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Evaluating Pain Management from Peripheral Nerve Block for Geriatric Patients following Bipolar Hemiarthroplasty for Displaced Femoral-Neck Fracture

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Keywords
Peripheral nerve block · Geriatric displaced femoral-neck fracture · Bipolar hemiarthroplasty

Abstract

Introduction: The purpose of this study was to evaluate peripheral nerve block (PNB) effectiveness in postoperative pain management and surgical outcomes for displaced femoral-neck fracture in geriatric patients (>70 years) who underwent bipolar hemiarthroplasty (BHA). ***Methods:*** From January 2017 to December 2021, 231 geriatric patients with displaced femoral-neck fracture who consecutively underwent BHA were retrospectively reviewed. Patients were divided into two groups: the patient-controlled analgesia (PCA) group (n = 132) who received only intravenous (IV) PCA for postoperative pain management, and all others who received PNB with IV PCA (PNB+PCA) such as femoral nerve block or fascia iliaca compartment block after surgery (n = 99). Primary outcomes were postoperative visual analog scale (VAS) at rest and during activity at 6, 24, and 48 h postoperatively. Secondary outcomes were postoperative complications, changes in hemoglobin, length of hospital stay, and total morphine usage after surgery. ***Results:*** Postoperative resting VAS at 6 h and 48 h was significantly lower in the PNB+PCA group compared with the PCA group ($p = 0.075$, $p = 0.0318$, respectively). However, there was no significant difference in either resting VAS at 24 h or active VAS. Complications of pneumonia and delirium until 1 month postoperative were significantly lower in the PNB + PCA group than the PCA group ($p = 0.0022$, $p = 0.0055$, respectively). ***Conclusion:*** PNB with IV PCA seems to have a beneficial effect on geriatric femoral-neck patients who underwent BHA with postoperative analgesia for reducing postoperative resting pain and complications, especially pneumonia and delirium.

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Introduction

Geriatric hip fractures are a worldwide epidemic and a major public health concern [1, 2]. Among hip fractures, geriatric, displaced femoral-neck fractures usually require surgical treatment [3–5], and bipolar hemiarthroplasty (BHA) has been the gold standard treatment for these

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fractures [6–8]. After BHA, most patients were free of major pain, had satisfactory motion and muscle power, and returned to the level of function before fracture [9]. However, in reality, after BHA, many patients suffer from postoperative pain and complications (pneumonia, delirium, pulmonary embolism, cardiovascular disease, urinary retention) because of delayed ambulation, which leads to longer hospital stays and, in severe cases, increased mortality and morbidity [10]. After hemiarthroplasty for hip fracture, postoperative pain is the most devastating consequence for patients and requires multimodal pain management for additional pain relief through the fourth postoperative day, which improves patient satisfaction at discharge and reduces total narcotic consumption for postoperative pain management after hip hemiarthroplasty for hip fractures [11].

Multimodal pain management refers to procedures acting on different regions of the pain pathway for pain relief, including preventive medications, periarticular injections, peripheral nerve block (PNB) [11]. Multimodal pain management could reduce postoperative pain, leading to reduction in opioid consumption. PNB is one of the recommended multimodal pain management for patients undergoing BHA [12–16]. The femoral nerve, obturator nerve, and sciatic nerve are distributed in the hip joint. The anterior capsule of the joint is mainly controlled by the joint branches of the femoral nerve, obturator nerve, and accessory obturator nerve. So PNB on the hip joint consists of femoral nerve block (FNB), supra-inguinal fascia iliaca compartment block, quadratus lumborus block, lateral femoral cutaneous nerve block, pericapsular nerve group block.

Pain management after hip-fracture surgery in geriatric patients not only results in diminished pain, but also in diminished complications that could be caused by pain. However, most studies of multimodal pain management only focused on patient-reported subjective outcomes (e.g., visual analog scale [VAS]). Thus, we hypothesized that PNB not only improves VAS score, but also reduces correlated disease and complications. Therefore, the purpose of this study was to evaluate the effectiveness of PNB on postoperative pain management and surgical outcomes for displaced femoral-neck fracture in geriatric patients who underwent BHA.

