Effects of a Preoperative Femoral Nerve Block on Pain Management and Rehabilitation After Total Knee Arthroplasty

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Abstract

The objective of this prospective, randomized, double-blind study was to determine if preoperative administration of a femoral nerve block reduces the amount of morphine needed for postoperative analgesia after total knee arthroplasty (TKA). Forty-two patients undergoing TKA were randomly assigned to receive either a femoral nerve block (0.50% bupivacaine hydrochloride with epinephrine 1:200,000) or matching placebo. Results showed postoperative morphine use was significantly lower in patients who received the nerve block (25.5 vs 37.5 mg, $P = .016$); however, the 2 groups had similar pain scores and rehabilitative outcomes. In general, a preoperative femoral nerve block is a safe and effective adjunct for decreasing morphine use for post-TKA analgesia.

Recent attention has been directed toward decreasing postoperative opioid analgesic use and improving pain management in patients undergoing total knee arthroplasty (TKA). Current post-TKA pain management protocols often involve administration of an opioid, usually morphine sulfate. However, morphine has been shown to produce side effects common to most narcotics—including ventilatory depression, sedation, postoperative nausea and vomiting, urinary retention, histamine release, and decreased bowel motility.[1-4] In addition, patients who receive morphine for postoperative pain analgesia still report pain after surgery. Furthermore, previous research has determined that insufficient post-TKA pain control has contributed to poor functional recovery.[5]

Although morphine is the most commonly administered opioid[6] and was found to produce high-quality analgesia for most procedures,[1,7] recent studies have investigated the adjuvant use of a femoral nerve block in pain management therapies for knee and hip surgeries.[8-12] Administration of a femoral nerve block after a knee procedure was shown to significantly decrease postoperative morphine use along with postoperative pain.[10-12] Similarly, a comparison of postoperative range of motion (ROM) about the replaced knee showed that patients who received the block had increased knee flexion on TKA postoperative day 2, although this difference was no longer significant at discharge.[10]

On the basis of previous reports on the effectiveness of postoperative femoral nerve block, we hypothesized that preoperative administration of a femoral nerve block would yield similar if not improved results with respect to decreasing total postoperative morphine use. The main purpose of this study was to determine if preoperative administration of a femoral nerve block is effective as an adjunct to morphine therapy for post-TKA pain management. The primary endpoint was total morphine administered to control postoperative pain. Secondary endpoints included postoperative pain scores, ambulation distance, and ROM about the replaced knee.

Materials and Methods

This prospective, randomized, double-blind, placebo-controlled study was conducted at Bryn Mawr Hospital (Bryn Mawr, Pa), which specializes in total joint replacements. Surgeons in the orthopedic section of the hospital perform approximately 6500 procedures annually, of which nearly 1000 are joint replacements. The hospital's institutional review board approved the study design, and all patients gave informed, written consent before initiation of any study-specific procedures.

Forty-two patients enrolled in the study during a 16-month period, December 1997 to March 1999. Patients were randomly assigned either to the experimental group (22 patients received a femoral nerve block consisting of 40 mL of 0.50% bupivacaine hydrochloride with epinephrine 1:200,000 before surgery) or to the control group (20 patients received a matching placebo consisting of a 40-mL solution of 0.9% normal saline before surgery).

The femoral nerve block or placebo was administered by an anesthesiologist at the start of the TKA in the operating suite. After the anesthesiologist used a nerve stimulator to locate the femoral nerve, the study medication was injected into the

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Table I. Patient Demographics

Demographic Characteristic	Nerve Block (n = 22)	Placebo (n = 20)
Age (y), median (mean ± SD)	70 (61 ± 13)	70 (68 ± 10)
Sex, n (%)		
Male	14 (64)	12 (60)
Female	8 (36)	8 (40)
Race, n (%)		
White	21 (96)	18 (90)
Black	1 (4)	2 (10)
Height (in), median (mean ± SD)	67.5 (70± 4)	64 (66 ± 4)
Weight (lb), median (mean ± SD)	180 (184 ± 22)	180 (188 ± 41)
Knee, n (%)		
Left	12 (55)	11 (55)
Right	10 (45)	9 (45)

Table II. Postoperative Pain Scores by Day*

Posoperative Day	Nerve Block (n = 22)	Placebo (n = 20)
1	5 (4.7 ± 1.8)	5 (5.3 ± 1.7)
2	4 (4.0 ± 1.9)	5 (4.9 ± 1.8)
3	4 (3.9 ± 2.1)	4 (3.4 ± 2.3)

*Values are median (mean ± SD). Pain scores were recorded on a scale ranging from 0 (no pain) to 10 (worst possible pain).

nerve sheath. The remainder of the procedure did not vary from the usual TKA protocol adopted by the orthopedic section of the hospital.

