, permits more focal treatment of the painful stimulus, thereby decreasing the unwanted systemic effects of narcotics and NSAIDs—such as central nervous system depression, respiratory depression, and gastrointestinal (GI) intolerance. Many different regional techniques have been advocated for managing lower extremity pain caused by injury or surgery: intra-articular injections (bupivicaine, morphine), femoral/sciatic nerve blocks, femoral/sciatic/obturator nerve blocks, femoral/lateral femoral cutaneous nerve blocks, intermittent and continuous femoral nerve blocks (FNBs) by catheter, 1-shot and continuous "3-in-1" blocks, and lateral femoral cutaneous nerve blocks.[1-17]

In 1973, Winnie and colleagues[18] first described the 3-in-1 block of the femoral, obturator, and lateral femoral cutaneous nerves for lower extremity anesthesia. Since then, others have recommended using FNBs and 3-in-1 blocks for decreasing postoperative pain and narcotic use in anterior cruciate ligament reconstructions (ACLRs), femoral neck and middle-third femur fractures, total knee arthroplasty, knee arthroscopy, and open knee surgery.[7,13,17,19-31] At our institution, use of FNBs and 3-in-1 blocks in ACLRs has significantly improved postoperative pain management. Our positive experience with FNBs led to their application in patellar realignment surgery (PRS). To date, no investigators have reported use of FNBs in PRS. The purpose of this study was to analyze the efficacy of FNBs in decreasing postoperative narcotic use in adolescents undergoing PRS.

Materials and Methods

This study was conducted at 2 tertiary-care children's hospitals, St. Louis Children's Hospital and Shriner's Hospital for Children, both in St. Louis, Missouri. We conducted a medical record search to identify all patients who underwent PRS at these hospitals between January 1, 1998, and December 31, 2002. In our analysis, we included patients whose surgery consisted of lateral retinacular release, medial retinacular imbrication, and tibial tubercle osteotomy and excluded patients who had previous PRS on the ipsilateral knee or had a concomitant neuromuscular disorder.

Dr. Luhmann is Assistant Professor, Department of Orthopaedic Surgery, Washington University School of Medicine, St. Louis, Missouri, and Assistant Professor, Pediatric Orthopedics, St. Louis Children's Hospital, St. Louis, Missouri.
Dr. Schootman is Associate Professor, Division of Health Behavioral Research, Washington University School of Medicine, St. Louis, Missouri.
Dr. Schoenecker is Professor, Department of Orthopaedic Surgery, Washington University School of Medicine, St. Louis, Missouri, and Acting Surgeon In-Chief, Pediatric Orthopedics, St. Louis Children's Hospital, St. Louis, Missouri.
Dr. Gordon is Associate Professor, Department of Orthopaedic Surgery, Washington University School of Medicine, St. Louis, Missouri, and Director of Clinical Services, Pediatric Orthopedics, St. Louis Children's Hospital, St. Louis, Missouri.
Dr. Schrock is Assistant Professor, Department of Anesthesiology, Washington University School of Medicine, St. Louis, Missouri.

Requests for reprints: Scott J. Luhmann, MD, St. Louis Children's Hospital, One Children's Place, Suite 4S20, St. Louis, MO 63110 (tel, 314-454-2045; fax, 314-454-4562; e-mail, luhmanns@wustl.edu).

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Table I. Patient Demographics

Analgesia Group*	Mean Age (Range), y	Sex	Side	Weight (Range), kg	Previous Ipsilateral Knee Surgery
FNB	14 (12-18)	2 M, 12 F	7 R, 7 L	68.3 (41-98)	1/14
PRN-IV	15.4 (12-17)	4 M, 12 F	8 R, 8 L	74.3 (48-129)	0/16
PCA	15.3 (12-18)	1 M, 12 F	7 R, 6 L	73.0 (54-109)	2/13

*FNB, femoral nerve block; PRN-IV, as-needed intravenous morphine; PCA, patient-controlled analgesia using morphine.

