

## BRIEF REPORT

# Total Knee Arthroplasty as an Overnight-Stay Procedure Using Continuous Femoral Nerve Blocks at Home: A Prospective Feasibility Study

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The average duration of hospitalization after total knee arthroplasty (TKA) in the United States is 4–5 days. In this two-phase study we investigated the feasibility of converting TKA into an overnight-stay procedure using a continuous femoral nerve block provided at home through postoperative day 4. Nine of 10 patients met discharge criteria and were discharged home the day after surgery. Pain was well controlled,

opioid requirements and sleep disturbances were minimal, and patient satisfaction was high. Additional research is required to replicate these results in a controlled trial, define the appropriate subset of patients, and assess the incidence of complications associated with this practice before its mainstream use.

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In the United States, criteria for home discharge after total knee arthroplasty (TKA) usually include the requirements that a) pain be controlled with only oral analgesics, and b) patients be able to ambulate at least 30 min so they may function at home (1). Consequently, the average duration of hospitalization after TKA in the United States is 4–5 days (2–5). A continuous femoral nerve block has been demonstrated to provide analgesia in hospitalized patients after TKA

(6,7), but the possibility of shortening hospital duration while continuing to provide potent analgesia with ambulatory perineural infusion has not been investigated. Therefore, this study was designed to evaluate the feasibility of converting TKA into an overnight-stay procedure using a continuous femoral nerve block at home through postoperative day (POD) 4.

## Methods

### Hospitalized Phase

This phase was designed to evaluate and improve the proposed protocol while having patients remain in the controlled environment of the hospital for at least 3 nights. After University of Florida IRB approval, we enrolled ASA physical status I–II patients (18–80 yr) scheduled for primary, unilateral, tricompartamental, cemented TKA via a 12–18 cm midline skin incision and parapatellar approach secondary to osteoarthritis. Subjects were required to 1) live within 2 h of the hospital and 2) have a caretaker who would remain with them during perineural infusion. Exclusion criteria were contraindication to femoral nerve block, current chronic opioid therapy, allergy to study medications, known hepatic or renal insufficiency, and body mass index >40 kg/m<sup>2</sup>.

After obtaining written, informed patient consent, a femoral catheter (StimuCath, Arrow International,

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Manufacturers donated the portable infusion pumps (Stryker Instruments, Kalamazoo, MI) and catheters (Arrow International, Reading, PA) used for this investigation. Stryker Instruments and Arrow International had no input into any aspect of study conceptualization, initiation, and design; data collection, analysis and interpretation; or manuscript preparation.

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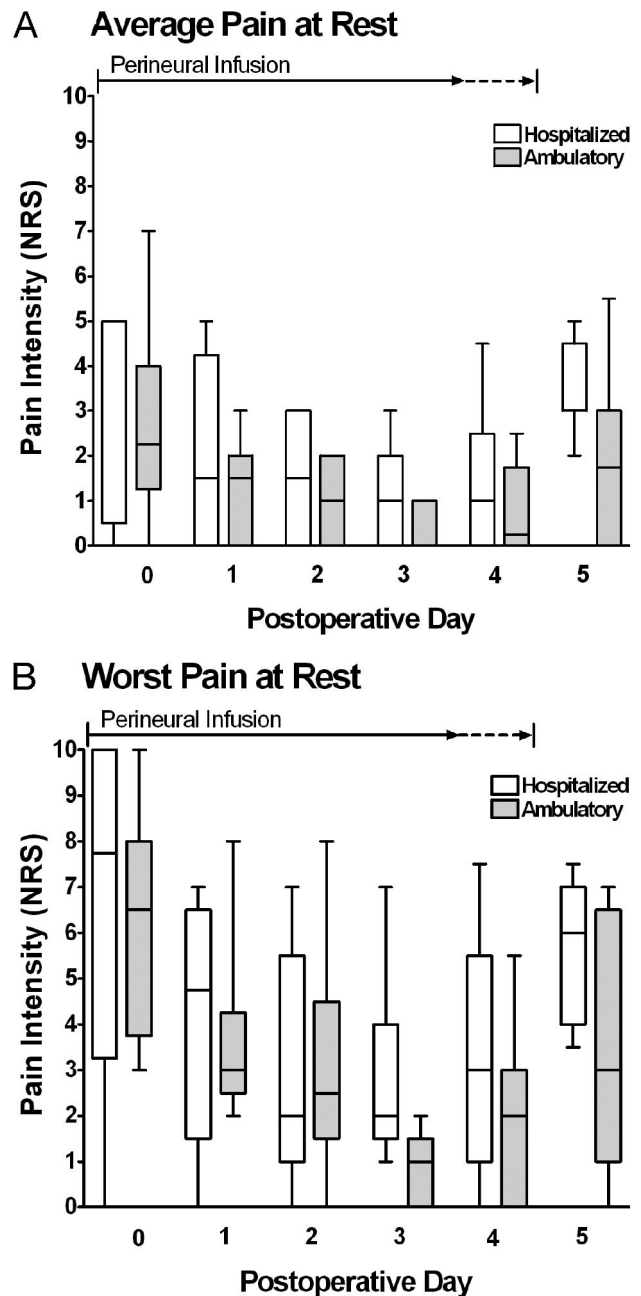
**Table 1.** Prospectively Defined Discharge Criteria for Hospitalized and Ambulatory Phases