Methods

Data Collection

This study was approved by an independent Institutional Review Board. A total of 231 geriatric patients (>70 years) who underwent primary BHA for displaced femoral-neck fracture from 2017 to 2021 at a single hospital were included and their electrical medical record (EMR) data were retrospectively reviewed. Age, sex, body mass index (BMI), American Society of Anesthesiologist (ASA) class, and postoperative VAS score at rest (at 45° passive flexion of the hip) and during activity (ambulation) at 6, 24, 48 h postoperative were evaluated. Patients with inflammatory hip arthritis including rheumatoid arthritis, hip-joint infection, revision surgery, severe instability, anatomical deformity, or bone defects were excluded. A total of 231 patients were divided into two groups: 99 patients who received PNB and IV patient-controlled analgesia (PCA) (PNB+PCA group) and 132 patients who received intravenous (IV) PCA only (PCA group).

All BHA surgeries are performed by a single senior orthopedic surgeon at a tertiary teaching hospital. All cases were performed with a posterolateral hip approach in the lateral position along with repair of the short rotator muscle. All cases used cementless press fit stems.

After surgery, patients receive either FNB or supra-inguinal fascia iliaca compartment block by an experienced anesthesiologist. An ultrasound-guided FNB (20 mL of 0.2% of ropivacaine with epinephrine 1:200,000, via a 22-gauge, 80 mm echogenic needle) with nerve stimulator confirmation was performed below the inguinal ligament using the linear 6–13 MHz ultrasound probe (HFL38xp; SonoSite Inc.). Ultrasound-guided supra-inguinal FICB (30–40 mL of 0.2% of ropivacaine with epinephrine 1:200,000) was performed; a 22-gauge, 80 mm echogenic needle was introduced 1 cm cephalad to the inguinal ligament, separating the fascia iliaca from the iliac muscle [17, 18].

All patients received standardized general or spinal anesthesia. Thirty minutes before the end of the surgery, IV fentanyl (1 μg/kg) and palonosetron (0.075 mg) were administered to the patient for postoperative analgesia and antiemetic effects, respectively. IV PCA that comprised 7 μg/kg of fentanyl and 0.075 g of palonosetron (total volume including saline: 100 mL) was administered for 48 h postoperatively in all patients and was delivered as 2 mL/h background infusion and in 0.5 mL doses upon patient demand with a 15-min lockout time. In the ward, all patients received celecoxib (200 mg) orally followed by acetaminophen (1 g) intravenously every 12 h [18].

All patients started postoperative exercise under the same rehabilitation protocol. Bedside exercises including ankle pump, quadricep stretches, and leg raising exercises were performed 0–6 h after surgery. Standing and walker ambulation was permitted on postoperative day one under the same rehabilitation protocol.

Outcome Measurements

A multivariable linear regression model that was adjusted for age, sex, BMI, and ASA score was fit to evaluate the postoperative VAS (0–10 with 0 = no pain and 10 = worst possible pain) at rest and during activity (6 h: during 45° passive hip flexion, 24 and 48 h: ambulation) at 6, 24, 48 h postoperatively as the primary outcomes. Subgroup analysis of VAS score at rest and activity at 6 h postoperatively according to anesthesia type (general, spinal) was done for intra group and intergroup. Secondary outcomes were preoperative hemoglobin (Hb), immediate postoperative Hb, postoperative day (POD) #1 Hb, hospital stay length, total

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Table 1. Baseline characteristics of femoral-neck fracture patients who underwent BHA

	BHA		*p* value
	PNB+PCA (*N* = 99)	PCA (*N* = 132)	
Age	78.38±9.37	80.70±8.46	0.0653
Height	158.32±7.74	158.16±9.78	0.8859
Weight	54.69±10.13	55.51±9.92	0.5395
BMI	21.80±3.68	22.18±3.42	0.4137
Sex, *n* (%)			0.4222
Female	21 (21.21)	34 (25.76)	
Male	78 (78.79)	98 (74.24)	
ASA, *n* (%)			0.7883
1	1 (1.01)	2 (1.52)	
2	17 (17.17)	20 (15.15)	
3	74 (74.75)	104 (78.79)	
4	7 (7.07)	6 (4.55)	

Data are shown as means ± standard errors for normally distributed variables. BHA, bipolar hemiarthroplasty; BMI, body mass index; PNB, peripheral nerve block; PCA, patient-controlled analgesia; ASA, American Society of Anesthesiologists.

morphine use after surgery (calculated by oral morphine equivalents (OME) [19]), and postoperative complications (pneumonia, delirium, pulmonary thromboembolism) 1 month postoperative.

