Clin Orthop Relat Res (2010) 468:135–140
DOI 10.1007/s11999-009-1025-1

SYMPOSIUM: PAPERS PRESENTED AT THE ANNUAL MEETINGS OF THE KNEE SOCIETY

Complications of Femoral Nerve Block for Total Knee Arthroplasty

Sanjeev Sharma MD, FRCSC, Richard Iorio MD, Lawrence M. Specht MD, Sara Davies-Lepie MD, William L. Healy MD

Published online: 13 August 2009

Abstract Preemptive and multimodal pain control protocols have been introduced to enhance rehabilitation after total knee arthroplasty (TKA). We determined the complication rate associated with preoperative femoral nerve block (FNB) for TKA. Among 1018 TKA operations, we performed 709 FNBs using a single-injection technique into the femoral nerve sheath and confirming position with nerve stimulation before induction. After TKA, weight-bearing as tolerated was initiated using a walker or crutches on postoperative Day 1. Twelve patients (1.6%) treated with FNB sustained falls, three (0.4%) of whom underwent reoperations. Five patients had postoperative femoral neuritis, which may have been secondary to the block. One patient had new onset of atrial fibrillation after FNB, and the TKA was postponed. Femoral nerve block before TKA is not a harmless intervention. We recommend postoperative protocols be modified for patients who have FNB to account for decreased quadriceps function in the early postoperative period, which can lead to falls.

Level of Evidence: Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Institutional research support was received from DePuy (Warsaw, IN). One author (WLH) is a designer surgeon/consultant for DePuy. Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

S. Sharma, R. Iorio (✉), L. M. Specht, S. Davies-Lepie, W. L. Healy
Department of Orthopaedic Surgery, Lahey Clinic Medical Center, 41 Mall Road, Burlington, MA 01805, USA
e-mail: Richard.Iorio@lahey.org

Introduction

Multimodal and preemptive analgesia protocols for TKA have been effective in decreasing requirements for narcotic medications in the early postoperative period. These pain control protocols are associated with decreasing adverse side effects of intravenous narcotic medication such as nausea, vomiting, hypotension, respiratory depression, and constipation [3, 4, 8, 17, 18], which can slow down rehabilitation [10, 16]. Optimal postoperative analgesia can lead to early mobilization, ambulation, and return to a normalized gait pattern. Prevention of arthrofibrosis is accomplished with early maximization of range of motion [5, 13, 22].

Single-shot femoral nerve block is reportedly effective in reducing pain and accelerating rehabilitation after TKA [19, 21]. The risk of peripheral neuropathy after femoral nerve block has been estimated to be approximately three in 10,000 [2]. However, there is limited information concerning complications associated with femoral nerve blocks and TKA [7, 19, 21]. Singelyn et al. compared femoral nerve block, epidural anesthesia, and patient-controlled anesthesia [19]. There was a considerable decrease in urinary retention in patients who were treated with femoral nerve block. Toftdahl et al. compared peri- and intraarticular analgesia with femoral nerve block [21]. There was no difference with respect to nausea, vomiting, and dizziness.

We therefore hypothesized patients with femoral nerve block for postoperative analgesia after TKA would have decreased length of stay, a decreased number of postoperative complications, and an accelerated rehabilitation leading to earlier range-of-motion maximization, decreased arthrofibrosis, and earlier mobilization than patients not receiving femoral nerve block.

Patients and Methods

From our database we identified and retrospectively reviewed the medical records of all 970 patients with primary, bilateral, and revision TKAs performed between January 1, 2005, and December 31, 2007. Seven hundred fifty-seven TKAs in 729 (75%) patients were treated with a preoperative femoral nerve block. The patients were divided into two groups: those who received a femoral nerve block (FNB, n = 729) and those who did not (non-FNB, n = 241). Selection of patients for FNB was at the discretion of the anesthesiologist. Data on all patients undergoing total joint arthroplasty are collected on a prospective basis as part of our institutional joint registry database. The hospital charts of patients, morbidity and mortality round minutes, and the registry were reviewed to identify patients in whom an operative or perioperative complication occurred secondary to the FNB. The preoperative characteristics of both groups were similar (Table 1), including the mean body mass index (32.1 kg/m^2 in the FNB group and 32.5 kg/m^2 in the non-FNB group). The minimum followup was 12 months (mean, 24 months; range, 12–36 months). No patients were lost to followup. Approval from the Institutional Review Board was obtained before undertaking this study.