Criteria	Details
Analgesia	Numeric rating pain score consistently $\leq 4$
Opioids	Required $< 5$ mg of IV morphine in previous 24 h (excluding recovery room)
Mobility	Able to ambulate $> 30$ m without assistance or dizziness
Oral intake	Tolerating liquids and solids without nausea
Vital signs	Stable after discharge from recovery room
Urinary voiding	Void without assistance following urinary catheter removal
Medical issues	No medical issues necessitating admission

Reading, PA) was placed by one author (BMI) using a technique similar to one previously described (muscle contraction end-point: quadriceps at 0.20–0.40 mA) (8,9). Forty milliliters of mepivacaine, 1.5%, with epinephrine, 100  $\mu$ g, was injected *via* the catheter. Patients were retained in the study if, within 15 min, they experienced a decreased sensation to cold temperature over the ipsilateral thigh and an inability to extend the knee. A perineural infusion of ropivacaine, 0.2%, was subsequently initiated (basal 8 mL/h, patient-controlled bolus-dose 4 mL, lockout time 30 min). For the surgical procedure, patients received a standardized general anesthetic with IV morphine titrated for a respiratory rate of 14.

Postoperatively, patients were transfused 2 U of packed red blood cells if their hematocrit decreased to less than 30 at any time, as is the standard of care after TKA for this surgeon (PFG). Patients received acetaminophen 975 mg every 6 h and enteric-coated aspirin 650 mg daily. Rescue opioid and route of administration were determined by pain severity: oral oxycodone 5 mg (numeric rating pain scale [NRS]  $< 4$ ), oral oxycodone 10 mg (NRS = 4–7), or IV morphine 2–4 mg (NRS  $> 7$ ). After 30 min, patients were reassessed and received oxycodone 5 mg (NRS  $< 4$ ) or IV morphine 2–4 mg (NRS  $> 4$ ).

On POD 2, a portable infusion pump (Pain Pump II, Stryker Corporation, Kalamazoo, MI) containing 400 mL of ropivacaine, 0.2%, was attached to the catheter (basal 5 mL/h, bolus 4 mL, lockout time 60 min) (10). The patient and caretaker were given pump and catheter instructions, physician telephone and pager numbers, and discharged home when all discharge criteria were met beginning on POD 3 (Table 1). Patients were contacted daily and patients' caretakers removed the catheters on POD 4 (11).



**Figure 1.** Preoperative and postoperative average (Panel A) and worst (Panel B) pain for patients at rest with a femoral perineural ropivacaine, 0.2%, infusion after total knee arthroplasty. Pain was evaluated with a numeric rating pain scale (NRS, 0–10, 0 = no pain and 10 = worst imaginable pain). Data are expressed as median (horizontal bar) with 25<sup>th</sup>–75<sup>th</sup> (box) and 10<sup>th</sup>–90<sup>th</sup> (whiskers) percentiles. For tightly clustered data (e.g., Panel A, postoperative day 0, Hospitalized group), the median approximated the 75<sup>th</sup> and 90<sup>th</sup> percentile values. In this case, the median is 5.0 and only the 10<sup>th</sup> and 25<sup>th</sup> percentiles are clearly noted.

### Ambulatory Phase

The purpose of the Ambulatory phase was to evaluate the feasibility of providing TKA as a single-night admission. Additional exclusion criteria were age  $> 70$  yr

**Table 2.** Postoperative Opioid Requirements, Dynamic Pain Scores, and Sleep Disturbances for Hospitalized and Ambulatory Phases