After the procedure, a patient-controlled morphine pump was attached to the patient's intravenous (IV) line in the postanesthesia care unit. Standard patient-controlled analgesia consisted of a 1-mg/mL concentration of morphine sulfate supplied in a 60-mL syringe. All patients were administered IV morphine at a standard basal rate of 1 mg/h, a dosage that could be increased to a maximum of 10 mg/h by the patient if needed. Patient-controlled morphine analgesia was discontinued after postoperative day 1 in both treatment groups.

Both treatment groups received the same postoperative mean dose of morphine analgesia treatment, were enrolled in the same rehabilitative program, and received physical therapy once a day for up to 3 days or until discharge from the hospital. The orthopedic surgeon, anesthesiologist, physical therapists, clinical nursing staff, and patients were blind to the treatment. Study medications were coded and supplied by the hospital pharmacy department. Study medication records were accessed and unblinded at the completion of the study.

Pain was assessed with the visual analog scale (VAS), which provides a simple, efficient, and minimally intrusive measurement of pain intensity and has been widely used in clinical and research settings.[13] The VAS procedure is to have the patient rank the intensity of his or her pain on a scale ranging from 0 (no pain) to 10 (worst imaginable pain). Therefore, pain scores were recorded as integers from 0 to 10. The clinical staff collected VAS pain scores every 8 hours on the day of surgery and on postoperative days 1 to 3. Attempts were made to record pain scores before administration of any analgesic medications.

Patient ambulation was observed on postoperative days 1 to 3 or until patient discharge. Ambulation distances were measured and graded 1 (able to ambulate ≤5 feet), 2 (able to ambulate >5 feet but <10 feet), 3 (able to ambulate >10 feet but <30 feet), or 4 (able to ambulate ≥30 feet).

ROM about the replaced knee was recorded on postoperative days 2 and 3. Extension and flexion of the knee were measured with a goniometer, and results were recorded in degrees. Measurements were taken at time-matched points on postoperative days 2 and 3 during the patient's daily physical therapy session.

Statistics

Frequency distributions were tabulated by treatment for sex, race, and replaced knee. Summary statistics were tabulated by treatment for age, height, and weight.

Total morphine use was calculated by adding the basal dose and doses self-administered by the patient. Total morphine use was summarized through medians and means with SDs by treatment group. VAS scores were tallied and averaged by day for each patient. VAS scores were then summarized through medians and means with SDs by day for each treatment group. ROM and ambulation scores were summarized through medians and means with SDs by day for each treatment group. All recorded adverse events were listed and tabulated by treatment.

Statistical comparisons for total morphine use, pain scores, ambulation distance, and ROM were completed using the Wilcoxon rank sum test. Analyses did not miss any signals of discrimination. *P* values were calculated for each variable.

Table III. Knee Range-of-Motion Measurements

	Postoperative Day 2		Postoperative Day 3	
Measurement	Nerve Block (n = 22)	Placebo (n = 20)	Nerve Block (n = 19)	Placebo (n = 19)
Extension (degrees)				
Median	-14	-15	-12.5	-15
(Mean ± SD)	(-14 ± 5)	(-15 ± 4)	(-13 ± 5)	(-14 ± 3)
Flexion (degrees)				
Median	55	55	60	64
(Mean ± SD)	(58 ± 15)	(54 ± 11)	(67 ± 16)	(62 ± 10)

Table IV. Ambulation Distances Based on Graded Scale*

Postoperative Day	Block (n = 22)	No Block (n = 20)
1	2 (1.8 ± 1.0)	1 (1.7 ± 1.0)
2	3 (3.3 ± 0.7)	3 (3.1 ± 0.9)
3	4 (3.5 ± 0.7)	4 (3.5 ± 0.7)

*Values are median (mean ± SD), determined on a graded scale ranging from 0 (worst score) to 4 (best score).

