



Effectiveness of Ultrasound-guided Single-injection Triple Nerve Block Before Cementless Bipolar Hip Hemiarthroplasty in Femoral Neck Fractures

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Purpose: To compare efficacy of ultrasound (US)-guided single-injection nerve blocks (SINB) before bipolar hemiarthroplasty (BHA) of the hip in patients with femoral neck fractures.

Materials and Methods: Clinical outcomes of 89 patients who underwent BHA between September 2016 and February 2018 were retrospectively compared. Eight patients were excluded according to exclusion criteria and the remaining patients were divided into two groups: patients who received SINB before surgery (Group I; n=40), and patients who did not (Group II; n=41). The femoral, obturator, and lateral femoral cutaneous nerves were each blocked separately under US guidance. Pain scores determined using the visual analogue scale (VAS) were recorded 6, 12, 24, and 48 hours postoperatively, and all use of analgesics were recorded separately for 72 hours after surgery. Duration of hospitalization, general complications, and local complications due to SINB were also compared among the groups.

Results: Significant differences were observed between the two groups: I) VAS at 6 hours and at 12 hours after the operation, II) total amounts of analgesics used. VAS at 24 hours and at 48 hours were not significantly different between the two groups. General complications and duration of hospitalization were also not significantly different between the groups.

Conclusion: US-guided lower limb nerve blocks provide excellent immediate postoperative pain relief and can be used as a safe, and effective method of pain control after BHA.

Key Words: Femur neck fractures, Hemiarthroplasty, Ultrasonography, Peripheral nerve block

Submitted: March 18, 2020 **1st revision:** June 18, 2020
2nd revision: July 7, 2020 **Final acceptance:** July 10, 2020
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INTRODUCTION

Elderly patients with femoral neck fracture present to the hospital in severe pain. In the elderly, uncontrolled pain results in worse outcomes (e.g., increased incidence of delirium, longer length of hospital stay)¹⁻³. Importantly, adequate pain management can lead to better outcomes (e.g., fewer deleterious effects on vital organs, improved patient satisfaction)⁴.

Research shows that aggressive pain control after total knee arthroplasty (TKA) helps provide pain relief and leads to speedier recovery of ambulatory function. Unfortunately,

for bipolar hemiarthroplasty (BHA) of femoral neck fracture in the elderly, even femoral neck fracture diminishes quality of life^{5,6}, and few reports have addressed methods of effective postoperative pain control.

As with TKA, continuous epidural injections have also proven to be effective, despite reports of various respiratory and hemodynamic side effects^{5,7}. The preemptive use of analgesics in combination with intra-articular and peri-articular injections is an opioid-sparing technique and shown to provide effective pain control for up to 4 days after BHA⁸.

The purpose of this study was to investigate the clinical benefits of ultrasound (US)-guided single-injection nerve blocks (SINB) performed on the femoral, obturator, and lateral femoral cutaneous nerves—peripheral nerves that innervate the proximal femur and hip joint—for patients undergoing BHA. It was hypothesized that SINB would reduce perioperative opioid consumption and immediate postoperative pain scores without complications.

MATERIALS AND METHODS

1. Patient Selection

Medical charts of 89 patients who underwent BHA for fragility femoral neck fracture at Busan Medical Center between September 2016 and February 2018 were retrospectively reviewed. This study was approved by the Institutional Review Board (approval #P01-202001-21-007) of Public Institutional Bioethics Committee designated by the MOHW.

A total of 8 patients were excluded for one or more of the following criteria: I) were already immobile before the injury, II) showed malunion or nonunion due to delayed initial treatment, III) had diagnosed severe dementia or other psychiatric conditions, IV) showed signs of delirium within 24 hours of surgery (delirium rating scale >10), or V) stopped patient-controlled intravenous analgesia (PCA) because of PCA side effect (nausea, vomiting).

2. Study Design and Procedure

All BHA were performed by a single surgeon using a direct lateral approach under spinal anesthesia. Patients were subsequently divided into two groups; Group I patients (n=40) received SINB before surgery and Group II patients (n=41) received surgery without SINB. All nerve blocks were performed after February 2017.

All SINB were performed by a single experienced orthopedic surgeon two hours before surgery using a 5-cm long, 5-12 MHz linear probe (LOGIQ e; GE Healthcare, Boston, MA, USA) and 22 G spinal needle. Under US-guidance, the femoral, obturator, and lateral femoral cutaneous nerves were each blocked using, respectively, 15, 8, and 8 mL of 0.75% ropivacaine mixed with 1% lidocaine at a 1:1 ratio (Fig. 1). To confirm block failure, sensory tests including the pin prick test was done before the surgery. Patients were given 200 mg of Celebrex (celecoxib; Pfizer, New York, NY, USA) as preemptive analgesia. During the operation, peri-articular injection or intra-operative analgesia were not given.