Patients diagnosed with pneumonia had a documented postoperative diagnosis of pneumonia recorded in their postoperative codes resulting in an extended infection stay beyond the usual 4- to 5-day hospitalization. Neuralgia or neuritis was diagnosed based on electromyography/nerve conduction test studies documenting abnormality with motor or sensory changes in the femoral nerve more than 3 months after FNB and TKA. Additionally, clinical presentation, physical examination, and patient history confirmed femoral neuropathy/neuritis symptoms in the affected extremities. Symptoms such as extreme quadriceps weakness (giving way of the affected extremity) and severe burning, irritation, or neurologic discomfort in the anterior thigh were causes for further neurologic workup, including electromyography/nerve conduction tests.

The anesthesiologist performed FNB after obtaining informed consent. Patients were monitored using electrocardiogram, pulse oximetry, and an automated blood pressure cuff. Oxygen was supplied by a nasal cannula or face mask. Patients were sedated with 1 to 2 mg midazolam ± 50 μg fentanyl. The groin and knee on the operative side were exposed, and the groin was prepped with chlorhexidine or Betadine (Purdue Pharma, Stamford, CT). A 2-inch, 21-gauge Stimuplex needle (B. Braun Medical Inc, Bethlehem, PA) with a Stimuplex nerve stimulator is used to locate the femoral nerve. The Stimuplex needle was attached to the nerve stimulator and flushed with local anesthetic solution. Using a sterile technique, the femoral artery was palpated and the Stimuplex needle was introduced lateral to the pulsation of the femoral artery. The assistant repeatedly attempted aspiration on the local anesthetic syringe to identify inadvertent intravascular needle placement.

The nerve stimulator was set at 1 to 1.5 mA and the needle advanced until twitching of the muscles of the thigh was observed. The needle was directed deep and then lateral until twitching in the quadriceps femoris was observed, usually accompanied by upward movement of the patella. In obese patients, it was sometimes necessary to palpate the thigh to appreciate muscle twitch. The nerve stimulator current was decreased while the twitch was observed trying

Table 1. Study population

Variable	Femoral nerve block	No femoral nerve block	p Value
Number of knees	757	261	
Number of patients	729	241	
Age (years)	68.9 (range, 31–101)	68.0 (range, 40–90)	0.264
Gender			
Male	301 (41.3%)	110 (45.6%)	0.259
Female	428 (58.7%)	131 (54.4%)	
Charnley class			
Unilateral	137 (24.5%)	51 (28.3%)	0.673
Bilateral	317 (56.7%)	95 (52.8%)	
With disability	105 (18.8%)	34 (18.9%)	
Body mass index (kg/m^2)	32.1 (range, 14.2–87.1)	32.5 (range, 15.5–67.1)	0.403
Tourniquet time (minutes)	91.8 (range, 8–182)	95.58 (range, 44–174)	0.046
Postoperative temperature (°F)	97.7 (range, 94.2–100.9)	97.5 (range, 93.7–99.4)	< 0.01
Length of stay (days)	3.96 (range, 2–21)	4.31 (range, 2–24)	0.058
Patients discharged to rehabilitation hospital	523 (71.74%)	176 (73.03%)	0.741

Table 2. Complications

Complication	Block	No block	p Value
Deep venous thrombosis	8 (1%)	1 (0.4%)	0.465
Pulmonary embolus	5 (0.7%)	2 (0.8%)	0.686
Atrial fibrillation	5 (0.7%)	1 (0.4%)	1.0
Ileus	2 (0.3%)	2 (0.8%)	0.259
Renal failure	2 (0.3%)	1 (0.4%)	0.576
Arthrofibrosis	2 (0.3%)	4 (1.5%)	0.036
Pneumonia	2 (0.3%)	4 (1.5%)	0.036
Fall	12 (1.6%)	1 (0.4%)	0.204
Reoperations	3 (0.4%)	0 (0%)	1.0
Femoral neuropathy/neuritis	5 (0.7%)	1 (0.4%)	1.0
Other complications	10 (1.4%)	5 (2.1%)	0.546
Total	56 (8.2%)	22 (9.1%)	0.495

to maintain a twitch at or below 0.5 mA; needle position was adjusted to achieve this.