Table II. Ketorolac and Gastrointestinal Problems

Postoperative Analgesia Group*	Ketorolac Use (%)		Nausea & Vomiting (%)
	Intraoperative	Postoperative	
FNB (n = 14)	86	21	46
PRN-IV (n = 16)	81	25	50
PCA (n = 13)	77	46	38

*FNB, femoral nerve block; PRN-IV, as-needed intravenous morphine; PCA, patient-controlled analgesia using morphine.

Thirty-seven patients (43 knees) satisfied the inclusion criteria. Mean age at time of surgery was 14.9 years (range, 12-18 years). Demographic data showed no group differences in age, sex, side involved, weight, or previous knee surgeries (Table I). Patients were placed into 1 of 3 groups according to type of postoperative analgesia: FNB (n = 14), as-needed IV morphine (PRN-IV; n = 16), or patient-controlled analgesia using morphine (PCA; n = 13). Patients' postoperative pain management was ordered by attending surgeons according to their preferences.

Reviewing inpatient medical records, we paid particular attention to intraoperative analgesics, surgery duration, tourniquet duration, time in operating room suite, and time in postanesthesia care unit (PACU). Postanesthetic use of narcotics—IV and oral, including all analgesics administered in the PACU and in the inpatient unit—was quantified. Morphine sulfate was the primary IV narcotic for immediate postoperative pain management. Total milligrams of morphine were determined for each patient during in-hospital stay. Meperidine was occasionally administered in the PACU for additional pain control; to account for its effect in pain management, we considered meperidine 10 mg equivalent to morphine 1 mg. The groups did not differ significantly in amount of meperidine used (mean 300 mg total in each group). Patients were converted to oral analgesics, either oxycodone/acetaminophen or hydrocodone/acetaminophen, as pain and GI status permitted. Dose and quantity of oral analgesic tablets were recorded. Ketorolac was commonly used intraoperatively but was not routinely given as part of postoperative pain management (Table II). Use of analgesics after hospital discharge was not quantified. A validated pain scale was not used as a measure in this retrospective analysis, as its routine clinical use, in documented form, was instituted only near the end of the study period.

All FNBs and 3-in-1 blocks were administered by a pediatric fellowship–trained anesthesiologist in the operating room suite. All blocks were completed with assistance of a nerve stimulator by perivascular approach, and all patients were under general anesthesia during block placement.[32] Bupivacaine 0.25% (mean volume, 25 cm^3) was injected under sterile technique. Overall, 50% of the FNBs were administered before the surgical procedure, the other 50% immediate after the procedure was completed. There were no documented FNB complications, and no local anesthetic agents were used at the knee during surgery. After surgery, all patients had access to IV and oral pain medications as needed.

Analysis of variance (ANOVA) was used to compare the 3 groups (FNB, PRN-IV, PCA) in mean morphine use (intraoperative, postoperative, PACU, total), mean total narcotic amount, mean number of doses of oral narcotic, and mean number of postoperative days in hospital. Pairwise comparisons of the 3 groups were based on the Tukey post hoc calculation of the 95% confidence intervals of the difference between the means of both groups. As the analyses were based on relatively few patients in each group, and some of the assumptions on which ANOVA is based may not hold, we also used the Kruskall-Wallis nonparametric test. The results were identical. All statistical analyses were performed with SAS (Version 8.02; SPSS Inc, Chicago, IL) with $P<.05$ considered statistically significant.

Results

Mean intraoperative IV morphine use was 1.4 mg for FNB, 6.4 mg for PRN-IV, and 7.5 mg for PCA (Table III). Data analysis demonstrated a statistically significant difference between the FNB group and each of the other groups (PRN-IV, PCA). The difference between the PRN-IV and PCA groups was not significant. In the PACU, mean morphine use was 3.8 mg for FNB and 5.1 mg for both PRN-IV and PCA. Between-group differences were not statistically significant. Mean total postoperative IV morphine use (PACU plus

Table III. Narcotic Use

Narcotic	Postoperative Analgesia Group* FNB	PRN-IV	PCA
Intraoperative morphine (mg)	1.4	6.4	7.5
Postanesthesia care unit morphine (mg)	3.8	5.1	5.1
Postoperative intravenous morphine (mg)	7.6	19.9	57.2
Total intravenous morphine (mg)	9.0	26.3	64.7
Oral narcotic (no. of tablets)	6.2	8.4	10.5
Oral narcotic (no. of doses)	3.4	4.3	5.9

*FNB, femoral nerve block; PRN-IV, as-needed intravenous morphine; PCA, patient-controlled analgesia using morphine.