	Postoperative Day					
	0	1	2	3	4	5
Oral opioid consumption (mg)*	0 (0–10) <i>5 (0–40)</i>	15 (0–45) <i>35 (0–55)</i>	20 (0–25) <i>15 (0–25)</i>	5 (0–15) <i>10 (0–40)</i>	5 (0–15) <i>10 (0–20)</i>	50 (30–50) <i>35 (0–60)</i>
Intravenous morphine consumption (mg)	6 (2–22) <i>8 (2–24)</i>	4 (0–18) <i>0 (0–0)</i>	0 (0–2) <i>0 (0–0)</i>	0 (0–0) <i>0 (0–0)</i>	0 (0–0) <i>0 (0–0)</i>	0 (0–0) <i>0 (0–0)</i>
Average NRS during ambulation		3 (1–7) <i>3 (1–6)</i>	2 (0–3) <i>3 (1–5)</i>	2 (1–3) <i>2 (0–3)</i>	NA <i>3 (1–5)</i>	NA <i>4 (2–6)</i>
Worst NRS during ambulation		4 (2–8) <i>4 (2–8)</i>	3 (0–5) <i>4 (3–7)</i>	3 (2–4) <i>5 (1–8)</i>	NA <i>4 (0–7)</i>	NA <i>6 (4–10)</i>
Patients reporting difficulty sleeping (#)†	1 <i>0</i>	0 <i>0</i>	0 <i>0</i>	2 <i>0</i>	2 <i>5</i>	
Awakenings each night (per patient)†	0 (0–0) <i>0 (0–0)</i>	0 (0–0) <i>0 (0–0)</i>	0 (0–0) <i>0 (0–0)</i>	0 (0–0) <i>0 (0–0)</i>	1 (0–1) <i>0 (0–2)</i>	
Satisfaction		9.6 ± 1.0 <i>9.8 ± 0.4</i>				9.0 ± 1.7 <i>9.7 ± 0.5</i>

Values presented as median (10<sup>th</sup>–90<sup>th</sup> percentiles), with the exception of satisfaction, presented as mean ± standard deviation. Femoral perineural ropivacaine, 0.2%, infusion provided postoperative days 0–4. Data for the Ambulatory phase presented in italics.

\* Oral opioid–oxycodone—taken for breakthrough pain (not including twice-daily scheduled Oxycontin 10 mg).

NA = not applicable (data not collected); NRS = numeric rating pain scale (0–10, 0 = no pain and 10 = worst imaginable pain); Satisfaction = 0–10 scale with 10 = very satisfied.

† As a result of surgical pain.

(12), any known cardiac disease, and any risk factors for deep vein thrombosis (13). Protocol changes were as follows: 1) after demonstration of correct catheter placement, 10 mL of ropivacaine, 0.5%, with epinephrine, 25 µg, was injected *via* the catheter; 2) intraoperatively, IV hetastarch 15 mL/kg was administered; 3) scheduled oxycontin (10 mg every 12 h) was added; 4) the portable infusion pump replaced the hospital-based pump 1 h before discharge; and 5) home discharge was allowed as early as POD 1.

## Results

### Hospitalized Phase

Eight patients were enrolled (1 man and 7 women): mean (± SD) age = 63 (± 9) yr, height = 166 (± 8) cm, weight = 86 (± 9) kg. All but one patient had a femoral catheter placed successfully. In the one failure, the catheter was inserted per protocol with a dense motor block evolving within 2 min, but no sensory block could be identified and the patient was removed from the study (the postoperative infusion provided no apparent analgesia and the catheter was removed secondary to profound motor block). Of the 7 remaining patients, 5 (71%) met all discharge criteria on POD 1, and 2 (29%) on POD 2 (Fig. 1, Table 1, Table 2). All subjects underwent perineural infusion at home (Fig. 1, Table 2) until their catheters were removed on the afternoon of POD 4, with a median (10<sup>th</sup>–90<sup>th</sup> percentiles) infusion duration of 4 days and 8 (6–10) h.

### Ambulatory Phase

Ten patients were enrolled (6 men and 4 women) with the following characteristics: mean (± SD) age = 61 (± 5) yr, height = 172 (± 11) cm, weight = 95 (± 13) kg. All had a femoral catheter placed successfully. Nine patients (90%) met all of the discharge criteria on POD 1 (Fig. 1, Table 2) and were discharged home that day: 7 in the morning and 2 in the afternoon. One patient (10%) was discharged home in the morning of POD 4 because of a bowel obstruction that resolved POD 3. All subjects underwent perineural infusion at home (Fig. 1, Table 2) until their catheters were inadvertently dislodged (*n* = 2, morning of POD 4) or local anesthetic reservoir exhausted, resulting in a median (10<sup>th</sup>–90<sup>th</sup> percentiles) infusion duration of 4 days and 4 (0–10) h.

## Discussion

This study demonstrates the feasibility of converting TKA into an overnight-stay procedure using an ambulatory continuous femoral nerve block as part of a multimodal analgesic regimen provided at home. Although this evidence demonstrates that TKA can be performed on an overnight-stay basis, it does not define the appropriate subset of patients and incidence of complications associated with this practice. Caution is warranted because after TKA, the median times to myocardial infarction and pulmonary embolism are 1 and 4 days, respectively (12). Further data are required to replicate these results in a controlled trial, define the

appropriate subset of patients, and assess the incidence of complications associated with this practice before its mainstream use.

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