Thirty to 40 mL of 0.5% ropivicaine or 0.5% bupivicaine (Naropin; AstraZeneca, Wilmington, DE) plus 1:200,000 to 1:400,000 epinephrine was injected in 5-mL aliquots while observing the heart rate and after asking the patient to report any altered mental status, tinnitus, or perioral numbness or tingling. The FNB usually takes at least 30 minutes to take effect and can last up to 24 hours. Decreased onset time can be achieved by adding 2 to 4 mg midazolam to the local anesthetic solution.

All total TKAs were performed using a midline skin incision with a medial parapatellar arthrotomy. All patients followed an inpatient clinical pathway that included early mobilization, continuous passive motion, and weightbearing as tolerated with a walker or crutches.

After discharge, we followed patients at 2 weeks, 6 weeks, 12 weeks, and 1 year postoperatively. Patients undergoing bilateral TKA were specifically examined to identify any increased complication risk.

Using a Fisher's exact test we compared the overall total number of complications between the two study cohorts as well as individual complications (Table 2). Major complications were listed individually and minor complications were listed as "other complications." We used SPSS Version 11.5 statistical system (SPSS, Chicago, IL) for all analyses.

Results

Length of hospital stay was similar between the two groups, but the FNB group had a decreased ($p = 0.058$) length of stay. The number of patients who required admission to a rehabilitation center after discharge from the acute care hospital was similar ($p = 0.741$). We observed similar percentages of complications in the two groups: 56 among the 729 patients (8.2%) who received a FNB and 22 (9.1%) among the 241 patients who did not receive a block (Table 2). A higher percentage ($p = 0.036$) of the non-FNB patients had arthrofibrosis than those with FNB (four of 241 versus two of the 729, respectively). Patients requiring manipulation under anesthesia underwent the procedure at an average of 52 days postoperatively (range, 28–84 days). All patients with arthrofibrosis underwent manipulation under anesthesia. Six patients developed postoperative pneumonia but more ($p = 0.036$) in the non-FNB group, four of 241 versus two of 729.

Thirteen patients had documented postoperative falls on the medical/surgical floor with similar percentages ($p = 0.204$ in the two groups; 12 of the 13 patients had a femoral nerve block preoperatively) (Table 2). All of the falls occurred within 48 hours of surgery. All three of the patients who underwent subsequent surgery for injuries had falls but there was no difference in the percentage of patients having reoperations between those without and with the block (0% and 0.4%, respectively). One patient sustained a disruption of the extensor mechanism along the medial arthrotomy (Patient 1, Table 3). He was brought to the operating room 1 week after the index procedure for

Table 3. Patient falls

Variable	Patient number													Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	
Femoral nerve block	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	13
Reoperation	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	3
Alcohol abuse	Yes	No	No	Yes	No	No	No	No	No	No	Yes	No	No	3
Quadriceps weakness	N/A	Yes	N/A	No	2/5	N/A	2/5	Yes	3/5	Yes	N/A	Yes	Yes	8
Confusion	Yes	No	Yes	Yes	No	No	No	No	No	Yes	No	No	No	4
Diabetes mellitus	No	No	Yes	No	No	No	No	No	No	Yes	No	No	No	2
Time	5:00	10:00	16:00	18:00	3:50	22:45	23:00	22:15	23:20	22:00	20:15	13:20	03:30	
Postoperative day	1	1	0	1	2	0	1	2	2	3	1	2	3	

N/A = not assessed.

