Postoperative Analgesia After Total Knee Replacement: The Effect of an Obturator Nerve Block Added to the Femoral 3-in-1 Nerve Block

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Femoral nerve block (FNB) does not consistently produce anesthesia of the obturator nerve. In this single-blind, randomized, controlled study we added a selective obturator nerve block (ONB) to FNB to analyze its influence on postoperative analgesia after total knee replacement (TKR). Before general anesthesia, 90 patients undergoing TKR received FNB (Group 1), FNB and selective ONB (Group 2), or placebo FNB (Group 3). Postoperative analgesia was further provided by morphine IV via patient-controlled analgesia. Analgesic efficacy and side effects were recorded in the first 6 h after surgery. Adductor strength decreased by 18% ± 9% in Group 1 and by 78% ± 22% in Group 2 ($P < 0.0001$). Total morphine consumption was reduced in Group 2 compared with Groups 1 and 3 ($P \leq 0.0001$). Patients in Group 2 reported lower pain scores than those in Groups 1 and 3 ($P = 0.0003$). The incidence of nausea was more frequent in Groups 1 and 3 ($P = 0.01$). We conclude that FNB does not produce complete anesthesia of the obturator nerve. Single-shot FNB does not provide additional benefits on pain at rest over opioids alone in the early postoperative period. The addition of an ONB to FNB improves postoperative analgesia after TKR.

(Anesth Analg 2004;99:251–4)

Femoral 3-in-1 nerve block (FNB) alone is frequently used for pain control after total knee replacement (TKR), but does not provide complete postoperative analgesia (1,2). Several investigators have demonstrated that the FNB, described by Winnie et al. (3) to result in blockade of the femoral, obturator, and lateral cutaneous nerves, does not consistently produce anesthesia of the obturator nerve (4,5). Consequently, the intact sensation in the back of the knee after a FNB alone could be attributable to either the obturator or the sciatic nerve, which also supplies the knee joint. But Allen et al. (6) reported that the addition of a sciatic nerve block to a FNB does not further improve analgesic efficacy. This suggests that the sciatic innervation of the posterior knee provides a relatively minor contribution to postoperative pain after TKR. The present study was designed to evaluate whether the addition of an obturator nerve block to FNB improves the quality of postoperative analgesia after TKR.

Methods

With approval from our IRB and written informed patient consent, 90 patients undergoing unilateral TKR participated in this prospective, randomized, placebo-controlled, single-blinded study.

Patients were tutored preoperatively in the use of a patient-controlled analgesia (PCA) system and a visual analog pain scale (VAS). Exclusion criteria included age <18 yr or >85 yr, ASA physical status >III, morbid obesity, allergy to local anesthetics or other medications used in this study, contraindications to regional anesthesia, preexisting neurological deficits in the lower extremities, pregnancy, breast-feeding, and inability to use a PCA or to comprehend pain scales.

Before surgery the patients were randomly assigned by envelope to one of three postoperative analgesia

Presented, in part, at the annual meeting of the French Society of Anesthesia, Paris, France, September 2003.

Accepted for publication January 22, 2004.

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DOI: 10.1213/01.ANE.0000121350.09915.84

0003-2999/04

groups: Group 1 received FNB (n = 29), Group 2 received combined and selective obturator nerve block FNB (n = 33), and Group 3 received a placebo FNB (n = 28) performed by the clinician in charge.