Postsurgical pain management involved PCA, with 2 mg butorphanol (butorphanol tartrate; Myungmoon Pharm., Seoul, Korea), 50 mg tridol (tramadol hydrochloride; Yuhan Corp., Seoul, Korea), and 30 mg ketorolac (ketorolac tromethamine; Hanmi Pharm., Seoul, Korea) mixed in 100 mL of saline (background infusion rate 0.05 mL/hr, bolus 0.2 mg, lock-out 8 minutes). The number of doses administered was confirmed by checking the volume remaining on the 3rd postoperative day. Patients were given rescue analgesics (50 mg of tramadol or 90 mg of diclofenac) as postoperative pain control.

Ankle pumps and knee extension/flexion exercises were taught before surgery and encouraged afterwards to aid rehabilitation. Patients were also taught postural changes and wore medical compression stockings throughout their hospital stay to help prevent postoperative complications.

3. Outcome Assessments

Postoperative pain intensity was measured from electronic medical records using the visual analogue scale (VAS) at 6, 12, 24, and 48 hours after surgery. Before initial VAS measurement, medical staff provided a detailed explanation of how to measure VAS. The number of doses administered by PCA and amount of rescue analgesics given were recorded separately for the first 72 hours. Notes on ambulatory function, local complications due to SINB, general postoperative complications, and duration of hospitalization were also compared.

4. Statistical Analysis

Statistical analyses were performed using IBM SPSS ver. 22.0 software (IBM Corp., Armonk, NY, USA). The paired *t*-test was used to verify differences in clinical results and

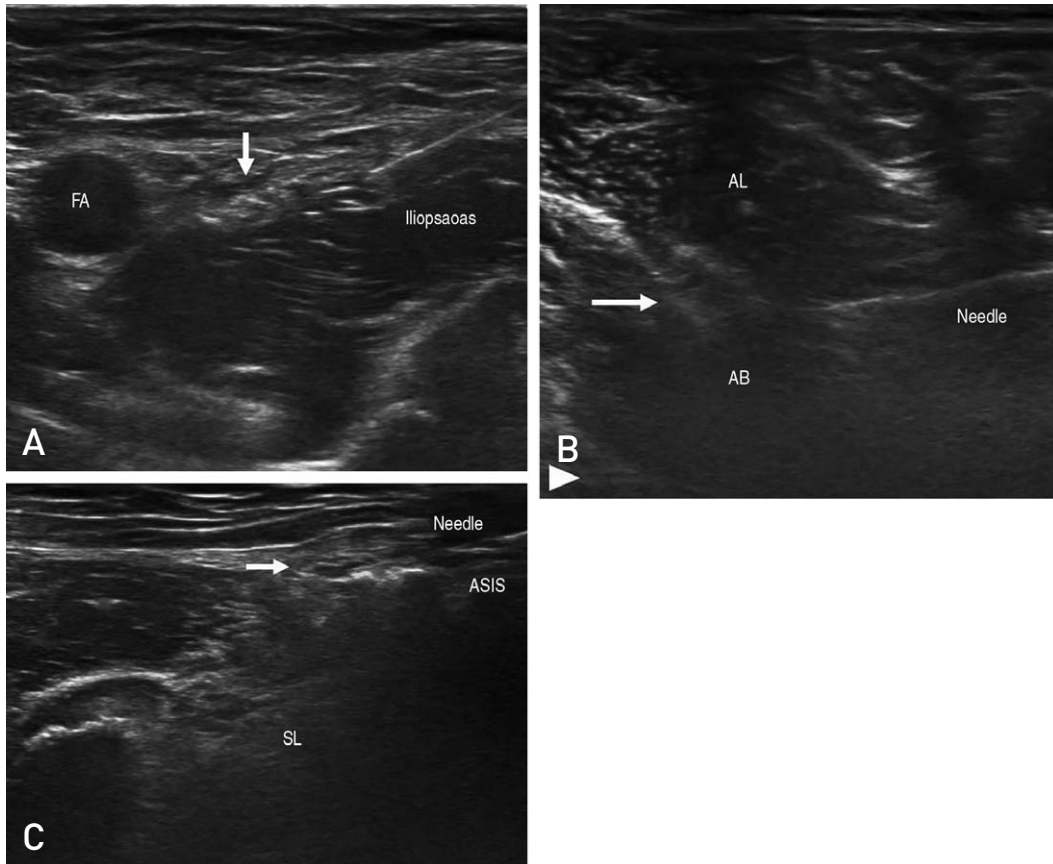


Fig. 1. Triple nerve block. (A) Femoral nerve block using ultrasonography; place the needle near the femoral nerve (arrow). (B) Obturator nerve block using ultrasonography; the needle was placed near the obturator nerve anterior branch (arrow), not posterior branch (arrow head). (C) Lateral femoral cutaneous nerve block using ultrasonography; the needle was placed near the lateral femoral cutaneous nerve (arrow).
 FA: femoral artery, AL: adductor longus, AB: adductor brevis, SL: sartorius muscle, ASIS: anterior superior iliac spine.