revision of the arthrotomy closure. There were no further complications with this patient. Another patient sustained a medial collateral ligament (MCL) rupture and spin out of a rotating platform polyethylene liner (Patient 2, Table 3). The patient was brought back to the operating room for repair of the MCL and a conversion of a rotating platform TKA to a fixed-bearing tibial component. The third patient (Patient 3, Table 3) sustained a patella dislocation and rupture of the MCL. This patient was brought back to the operating room for primary repair of the MCL. Seven falls occurred before the end of the first postoperative day. Eight patients had documented quadriceps weakness before the fall, whereas four more patients fell on postoperative Day 1 before being formally assessed by the physiotherapy team. Four patients had documented confusion at the time of their fall.

Six patients experienced neuropathy/neuritis but there was no difference in percentages between the groups. The patient in whom a FNB was not performed had bilateral TKA performed under epidural anesthesia. The neuropathy resolved in four of the five patients receiving FNBs without further intervention. One patient receiving a FNB had residual sensory symptoms in the femoral nerve distribution 1 year after TKA.

Discussion

Femoral nerve blocks have been used in TKA to minimize postoperative discomfort and promote faster rehabilitation. The efficacy of FNB as part of a multimodal analgesic protocol has been well documented [1, 6, 11, 14, 20, 22]. Single-injection FNB is reportedly as effective for pain control as continuous infusion 3-in-1 FNB [8, 12]. Despite the literature confirming the efficacy of FNB and the increase in clinical use of FNB in TKA, there are little published data discussing complications associated with FNB. We therefore assessed the safety (as reflected by complications) of using an FNB on an unselected group of patients undergoing TKA. Additionally, we examined the length of stay, overall and specific complication rate, fall and reoperation rate, and neuralgia/neuritis rate of patients undergoing TKA with or without FNB.

There are several limitations to this study. First, it was not a prospective randomized study of patients undergoing TKA receiving FNB and the cohorts were retrospectively constructed. The data were, however, prospectively collected in patients undergoing FNB for postoperative analgesia after TKA. Patients undergoing TKA refusing FNB or anesthesiologists who would not perform FNB on some patients provided the control group. Second, there was no standardization for operative and anesthetic technique. Third, it is possible complications that occurred after patient discharge from the hospital would not have been captured in the review of the TKA patient records, morbidity and mortality conference records, and total joint arthroplasty database records. Fourth, we did not define the complications to be studied prospectively; therefore, there may be an underestimate of incidence in both groups. Finally, the surgeons were not involved in selecting the patients who received FNB for postoperative analgesia after TKA.

Wang et al. [22] reported patients with FNB had a shorter hospital stay than those who had not received an FNB. These findings were confirmed by Munin et al. [15]. We could not confirm a substantial reduction of hospital length stay for patients receiving FNBs before TKA. The mean length of stay for patients who received a FNB was reduced by 0.35 days.

Wang et al. also suggested patients with FNB will benefit from early ambulation and thus decrease their risk for postoperative deep venous thrombosis [22]. We found no difference in deep vein thrombosis or pulmonary embolism between patients who received a FNB and those who did not.

The overall rate of femoral neuropathy/neuritis in this cohort was 0.59%. Five patients (0.66%) receiving an FNB had neuropathy/neuritis. In all but one patient receiving FNB, the neurologic deficits resolved within 1 year of TKA. It is unclear if ultrasound guidance for the FNB or continuous infusion catheters would change the incidence of femoral neuritis/neuropathy after FNB. Further study is necessary to determine if the technique associated with the single-injection FNB is associated with the incidence of femoral neuritis/neuropathy. The reported incidence of femoral nerve palsy has been reported to be as low as three in 10,309 [2]. However, unlike our series in which none of the nerve injuries resulted in femoral palsy, more than half of patients with nerve injury in the series of Auroy et al. had residual symptoms 6 months after injury [2].

The incidence of arthrofibrosis requiring manipulation under anesthesia in patients who received an FNB was half of that in patients who did not receive a FNB (Table 2). Although the incidence was low in each group, 1.7% versus 0.3%, respectively, this finding suggests the decreased pain and accelerated range-of-motion maximization experienced by patients with FNB in the early postoperative period may be associated with a lower incidence of arthrofibrosis.