Premedication consisted of 0.25 mg oral alprazolam 1.5 h preoperatively. On arrival to the operating room, a baseline measurement of adductor muscle strength was performed. The nerve blocks were performed before induction of general anesthesia by one of the authors experienced in the techniques. In Groups 1 and 2 we used a nerve stimulator (Stimuplex® HNS 11; B Braun, Melsungen, Germany), a 50-mm 22-gauge insulated needle (Stimuplex® A; B Braun) for the FNB, a 50-mm 22-gauge insulated needle (Stimuplex® A; B Braun) for the obturator nerve block, and a mixture of 0.5% bupivacaine and 2% lidocaine with 1:200 000 epinephrine. Group 3 received a subcutaneous injection of 10 mL saline at the site of the femoral nerve. FNB was performed as originally described by Winnie et al. (3). Successful location was indicated by contraction of the quadriceps muscle (dancing patella sign) with cessation of contraction ≤0.5 mA, and 25 mL of the local anesthetic solution was injected. Obturator nerve block was performed as follows: with the patient in the supine position, legs slightly abducted, the needle was inserted with an angle of 30 degrees to the skin, 2 cm caudal and 2 cm lateral to the pubic tubercle. The needle was advanced until it contacted the inferior border of the superior pubic ramus bone before it was redirected posteriorly and slightly laterally to walk off the inferior margin of the superior pubic ramus. Successful location was indicated by contraction of thigh adductors with cessation of contraction ≤0.5 mA, and 7 mL of local anesthetic solution was injected. The extent of both blocks was evaluated 30 min after injection of the anesthetic solution by an investigator unaware of the patient's group assignment. Sensation was assessed by loss of cold sensation and light touch. The strength of adduction was measured before and after the block with the help of a mercury sphygmomanometer as described by Lang et al. (4). The patients were asked to extend the knees and hips. They were then asked to squeeze a blood pressure cuff previously inflated to 40 mm Hg between their knees. The maximal sustained pressure generated on the mercury sphygmomanometer was recorded as an index of adductor strength. Patients with complete sensory abolition in the distribution of the femoral nerve and complete femoral motor block (inability to flex the knee) were considered to have a successful FNB and were included in Groups 1 and 2. Only the motor function was evaluated to assess the obturator nerve block.

Patients then underwent TKR. General anesthesia, standardized for all study groups, was induced with 1.5–2 mg/kg propofol and 0.5 μg/kg sufentanil. Each patient's trachea was intubated, and controlled ventilation was applied for the duration of surgery. Anesthesia was maintained using 60% nitrous oxide in oxygen, 0.75%–1.5% isoflurane end-tidal concentration, and 0.15 $\mu g \cdot kg^{-1} \cdot h^{-1}$ continuous infusion of sufentanil, which was stopped 30 min before the end of the surgery.

Postoperatively pain was evaluated during the study period using a VAS ranging from 0 mm (no pain) to 100 mm (worst imaginable pain). All patients received an initial IV manually titration of 1 mg morphine at 5-min intervals until VAS scores of 30 mm were obtained in the postanesthesia care unit. At this time, an IV PCA pump with morphine was connected, delivering 1-mg doses with a 7-min lockout period and a maximum dose of 25 mg in 4 h. During the first 24 h after surgery, all patients received 2 g propacetamol and 50 mg ketoprofen infused IV over 15 min at 6-h intervals. The first dose was given 30 min before the end of the surgery.

Pain was evaluated at rest by another blinded investigator. The pain levels were determined at the arrival in the postanesthesia care unit, as well as 0.5, 1, 2, 3, 4, 5, and 6 h after surgery. The pain evaluations were associated with surveillance for possible side effects arising from the analgesic protocol (vomiting, nausea, sedation, arterial hypotension, respiratory depression, or bradycardia). A respiratory rate <10 breaths/min was considered as respiratory depression. The sedation was assessed with a four-point grading scale as follows: 0 = awake, 1 = sleepy but awakened by oral order, 2 = sleepy but awakened by nociceptive stimulation, 3 = not awakened). Nausea and vomiting were assessed by the absolute presence or absence of the symptom. The analgesic efficacy (total morphine consumption in mg, number of morphine boluses via PCA, number of morphine requests via PCA, VAS pain scores) were recorded in the first 6 h after surgery for each group.

Data were analyzed using SAS/SAT version 8.1 software (SAS, Cary, NC). They were compared by using analysis of variance or by using χ^2 analysis when appropriate. Results are expressed as mean ± SD. Statistical significance was accepted as $P < 0.05$.