Table IV. Operative Time and Perioperative Time

Mean Time (min)	Postoperative Analgesia Group* FNB	PRN-IV	PCA
In operating room suite before incision	35	30	29
Duration of procedure	97	93	105
Duration of anesthesia	141	134	141
Duration of tourniquet	79	79	89
In postanesthesia care unit	73	87	90

*FNB, femoral nerve block; PRN-IV, as-needed intravenous morphine; PCA, patient-controlled analgesia using morphine.

inpatient care) was 7.6 mg for FNB, 19.9 mg for PRN-IV, and 57.2 mg for PCA. There was a statistically significant difference between the PCA group and each of the other groups (FNB, PRN-IV) but no difference between the FNB and PRN-IV groups. To negate the effect of longer inpatient stays on narcotic use, we quantified IV morphine use over the first 24 postoperative hours: 8.4 mg for FNB, 8.1 mg for PRN-IV, and 42.0 mg for PCA. In the first 24 hours, there was a statistically significant difference between the PCA group and each of the other groups (FNB, PRN-IV). Total IV morphine use during hospital stay (intraoperative plus postoperative) was 9.0 mg for FNB, 26.3 mg for PRN-IV, and 64.7 mg for PCA. When total IV narcotic use was analyzed, statistically significant differences were detected among all 3 groups ($P<.05$). Postoperative assessment revealed no clinical failures of FNB in any patient.

Only after postoperative pain was under control with IV narcotics were patients converted to oral narcotics (oxycodone/acetaminophen or hydrocodone/acetaminophen), and then only if the patients could tolerate the oral narcotics (Table III). Mean oral narcotic use was 6.2 tablets for FNB, 8.4 tablets for PRN-IV, and 10.5 tablets for PCA. Only the difference between the FNB and PCA groups was statistically significant. Mean number of oral narcotic doses was 3.4 for FNB, 4.3 for PRN-IV, and 5.9 for PCA. Again, the only statistically significant difference was between the FNB and PCA groups.

Total documented use of narcotics after surgery is directly influenced by length of inpatient hospital stay, as postdischarge narcotic use was not quantified. Mean overall length of stay for patients managed with postoperative PCA was 2.1 days—significantly different from the 1.1 days for FNB and the 1.3 days for PRN-IV ($P<.05$); there was no difference between the FNB and PRN-IV groups. The 3 groups were similar on the other parameters measured: intraoperative tourniquet duration, procedure duration, time from entering operating room to start of procedure, duration and type of general anesthesia, and time in postoperative recovery unit ($P>.05$; Table IV). The common postoperative complication of nausea and vomiting was similar among the groups (Table II).

Discussion

Since they were originally described, FNBs and 3-in-1 blocks have been reported to be effective in decreasing pain and narcotic use after injury or surgery in the anatomical area from the hip joint (femoral neck fracture) to the proximal tibia (knee arthroplasty and ACLR).[5,7-9,19,20,23,25,31,33] When Winnie and colleagues[18] originally described 3-in-1 blocks, they attributed their effects to direct anesthesia at the level of the lumbar plexus. However, magnetic resonance imaging of local anesthetic after placement of 3-in-1 blocks has not been able to document cephalad spread from the injection site within the femoral sheath to the lumbar plexus.[34] In addition, the lack of the 3-in-1 block to anesthetize the parent trunk of the obturator nerve and the proximal and posterior portions of the obturator nerve indicates that its mechanism of action is the result of local infiltration and spread of the anesthetic to all 3 nerves in the inguinal region.[34,35]

Winnie and colleagues[18] emphasized that a minimum of 20 cm^3 of local anesthetic must be infused to obtain proper analgesia of all 3 nerves. Hence, a main difference between FNB and 3-in-1 block is volume of local anesthetic injected. As all patients in our study received a minimum of 20 cm^3 (mean, 25 cm^3) of bupivacaine 0.25%, the implication is that all our patients received 3-in-1 block.