Table 1. Baseline Demographics

Variable	Group I (n=40)	Group II (n=41)	P-value
Mean age (yr)	77.05	74.66	0.266
Sex			
Male	15	16	0.888
Female	25	25	
Mean BMI	23.40	23.73	0.621
Mean CCI	0.73	0.78	0.709

Group I: triple nerve block by single injection group, Group II: control group (no injection), BMI: body mass index, CCI: Charlson comorbidity index.

patient demographics between the two groups. Power analysis revealed an effect size of 0.5, statistical significance of 0.05, and statistical power of 0.603 for both groups.

RESULTS

As shown in Table 1, there were no significant differences

in baseline characteristics between the groups (i.e., age, sex, body mass index, Charlson comorbidity index). Group I patients’ subjective pain scores at 6 and 12 hours after BHA were significantly lower compared with Group II ($P<0.05$) at 6 hours, Group I VAS averaged 2.15 ± 0.77 while Group II VAS averaged 3.85 ± 1.22 , and at 12 hours, Group I VAS averaged 3.53 ± 0.82 while Group II VAS averaged $3.90 \pm$

0.86. Postoperative VAS scores at 24 and 48 hours were not significantly different (Fig. 2).

PCA use in the first 48 hours was also significantly reduced in Group I, with average PCA use at 69.68 ± 9.78 mL for Group I patients and 86.90 ± 17.39 mL for Group II patients. The amount of rescue analgesics given was significantly lower for Group I as well, with an average of 0.48 injections for Group I patients and 0.85 injections for Group II patients (Table 2, 3).

There were no statistically significant differences in incidence of pressure sores or pneumonia between the groups. Careful review of the charts revealed no reports of deep vein thrombosis. There were also no reports of any local complications due to SINB, nor any reports of block failure. There

were no statistically significant differences in length of hospital stay between the groups (Table 4).

DISCUSSION

Hip arthroplasty is an operation that affects both the fractured bone and the surrounding soft tissue. Because patients experience substantial postoperative pain, traditional methods of pain control have relied heavily on opioids. Unfortunately, opioids provide suboptimal pain control⁹, as confirmed by the relatively high VAS scores in our study. Opioid-related adverse events are also often severe and delay recovery.

Proper pain management stems from a keen understand-

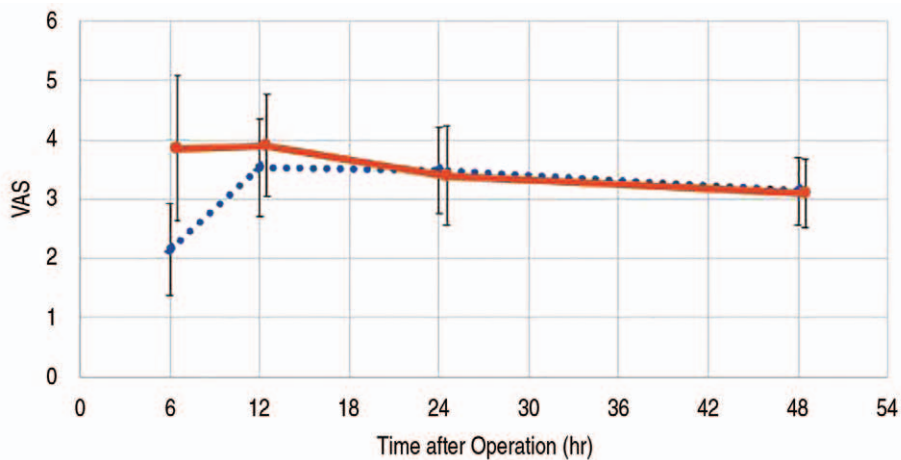


Fig. 2. Visual analogue scale (VAS) for postoperative hours (mean, standard deviation) at 6, 12, 24, and 48 hours. Solid line: control group (no injection); dashed line: triple nerve block by single injection group.