Results

Ninety patients were enrolled in the study. There were no significant demographic differences among the three groups who completed the study (Table 1). No patient was excluded as a result of femoral or obturator nerve block failure. Thirty minutes after performance of the block adductor strength decreased by 18% ± 9% in Group 1 and by 78% ± 22% in Group 2. This difference was statistically significant ($P <$ 0.0001). In the first 6 h after surgery total morphine

Table 1. Anthropometric Characteristics and Duration of Surgery

	Group 1 (n = 29)	Group 2 (n = 33)	Group 3 (n = 28)
Sex (M/F)	7/22	4/29	8/20
ASA physical status (1/2/3)	7/18/4	5/26/2	1/24/3
Body mass index (kg/m^2)	30 ± 5	28 ± 5	29 ± 6
Age (yr)	68 ± 9	71 ± 9	70 ± 7
Duration of surgery (min)	150 ± 41	129 ± 33	139 ± 33

Data are mean ± SD. No significant differences were observed.

consumption and the number of morphine bolus received via PCA were significantly reduced in Group 2 compared with Groups 1 and 3. Group 2 showed a significant reduction in the number of morphine requests via PCA in the first 6 h compared with Group 3 (Table 2). Patients in Group 2 reported significantly lower VAS pain scores than those in Groups 1 and 3 (Fig. 1). No difference in pain scores or morphine consumption was observed between Groups 1 and 3. The incidence of nausea was significantly more frequent in Groups 1 and 3 (Table 3). No complications were observed.

Discussion

Effective pain control is a major concern in the postoperative management of TKR and one that has a significant impact on our health care system (2,7–9).

The FNB has become the technique of choice after TKR. It is as efficient as epidural analgesia, has fewer side effects, and is easier to manage in the surgical ward (2,9). Pain persisting in the back of the knee after a 3-in-1 nerve block suggests that the sciatic nerve provides a major contribution to the innervation of the knee joint (1,2). Allen et al. (6) failed to confirm that hypothesis in their clinical study and demonstrated that the addition of a sciatic nerve block to a FNB does not further improve analgesic efficacy after TKR.

In 1973, Winnie et al. (3) described the technique called 3-in-1 FNB, which was supposed to provide anesthesia of the femoral, lateral femoral cutaneous, and obturator nerves with a single injection of local anesthetic, provided a volume of 20 mL or more was used, in 100% of patients. Other authors failed to reproduce these results. It appears that the 3-in-1 FNB usually spares the obturator nerve (4,5,10–14). This could explain the clinical observations where patients have experienced pain in the knee joint despite complete cutaneous anesthesia of the knee provided by FNB alone or combined sciatic and 3-in-1 FNB (1,2,4). Bouaziz et al. (15) showed that testing the efficacy of obturator nerve blocks by sensory evaluation is not sufficient (as the cutaneous contribution of the obturator nerve is absent in 57% of patients).

Table 2. Number of Morphine Request Via PCA, Number of Morphine Boluses Received Via PCA and Total Morphine Consumption in the First 6 H

	Group 1	Group 2	Group 3
Morphine request via PCA	18.2 ± 12.8	9.6 ± 13.4*	27.7 ± 23
Morphine bolus received via PCA	11.6 ± 6.2	4.8 ± 5.3†	12.1 ± 5
Total morphine consumption (mg)	21.1 ± 8	8.1 ± 7.6‡	21.8 ± 7.2

Data are mean ± SD.
PCA = patient-controlled analgesia.
* Significantly different compared with Group 3 (P = 0.0058); † significantly different compared with Group 1 (P = 0.0001) and Group 3 (P < 0.0001); ‡ significantly different compared with Groups 1 and 3 (P < 0.001).