We observed a nonsignificant trend for a larger percentage of postoperative falls among patients who received a FNB. Further, while, patients who had femoral nerve blocks and falls tended to have more reoperations after their falls than patients who had falls without femoral nerve blocks this trend was not statistically significant (Table 2).

The numbers, however, are small, so there could be a Type II error.

Quadriceps weakness appears to be a contributing factor to the falls because 67% of the patients had documented weakness by the physiotherapist and four of the remaining patients fell before they could be examined by the physiotherapist on the first postoperative day. YaDeau et al. reported 29% of patients who received FNB had buckling because of decreased quadriceps strength, whereas only 3% of patients who did not receive FNB had buckling [23]. In that study, patients who had quadriceps weakness were delayed in ambulation training exercises. All patients had adequate quadriceps strength by postoperative Day 2. Quadriceps weakness may also be explained by the finding that a substantial portion of patients undergoing TKA report quadriceps weakness, even after sham FNB injections [9]. The fall data in this series suggest the need for more fall protection measures for patients undergoing TKA treated with and without FNB. The patients in this series were not treated with knee immobilizers. To allow early ambulation and full weightbearing after TKA and prevent falls associated with FNB, we have added the use of knee immobilizers to our TKA clinical pathway for the first 48 hours postoperatively until quadriceps function returns.

As the use of FNB in TKA becomes more common, the issues identified in this study should be confirmed in a prospective, randomized multicenter trial. FNB before TKA is not a harmless intervention. Femoral neuropathy, neuritis, and postoperative falls, which can lead to injury requiring reoperation, are complications of FNB after TKA necessitating further study. We recommend FNB postoperative protocols be modified to account for decreased quadriceps function in postoperative patients undergoing TKA in the early postoperative period to prevent falls. We continue to use FNBs for TKA postoperative analgesia as a result of high patient satisfaction with the pain relief provided compared with traditional pain relief medications only. However, we now use knee immobilizers for the first 48 hours after the TKA to compensate for quadriceps weakness from FNB and prevent falls.

Acknowledgments We thank John Garfi for his help with the preparation of this article and John Tilzey, MD, and Michael Thompson, MD, for their contributions to this work.