Statistical Analyses

Data analyses were conducted in R, version 3.6.0 (The R Foundation for Statistical Computing, Vienna, Austria). Absolute values of the standardized difference, the independent *t* test, χ^2 test, Fisher's exact test, and linear regression were used.

Results

Baseline Characteristics

Patient baseline characteristics were compared with regard to age, gender, BMI, and ASA class between the two groups (Table 1).

Primary Outcomes

Resting postoperative VAS at 6 h and 48 h was significantly lower in the PNB+PCA group compared with the PCA group (adjusted $p < 0.0075$, $p < 0.0318$, respectively; Table 2; Fig. 1). However, there was no significant difference in active VAS at any time point (Table 3; Fig. 2). There was no significant difference in resting operative VAS at 6 h according to anesthesia type in PNB+PCA group and PCA group (*p* value >0.05 each). There was no significant difference in active operative VAS at 6 h according to anesthesia type in PNB+PCA group and PCA group (*p* value >0.05 each). Intergroup of subgroup analysis had the same results in both groups.

Secondary Outcomes

Complications from pneumonia and delirium were significantly lower in the PNB+PCA group compared with the PCA group ($p < 0.0022$, $p < 0.0055$, respectively). There was no significant difference in preoperative Hb, immediate postoperative Hb, postoperative day (POD) #1 Hb, hospital stay length, total morphine use after surgery, or complications from pulmonary thromboembolism (Table 4).

Discussion

This is a single-center, large-sample retrospective study that focused on analgesic effects and early outcomes of PNB. The most important finding of this study was that resting VAS scores 6 h and 48 h postoperatively were significantly lower in the PNB+PCA group than the PCA group. Although the resting VAS score at rest after 24 h showed no significant difference, the average resting VAS score was lower at all time points in the PNB+PCA group (Fig. 1), indicating that PNB affects pain in postoperative patients. Additionally, by adding PNB after surgery, postoperative complications such as pneumonia and delirium were significantly reduced because pain-relieved postoperative patients at rest could get willingness to begin ambulation and eating sooner, leading to fewer complications. Furthermore, PNB might make early rehabilitation possible.

However, the active VAS score was not significantly different between the groups, indicating that movement after surgery is still painful for most patients, even if they received PNB. This might cause patients to require more opioids, so there was no significant difference in total morphine use between the groups.

Poor postoperative outcomes, including longer hospital stay, and more complications, are associated with postoperative pain [3, 20]. Thus, less postoperative pain at rest can offer advantages including early ambulation and fewer complications [21]. Many studies focused on periarticular injection after total hip arthroplasty [22–24], but few studies have focused on BHA. Because we assume fracture can cause pain, pain management after hip-fracture surgery is usually underestimated. This study focused on PNB effectiveness for geriatric femoral-neck fracture patients and demonstrated that less pain at rest was achieved, which could give geriatric

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Table 2. Outcome: VAS-rest

Time	PNB+PCA		PCA only		Raw *p* value	Adjusted *p* value
	estimated mean*	SE*	estimated mean*	SE*		
VAS_6 h_rest	2.8251	0.3581	3.8713	0.3313	0.0025	**0.0075**
VAS_24 h_rest	1.8275	0.3257	2.1991	0.3053	0.1843	0.5529
VAS_48 h_rest	1.3607	0.3047	1.9638	0.2871	0.0106	**0.0318**

SE, standard error. Adjusted *p* values were obtained by Bonferroni correction. *Estimated means and standard errors were adjusted for age, BMI, sex, and ASA.