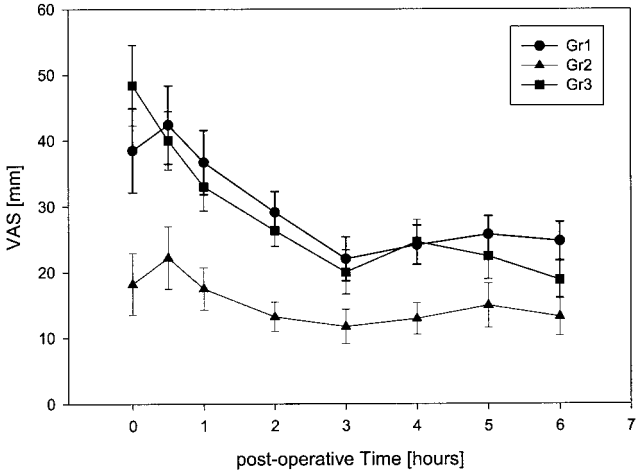

Figure 1. Pain scores at rest in the first 6 h after surgery. Data are mean ± SEM. VAS = visual analog scale pain scores. *Significantly different compared with Groups 1 and 3: VAS 0 (P = 0.0018); VAS 0.5 (P = 0.0060); VAS 1 (P = 0.0055); VAS 2 (P = 0.0003); VAS 4 (P = 0.0166); VAS 6 (P = 0.0257).

Table 3. Side Effects in the Three Groups

	Group 1	Group 2	Group 3
Nausea	10	4*	13
Sedation (grade 1 and 2 of the scale)	6	5	11
Vomiting	2	2	7
Hypotension, requiring sympathomimetic drugs (n)	0	1	0
Respiratory depression (grade 1, 2, 3 of the scale)	4	0	4
Bradycardia (< 40 bpm)	0	2	0

* Significantly different compared with Groups 1 and 3 (P = 0.0117).

In the present study the motor function of the obturator nerve was measured by evaluating the adductor muscle strength with the help of a mercury sphygmomanometer as described by Lang et al. (4) in 1993. Similar results in the decrease of adductor muscle strength have been observed in the present study (78% ± 22%)

and our previous study (77% ± 17%) when the obturator nerve block was performed and assessed before the FNB (15). This suggests a high efficacy of obturator nerve blocks. However, the adductor strength decreased by only 17.9% ± 9.2% in Group 1, proving no or little anesthesia of the obturator nerve.

We observed an opioid-sparing effect and improved analgesia in patients with the obturator-FNB. Our results agreed with the findings of McNamee et al. (16). They stated that the addition of an obturator nerve block to femoral and sciatic blockade results in a significant reduction in total requirements for morphine in the first 48 h after TKR, significantly between the 20–48 h. But in contrast to the present study, they failed to show significantly decreased pain scores and less frequent incidence of side effects in the group that received the obturator nerve block. Nevertheless, the McNamee et al. (16) study was not controlled; the assessment of the obturator nerve block was only based on the cutaneous blockade, which should be considered obsolete, and the pain scores were evaluated during mobilization.

We were not able to demonstrate additional benefits of a single-shot FNB on pain at rest in the early postoperative period compared with the placebo FNB. Previous research evaluating improvements in analgesia provided by a FNB after TKR have produced conflicting results. Concerning the study design, these investigations are difficult to compare. Our findings confirm the results of Hirst et al. (1), who also failed to show improved analgesia and an opioid-sparing effect of single-shot or continuous 3-in-1 FNB over 72 h in a randomized, double-blind and placebo-controlled study. Only the pain scores with motion in the early postoperative period were lower in the groups who received a FNB compared with the control group.

The advantage of a FNB in this major joint surgery seems to be the analgesic effect on pain during mobilization. In contrast, more recently, Wang et al. (17) reported effective analgesia at rest and during rehabilitation provided by a single-injection FNB compared with a placebo FNB, which may reflect the variable incidence of effective obturator blockade after a FNB.

In our study, the incidence of nausea was less frequent with the obturator-FNB, which could be attributed to their opioid-sparing properties. It is likely that we did not study enough patients to detect a difference in the remaining side effects, as our sample size was chosen to detect a difference in opioid consumption.

In conclusion, FNB does not produce complete anesthesia of the obturator nerve. A single-shot FNB does not provide additional benefits on pain at rest in the early postoperative period after TKR. The addition of an obturator nerve block to FNB improves postoperative analgesia. This suggests that the obturator innervation of the knee joint is a major contributor to postoperative pain.

Our observations require further investigations to explore the influence of obturator-FNB on the quality of rehabilitation, functional outcome, and length of hospital and rehabilitation center stay.

The authors thank all members of the Departments of Orthopedics and Anesthesia of the University Hospitals of Nancy and Montpellier, France, for their cooperation with this study. We are especially grateful to M. Gründel, MD, Berlin, Germany, for his valuable help.

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