References

1. Allen HW, Liu SS, Ware PD, Nairn CS, Owens BD. Peripheral nerve blocks improve analgesia after total knee replacement surgery. *Anesth Analg.* 1998;87:93–97.
2. Auroy Y, Benhamou D, Bargues L, Ecoffey C, Falissard B, Mercier FJ, Bouaziz H, Samii K. Major complications of regional anesthesia in France: the SOS Regional Anesthesia Hotline Service. *Anesthesiology*. 2002;97:1274–1280.
3. Barrington MJ, Olive DJ, McCutcheon CA, Scarff C, Said S, Kluger R, Gillett N, Choong P. Stimulating catheters for continuous femoral nerve blockade after total knee arthroplasty: a randomized, controlled, double-blinded trial. *Anesth Analg.* 2008;106:1316–1321.
4. Bunburaphong P, Niruthisard S, Werawatganon T, Keeyapaj W, Vimuktanandana A, Toleb K. Postoperative analgesia for total knee replacement: comparing between pre- and postoperative '3-in-1' femoral nerve block. *J Med Assoc Thai.* 2006;89:462–467.
5. Chelly JE, Ben-David B. Do continuous femoral nerve blocks affect the hospital length of stay and functional outcome? *Anesth Analg.* 2007;104:996–997; author reply 997–998.
6. Chelly JE, Greger J, Gebhard R, Coupe K, Clyburn TA, Buckle R, Criswell A. Continuous femoral nerve blocks improve recovery and outcome of patients undergoing total knee arthroplasty. *J Arthroplasty*. 2001;16:436–445.
7. Cornet C, Compère V, Fourdrinier V, Lignot S, Dujardin F, Dureuil B. Sciatic nerve extension complicating femoral blockade. *Anaesth Intensive Care*. 2006;34:684–685.
8. Fowler SJ, Symons J, Sabato S, Myles PS. Epidural analgesia compared with peripheral nerve blockade after major knee surgery: a systematic review and meta-analysis of randomized trials. *Br J Anaesth*. 2008;100:154–164.
9. Ganapathy S, Wasserman RA, Watson JT, Bennett J, Armstrong KP, Stockall CA, Chess G, Macdonald C. Modified continuous femoral three-in-one block for post-operative pain after total knee arthroplasty. *Anesth Analg.* 1999;89:1197–1202.
10. Good RP, Snedden MH, Schieber FC, Polachek A. Effects of a preoperative femoral nerve block on pain management and rehabilitation after total knee arthroplasty. *Am J Orthop*. 2007;36:554–557.
11. Guay J. Peripheral nerve blocks for postoperative pain relief after total knee replacement: more questions than answers. *Anesth Analg*. 2005;100:1547; author reply 1547–1548.
12. Hirst GC, Lang SA, Dust WN, Cassidy JD, Yip RW. Femoral nerve block. Single injection versus continuous infusion for total knee arthroplasty. *Reg Anesth*. 1996;21:292–297.
13. Kroll MA, Otis JC, Sculco TP, Lee AC, Paget SA, Bauckenstein R, Jewsen DA. The relationship of stride characteristics to pain before and after total knee arthroplasty. *Clin Orthop Relat Res.* 1989;239:191.
14. Lang SA, Rooney ME. Postoperative analgesia following total knee arthroplasty. *Anesth Analg*. 2004;99:954; author reply 954–955.
15. Munin MC, Rudy TE, Glynn NW, Crossett LS. Earlier inpatient rehabilitation after elective hip and knee arthroplasty. *JAMA.* 1998;279:847–852.
16. Pang WW, Hsu TC, Tung CC, Hung CP, Chang DP, Huang MH. Is total knee replacement more painful than total hip replacement? *Acta Anaesthesiol Sin.* 2000;38:143–148.
17. Parvataneni HK, Shah VP, Howard H, Cole N, Ranawat AS, Ranawat CS. Controlling pain after total hip and knee arthroplasty using a multimodal protocol with local periarticular injections: a prospective randomized study. *J Arthroplasty*. 2007;22(Suppl 2):33–38.
18. Raj PP, Knarr DC, Vigdorth E, Dewson DD, Pitler CE, Hartrick CT, Hopson CN, Edstrom HH. Comparison of continuous epidural infusion of local anesthetic and administration of systemic narcotics in management of pain after total knee replacement surgery. *Anesth Analg.* 1987;66:401–406.
19. Singelyn FJ, Deyaert M, Joris D, Pendeville E, Goureweur JM. Effects of intravenous patient-controlled analgesia with morphine, continuous epidural analgesia, and continuous three-in-one block on postoperative pain and knee rehabilitation after unilateral total knee arthroplasty. *Anesth Analg.* 1998;87:88–92.

20. Szczukowski MJ Jr, Hines JA, Snell JA, Sisca TS. Femoral nerve block for total knee arthroplasty patients: a method to control postoperative pain. *J Arthroplasty*. 2004;19:720–725.
21. Toftdahl K, Nikolajsen L, Haraldsted V, Madsen F, Tønnesen EK, Søballe K. Comparison of peri- and intraarticular analgesia with femoral nerve block after total knee arthroplasty: a randomized clinical trial. *Acta Orthop*. 2007;78:172–179.
22. Wang H, Boctor B, Verner J. The effect of single-injection femoral nerve block on rehabilitation and length of hospital stay after total knee replacement. *Reg Anesth Pain Med*. 2002;27:139–144.
23. YaDeau JT, Cahill JB, Zawadsky MW, Sharrock NE, Bottner F, Morelli CM, Kahn RL, Sculco TP. The effects of femoral nerve blockade in conjunction with epidural analgesia after total knee arthroplasty. *Anesth Analg*. 2005;101:891–895.