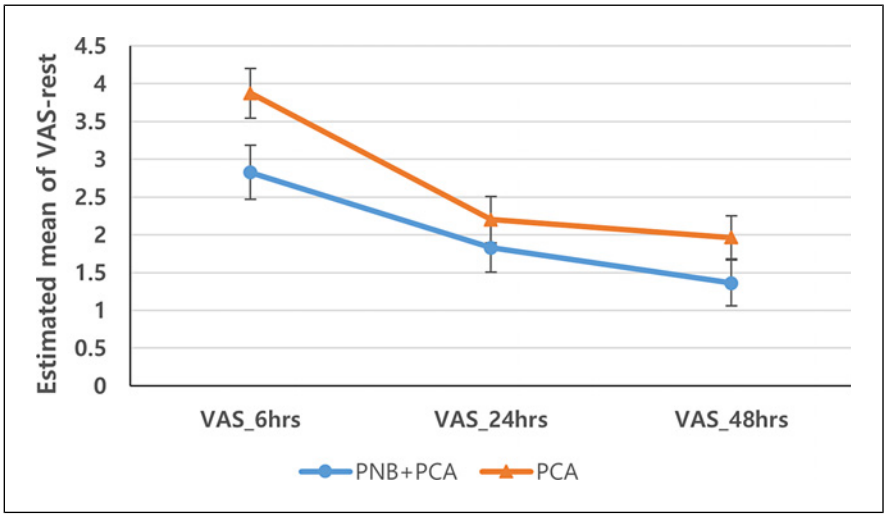

Fig. 1. Resting VAS score for the PNB+PCA group and the PCA group.

Table 3. Outcome: VAS-active

Time	PNB+PCA		PCA only		Raw *p* value	Adjusted *p* value
	estimated mean*	SE*	estimated mean*	SE*		
VAS_6 h_active	5.0817	0.4177	5.1202	0.3882	0.9193	>0.9999
VAS_24 h_active	4.7629	0.3883	4.122	0.3661	0.0461	0.1383
VAS_48 h_active	3.7675	0.3732	3.5266	0.351	0.4018	>0.9999

SE, standard error. Adjusted *p* values were obtained by Bonferroni correction. *Estimated means and standard errors were adjusted for age, BMI, sex, ASA.

patients greater will to move and eat. Although we did not analyze the effect of periarticular injection in this study, other studies have demonstrated its effectiveness [25–27]. We also performed periarticular injection in all patients, so further studies can focus on periarticular injection with PNB.

In geriatric femoral-neck fracture patients, pneumonia (especially aspiration pneumonia) is the major

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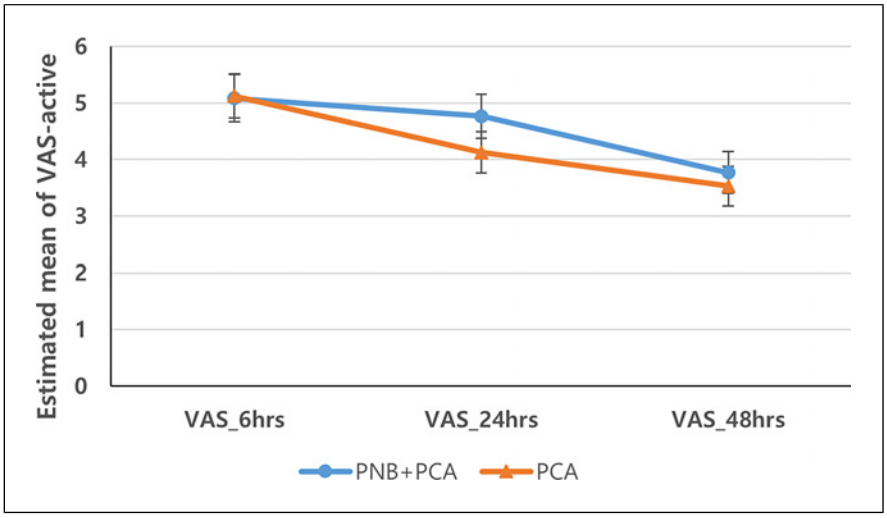

Fig. 2. Active VAS score for the PNB+PCA group and the PCA group.

Table 4. Secondary outcomes

	PNB+PCA (n = 99)	PCA (n = 132)	p value
Preoperative_Hb	11.65±1.77	11.66±1.58	0.9718
Immediate_postop_Hb	11.10±1.77	11.23±1.53	0.5534
POD #1_Hb	9.92±1.49	10.27±1.39	0.0699
Length of hospital stay	9.21±10.87	11.64±18.34	0.21
Total morphine usage	42.53±48.28	41.67±49.81	0.8956
Pneumonia, *n* (%)			**0.0022**
No	98 (98.99)	117 (88.64)	
Yes	1 (1.01)	15 (11.36)	
Delirium, *n* (%)			**0.0055**
No	96 (96.97)	114 (86.36)	
Yes	3 (3.03)	18 (13.63)	
Pulmonary thromboembolism, *n* (%)			0.4666
No	98 (98.99)	129 (97.73)	
Yes	1 (1.01)	3 (2.27)	