Table V. Adverse Events

Adverse Event	Nerve Block (n = 22)	Placebo (n = 20)
Fever, n (%)	4 (18)	3 (15)
Urinary retention, n (%)	2 (9)	1 (5)
Numbness about knee, n (%)	1 (4.5)	0 (0)
Difficult ambulating, n (%)	1 (4.5)	0 (0)
Postoperative nausea, n (%)	1 (4.5)	2 (10)
Depression, n (%)	1 (4.5)	1 (5)
Skin breakdown around knee, n (%)	1 (4.5)	0 (0)
Gastrointestinal tract event, n (%)	1 (4.5)	0 (0)
Infection, n (%)	0 (0)	2 (10)
Anemia, n (%)	0 (0)	2 (0)
Dyspnea (%)	0 (0)	1 (5)

Results

Demographic information was similar between the femoral nerve block and placebo groups (Table I). The majority of subjects were white (93%). Three patients who received the nerve block (14%) and 1 patient who received placebo (5%) were discharged early (on postoperative day 2) because of increased recovery rate.

Patients who received the femoral nerve block required significantly less morphine for postoperative pain control compared with patients who received placebo (25.5 vs 37.5 mg, $P = .016$). Trends in the pain scores on postoperative days 1 and 2 suggest a potential benefit but were not significant (Ps = .20 and .08, respectively). The largest difference in pain scores between the experimental and control groups was observed on postoperative day 2 (Table II). Pain scores recorded on postoperative day 3 support equivalence between the study groups ($P = .767$).

Rehabilitative measures were similar for the treatment groups. ROM about the replaced knee was similar for the groups on postoperative days 2 and 3 (Table III). Observed ambulation was also similar for the groups on all postoperative days (Table IV).

Overall incidence of adverse events was similar for patients who received a femoral nerve block and patients who received placebo (Table V). The most common adverse event was fever, which was reported by 4 patients (18%) in the nerve block group and 3 patients (15%) in the placebo group. Urinary retention was noted in 2 patients (9%) who received the preoperative nerve block and in 1 patient (5%) who received placebo. Depression was reported by 1 patient (5%) who received the nerve block and by 1 patient (5%) who received placebo. Psychiatric evaluation showed that the depression experienced by both patients was most likely related to social concerns and postoperative medications and not to the study medication. All adverse events were mild to moderate in intensity.

Discussion

Concern about effective management of post-TKA pain has been increasing, as research has shown that patients who have a high degree of post-TKA pain are more likely to have poor functional outcomes.[5] Previous investigators have studied adding a postoperative femoral nerve block to pain management therapy for hip and knee surgeries[8,9,11,12] and TKAs.[10] These studies showed that patients who received a nerve block after surgery had less pain and required less morphine for pain management after surgery. The purpose of this study was to determine if preoperative administration of a femoral nerve block results in decreased morphine use among patients undergoing TKA.

Study results showed that total morphine use was significantly lower in patients who received a femoral nerve block before TKA (25.5 vs 37.5 mg, $P = .016$). Although pain scores for the groups were similar, trends favored the nerve block on postoperative days 1 and 2. There were no observed group differences in ROM about the replaced knee or in ambulation.

Administering a preoperative femoral nerve block appears to decrease the morphine needed in post-TKA pain management by a considerable amount. There are many advantages to decreasing morphine use for postoperative pain control. Morphine, as well as opioids in general, has been known to cause postoperative nausea and vomiting.[14] There is also concern about use of opioids in pain management because of their adverse effects, including ventilatory depression, sedation, urinary retention, histamine release, and decreased bowel motility.[1-4] In addition, there is an associated increase in cost to treat these opioid-related side effects.[15]

A possible study limitation is that our population size was not large enough to detect a decrease in morphine-related side effects. In addition, the population size might not have been large enough to detect a difference in rehabilitative outcome measurements. An additional research study with a larger study population is needed to further investigate these findings.

In summary, adding a preoperative femoral nerve block to the anesthesia protocol of patients undergoing TKA was well tolerated and effective. Patients who received a femoral nerve block before TKA used less morphine to manage their postoperative pain. Contrary to clinical perceptions, pain scores of patients who received the femoral nerve block were not statistically different from those of patients who received placebo. However, the subjective impressions of the clinical team suggested that patients who received a femoral nerve block tended to report pain less often. These impressions are reflected in the difference in morphine use. The findings of this study support use of a preoperative femoral nerve block to decrease postoperative morphine

use, which could be especially relevant to patients who cannot tolerate large doses of morphine for postoperative pain control.

Authors' Disclosure Statement

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

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