Table 2. VAS for Postoperative

Time after operation	Group I (n=40)	Group II (n=41)	P-value
6 hours	2.15±0.77	3.85±1.22	<0.001
12 hours	3.53±0.82	3.90±0.86	0.029
24 hours	3.48±0.72	3.39±0.83	0.715
48 hours	3.13±0.56	3.10±0.58	0.864

Values are presented as mean ± standard deviation.

VAS: visual analogue scale, Group I: triple nerve block by single injection group, Group II: control group (no injection).

Table 3. PCA Consumption for Postoperative 72 hours

Variable	Group I (n=40)	Group II (n=41)	P-value
PCA consumption (mL)	69.68±9.78	86.90±17.39	<0.001
Additional analgesic injection (no. of injections)	0.48	0.85	0.027

Values are presented as mean ± standard deviation or mean number only.

PCA: patient controlled analgesia, Group I: triple nerve block by single injection group, Group II: control group (no injection).

Table 4. Complications and Length of Stay

Variable	Group I (n=40)	Group II (n=41)	P-value
General complications			
Pressure sore	1	2	0.571
Pneumonia	3	3	0.975
DVT	0	0	-
Local complications			
Length of stay (mean)	28.35	27.59	0.658

Group I: triple nerve block by single injection group, Group II: control group (no injection), DVT: deep vein thrombosis.

ing that postsurgical pain is multifactorial and multifaceted. Accordingly, there have been increasing numbers of reports on management modalities that combine preemptive analgesia and multimodal analgesia to minimize opioid use in patients undergoing BHA^{8,10}. Intraarticular injections, periarticular injections, and peripheral nerve blocks are a part of the multimodal approach.

The 3-in-1 block, as originally described by Winnie et al.¹¹, contends a single perivascular injection distal to the inguinal ligament achieves blockage of the entire lumbar plexus¹². The current consensus, however, is that this approach does not provide proper anesthesia to the obturator nerve^{13,14}. The femoral nerve block and the fascia iliaca compartment block have also been shown to be effective in hip replacement surgeries¹⁰ but often result in inadequate blockage of the lateral femoral cutaneous nerve and obturator nerve.

The authors believe that visual identification by US and subsequent deposition of local anesthetic under US-guidance allows for accurate blockage and, therefore, improves pain control. The procedure employed in our study took less than ten minutes to perform and did not result in any complications. US-guided nerve blocks are safe and efficient, and can be useful considering pain control by PCA proved insufficient even when used in conjunction with preemptive analgesics.

In this study, SINB helped to achieve adequate pain control up to 12-hours after surgery. The results also demonstrated a reduced need for both opioids and for rescue analgesics. Clinically significant pain relief was confirmed by chart notes, which revealed that patients not only had fewer complaints of pain, but they also found postoperative breathing and rehabilitation exercises easier to perform.

Temporary weakness in the quadriceps muscle is a possible side effect of femoral nerve blockage. However, patients did not walk enough within the first 24 hours for the weakness to have a significant impact. Patients were also able to perform ankle pumps and knee extension/flexion exercises without much difficulty.

An important point to consider when analyzing these results is whether the pain reduction effect due to spinal anesthesia affects the pain assessment in the early stage of this study. Most spinal anesthesia is known to last 2-3 hours, and according to Kooger Infante et al.¹⁵, the effect of the drug used in this study is considered to last 2-3 hours. Therefore, it is believed that it did not affect the 6-hour, 12-hour VAS.

The primary limitation of this study is its retrospective design, which limits the ability to measure key statistics and control for potential biases. A randomized, double blind study may be needed to confirm these results. An additional limitation of this study is that VAS itself is not an objective measurement of pain. After considering the results, VAS appeared capable of expressing the level of pain. Moreover, additional injection dosage of pain control was compared in this study, so lack of objectivity could be supplemented. Theoretically, to resolve the lack of objectivity, the summed pain-intensity difference may be a better method of evaluating pain relief because it corrects for individual basal pain intensity.

Due to the limited number of patients enrolled, further studies may be required to more confidently interpret these results. Comparison of pain control with continuous nerve blocks may be meaningful and further studies are warranted.

The primary purpose of preemptive pain control is to decrease postoperative complications, shorten hospital stays and obtain earlier mobilization. The study was conducted by public medical institutions, and the overall length of stay of patients became longer than expected, which limited the comparison of the difference in length of stay due to SINB. Comparing early mobilization between two groups could not be implemented because muscle strength between patients was too varied. In this situation, postoperative bedside exercise and wheelchair ambulation are initially performed.

CONCLUSION

US-guided SINB provides excellent early postoperative pain control and can be used as a safe, effective method of immediate postoperative pain management after BHA for patients with femur fractures without complication.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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