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Original contribution

A comparison of ultrasound alone vs ultrasound with nerve stimulation guidance for continuous femoral nerve block in patients undergoing total knee arthroplasty

Hee-Young Kim MD (Assistant Professor)[a,b], Gyeong-Jo Byeon MD, PhD (Assistant Professor)[a,b,*], Hyun-Jun Cho MD (Fellowship)[a], Seung-Hoon Baek MD, PhD (Assistant Professor)[a,b], Sang-Wook Shin MD, PhD (Professor)[a,b], Hyung-Jun Cho MD, PhD (Assistant Professor)[b,c]

[a]*Department of Anesthesia and Pain Medicine, School of Medicine, Pusan National University, Busan, Republic of Korea*
[b]*Research Institute for Convergence of biomedical science and technology Pusan National University Yangsan Hospital, Yangsan, Gyeongnam, Republic of Korea*
[c]*Department of Orthopedic Surgery, Pusan National University Yangsan Hospital, Yangsan, Gyeongnam, Republic of Korea*

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Abstract

Study Objective: To compare analgesic efficacy of ultrasound (US) guidance alone and US guidance combined with nerve stimulation (NS) for continuous femoral nerve block (CFNB) in patients undergoing total knee arthroplasty (TKA).

Design: Prospective, randomized double-blind trial.

Setting: Postanesthesia care unit and general ward.

Patients: Fifty American Society of Anesthesiologist physical status I to II patients undergoing TKA under spinal anesthesia.

Interventions: In group A (n = 25), an 18-gauge Tuohy needle was directed at the lower mid-part of the femoral nerve, and a nonstimulating catheter was inserted through the needle under US guidance. In group B (n = 25), an 18-gauge Tuohy needle and stimulating catheter were directed to the lower part of femoral nerve under US guidance, and quadriceps muscle contraction was checked using NS. All patients received a 20-mL loading dose of 0.2% ropivacaine, a continuous infusion of 4 mL/h, and a 4-mL bolus of 0.2% ropivacaine with a lockout time of 60 minutes for patient-controlled analgesia.

Measurements: The primary outcome was resting and exercising pain quality assessed by numeric rating scale. Other outcomes included procedure time for correct catheter placement, block failure rate, patient satisfaction for postoperative pain control, total dose of local anesthetic, additional opioid requirement, and adverse effects postoperatively.

Main Results: There were no significant differences between groups in resting and exercising numeric rating scale. Procedure times were longer in group B than group A ($P < .05$). There were no significant differences between groups in block failure rate or other outcomes.

* Corresponding author at: Department of Anesthesia and Pain Medicine, Pusan National University Yangsan Hospital, Geumo-ro 20, Yangsan, Gyeongnam, 626-770, Republic of Korea. Tel.: +82 55 360 129; fax: 82-55-360-2149.
E-mail address: byeongj@pusan.ac.kr (G.-J. Byeon).

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Conclusions: US-guided CFNB was associated with similar analgesic efficacy and block failure rate and reduced procedure time compared to US with NS guidance for CFNB in patients undergoing TKA.

1. Introduction

Effective postoperative analgesia after total knee arthroplasty (TKA) facilitates rehabilitation, prevents knee stiffness, improves patient satisfaction, and may reduce the length of hospital stay [1]. For postoperative pain management after TKA, continuous infusion of local anesthetics through an indwelling femoral nerve catheter (continuous femoral nerve block [CFNB]) has been shown to decrease opioid use and has resulted in excellent analgesia. CFNB has also been shown to decrease length of hospital stay and complication rates and to facilitate postoperative rehabilitation in patients undergoing TKA [2-5].

Contraction of the quadriceps muscle is the traditionally accepted motor end point for NS-guided CFNB. Recently, ultrasound (US)–guided CFNB has been performed for postoperative analgesia in patients undergoing TKA. Because of difficulty identifying the femoral nerve and catheter tip position during catheter insertion, the addition of NS via a stimulating catheter during US-guided CFNB may offset the disadvantages of each method and allow successful localization of needle and nerve [6].

We hypothesized that US-guided CFNB combined with NS will provide greater analgesic efficacy than US alone because this method should allow more precise identification of the femoral nerve and more accurate positioning of the catheter tip. The purpose of the study was to know better and more precise method of CFNB, to reduce postoperative pain in patients undergoing TKA. So, we used analgesic efficacy as the primary outcome and compared US-guided CFNB with US- plus NS-guided CFNB in patients undergoing TKA. We also compared secondary outcomes, including the time to correct localization of the catheter, block failure rate, patient satisfaction for postoperative pain control, total consumed doses of local anesthetic, additional opioid requirement, and adverse effects postoperatively.

2. Materials and methods

2.1. Enrollment

The prospective, randomized study was approved by the institutional review board and registered at the Korean Clinical Research Information Service (register no. KCT0001196). After obtaining written informed consent, we enrolled 50 American Society of Anesthesiologist physical status I to II patients undergoing TKA under spinal anesthesia. Patients with preexisting neurologic deficits, allergy to amide local anesthetics, contraindications to nerve block (eg, local infection, sepsis, coagulation deficiency), and those who were unable to cooperate during the procedure were excluded.

2.2. Randomization

A computer-generated sequence of random numbers was used to assign patients to undergo either US-guided CFNB with a nonstimulating catheter (group A, n = 25) or US- with NS-guided CFNB using the stimulating catheter (group B, n = 25).

2.3. Analgesic technique

All of the nerve blocks were performed by the same anesthesiologist (GJB), who has extensive experience in these techniques.

After skin preparation with chlorhexidine-alcohol, all patients underwent the CFNB procedures in the supine position with the leg slightly extended. Femoral nerve location was assessed using a 5.0- to 13.0-MHz linear probe (LOGIQ e; GE Healthcare, Princeton, NJ).

In group A, after infiltration of the puncture site with local anesthetic (3-4 mL of 2% lidocaine), a 10-cm, an 18-gauge Tuohy needle (Perisafe; BD Medical, Franklin Lakes, NJ) was inserted laterally into the femoral nerve with in-plane needle advancement under US guidance. The needle was inserted 4 to 5 cm from the inguinal crease in a cephalad, medial, and slightly dorsal direction from the puncture site and placed at the lower lateral part of the visualized femoral nerve. A 20-gauge catheter (Perisafe; BD Medical) was inserted through the needle and advanced to 1 cm beyond the needle tip. The needle was then withdrawn over the catheter. The catheter tip was localized at the lower mid-point of the femoral nerve and adjusted using the US image and injection of 1 to 2 mL of normal saline. If the tip of the catheter could not be seen, the process of catheter insertion and localization was repeated.

In group B, in the same manner as in group A, a 10-cm, 18-gauge Tuohy cannula (Stimulong Nanoline Kit; Pajunk GmbH, Geisingen, Germany) was inserted and placed along the lower lateral part of the femoral nerve under US guidance. Electrocardiogram pads were placed 0 to 1 cm medial to the distal quadriceps tendon and attached to a nerve stimulator (MultiStim SENSOR; Pajunk GmbH) and an initial output of 1 mA, 2 Hz, and 0.2 ms was applied as the block needle was advanced along the lower part of the femoral nerve until quadriceps femoris muscle contractions were elicited, at which time the nerve stimulator was turned off. A 20-gauge stimulating catheter (Stimulong Nanoline Kit; Pajunk GmbH) was inserted through the needle. A nerve stimulator clip was attached to the proximal end of the stimulating catheter, and the nerve stimulator was set to 1