Data are shown as means ± standard errors for normally distributed variables. Hb, hemoglobin; POD #1, postoperative day 1.

mortality-causing complication after surgical treatment [28]. The main reason for aspiration pneumonia is a non-ambulatory state due to postoperative pain. After complications from aspiration pneumonia occur, IV antibiotic treatment is necessary, which leads to other morbidities. This study showed that PNB after femoral-neck fracture surgery significantly lowered the risk of aspiration pneumonia. One retrospective study suggested that longer duration of surgery, delayed surgery, age, low BMI, and malnutrition were risk factors for aspiration pneumonia [29]. In patients with a high risk of aspiration pneumonia, post-surgical PNB should be administered.

Another mortality-causing complication after hip-fracture surgery is delirium, and development of post-operative delirium is associated with longer hospital stay, increased medical complications, and poorer short-term functional outcome [30–32]. If delirium after geriatric

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hip-fracture surgery is well controlled, complications can be alleviated. One retrospective cohort study showed that PNB and general anesthesia were associated with a small reduction in postoperative delirium [33]. This study showed the PNB+PCA group had a significantly lower risk of delirium, which can lead to earlier ambulation and rehabilitation. Postoperative delirium with severe pain and distress occurred most on postoperative day 1 and day 2; thus, PNB should be considered to control postoperative pain.

Subgroup analysis according to anesthesia type (general and spinal) was done for evaluating the effectiveness of early postoperative pain score difference. Although spinal anesthesia can influence on pain in postoperative 6 h, the result showed no significant difference in both subgroups in both PNB+PCA and PCA groups. Also, intergroup of subgroup analysis had the same results in both groups. In both general anesthesia patients and spinal anesthesia patients, resting postoperative 6 h VAS was significantly lower in the PNB+PCA group.

The analgesic effect of ropivacaine is 11 h on average; the effect of PNB would be less in postoperative days 1 and 2 [34]. However, Desmet et al. [35] have demonstrated that, compared with no block, suprainguinal FICB results in lower pain scores and decreased morphine consumption (at 24 and 48 h) after THA. As the FICB is a field block, the high volumes of local anesthesia combined with epinephrine injected during FICB could contribute to the duration of analgesic effect. So, early postoperative pain reduction can influence on patients' pain perception, which can influence on pain reduction until 48 h after surgery.

There are some limitations to this study. First, PNB was given as a single shot after the surgery. If we use continuous PNB for femoral-neck fracture patients, postoperative pain and active VAS score might both be much lower [36]. And PNB can be divided into two groups (FNB and fascia iliaca compartment block), which can be a bias. Future studies can focus on block type. Second, this was a single-center retrospective study, but it included a large patient sample and statistical correction for age, BMI, sex, and ASA score. Third, we did not analyze long-term follow-up data including functional scores because geriatric femoral-neck fracture patients are often lost during follow-up and can be difficult to survey. Further studies are required for long-term follow-up. Fourth, IV PCA can be a confounding factor. IV PCA could affect the postoperative pain. However, if all patients received IV PCA, the baseline of the pain might be equal.

Conclusion

PNB with IV PCA seems to have beneficial effects on geriatric femoral-neck patients who underwent BHA with postoperative analgesia for reducing postoperative resting pain and associated complications, especially pneumonia and delirium.

Statement of Ethics

This study protocol was reviewed and approved by the Institutional Review Board of Yonsei University, approval number 4-2021-0772. All the methods were performed in accordance with the relevant guidelines and regulations. The need for consent was exempted due to the nature of secondary data analysis of this study by the Institutional Review Board of Yonsei University.

Conflict of Interest Statement

The authors declare no competing interests.

Funding Sources

No funding was obtained.

Author Contributions

T.S.L. wrote the main manuscript. H.M.K. wrote the main manuscript and revised manuscript. J.Y.P. collected data. M.C.P. collected data and prepared Figures 1, 2. K.K.P. supervised the article and revised the manuscript. Y.S.C. supervised and revised manuscript. All authors reviewed the manuscript.

Data Availability Statement

The data that support the findings of this study are not publicly available due to their containing information that could compromise the privacy of research participants but are available from the corresponding authors, Kwan Kyu Park or Yong Seon Choi, upon reasonable request.

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