Preemptive analgesia (application of block before incision) has been touted as an important reason for the effectiveness of a regional anesthetic for postoperative pain management. However, preincisional FNB/3-in-1 block, compared with postsurgical injection, has been reported only to lower pain scores and mean IV morphine consumption in the PACU and not to have other, more long-acting benefits.[36] In our data analysis, we could not identify any difference in narcotic use in the PACU, but a difference was detected intraoperatively—most likely attributable to the anesthesiologist's knowing which patient had an adjunctive regional anesthesia. In this study, only 50% of patients had the FNB placed before surgery. A larger difference in narcotic use might have been identified, both intraoperatively and in the PACU, had all patients received their blocks preemptively, before surgical incision. In addition, there was no correlation of intraoperative narcotic administration to narcotic use in the PACU.

Compared with the PCA group, the FNB and PRN-IV groups used statistically less postoperative IV narcotics (PACU plus inpatient stay), but, interestingly, we could not detect a difference between the FNB and PRN-IV groups, though their mean narcotic use was 7.6 mg and 19.9 mg, respectively. The small group sizes in our study limited our ability to find statistically significant differences; larger group sizes would likely have achieved statistical significance. However, when total morphine use, specifically intraoperative and postoperative use, was analyzed, a statistically significant difference was detected among all 3 groups. Hence, FNB was effective in decreasing overall need for IV narcotics when compared with the other, more standard pain management regimens. The effectiveness of FNB was also demonstrated by the fact that 3 (21%) of the 14 patients who received FNB in our series did not receive any IV morphine, intraoperatively or postoperatively, during their hospital stay.

Mean duration of the effect of FNB has been reported to be as short as 6.5 hours and as long as 35 hours.[1,19,24,25,28] Our clinical experience is that most blocks are effective for 12 to 18 hours. As evidenced by the FNB group's postoperative IV morphine use (7.6 mg in PACU and inpatient stay), most patients receive 1 or 2 doses of IV morphine before conversion to an oral narcotic. We could not demonstrate a lasting effect of the FNB as documented by lower oral narcotic use—which is similar to the findings of Mulroy and colleagues[25] and Peng and colleagues[27] but contrasts with other findings, of more lasting analgesic effects.[19,20,26,28,30,31] Our study was limited in that it could not discern this effect because of the retrospective nature of the study and its lack of quantitative pain assessment measures.

An interesting finding of our study is that PCA use increased length of hospital stay for the FNB and PRN-IV groups from a mean of 1 day to a mean of 2 days. Use of PCA requires special IV delivery systems, pharmacy-created carrier solutions, and nursing staff training. These systems are not inexpensive, and, more important, they can be considered treatment interventions, thereby prolonging their use. The longer inpatient stay can partly explain increased use of both IV morphine and oral narcotic use in the PCA group, as duration of monitored pain medication use increased from 24 to 48 hours on average. More pertinent for this study is the statistically significant difference in IV and oral narcotic use between the FNB and PRN-IV groups, which cannot be explained by the mean length of hospitalization.

There were no complications of FNB use in this series. The safety of properly administered FNBs has been documented in multiple published reports of no FNB complications.[1,5,7,8,15,19,25,27-30,33,37] Minor complications, local dermatitis and urinary retention, have occurred in up to 4% of patients.[20] Serious complications, such as intravascular or intraneural injection of the local anesthetic, can occur. With proper technique, local anesthetic plasma levels are well below the toxic threshold and reach a peak absorption level within 24 minutes after injection.[7,29] Use of bupivacaine 0.25% versus 0.5%, without epinephrine, can minimize plasma levels of local anesthetic and potential systemic toxicity while still delivering the desired anesthetic effect.[17,25,26]

Conclusions

Use of FNBs in adolescents undergoing PRS was effective in decreasing overall IV and oral narcotic use without negatively affecting other patient and surgical variables. This study provides the impetus for further prospective analysis of FNBs in PRS to better elucidate the potential benefits in postoperative patient recovery.

Authors' Disclosure Statement and Acknowledgment

The authors report no actual or potential conflict of interest in relation to this article.

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