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Posted Date: 5 March 2025

doi: 10.20944/preprints202503.0308.v1

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Reducing Emergency Department Burden Through the Implementation of Femoral Nerve Block in Patients with Femur Fractures

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Abstract: Background: The emergency room is a fast-paced, high-pressure environment that demands efficient, streamlined medical procedures. Preoperative femoral nerve blocks remain underutilized and less discussed compared to traditional intravenous opioid administration. This study evaluates the analgesic efficacy of femoral nerve blocks and investigates whether they can reduce opioid use, thereby decreasing the workload for emergency healthcare professionals. **Methods**: Patients with femoral fractures presenting to the emergency room were enrolled. A single emergency physician administered femoral nerve blocks in the treatment group (Group 1). The primary outcome was the improvement in pain scores measured by the numerical rating scale (NRS), while the secondary outcome was the frequency of intravenous opioid administration. These outcomes were compared with a standard care group receiving only intravenous opioids (Group 2). **Results**: Group 1 exhibited a greater reduction in NRS pain scores, with an average decrease of 4.96 compared to 3.99 in Group 2. Although the difference in opioid administration frequency approached significance (1.35 in Group 1 vs. 1.64 in Group 2, $p = 0.063$), the trend favors reduced opioid use in Group 1. Additionally, the mean time to an extra opioid administration after the nerve block was 6.49 hours. **Conclusions**: Femoral nerve blocks provide superior analgesia for femoral fractures and may lower the reliance on intravenous opioids, potentially reducing the burden on emergency staff. Further research is warranted to confirm these findings and assess the impact on opioid administration frequency.

Keywords: femoral fracture; femoral nerve block; pain control

1. Introduction

Alleviating pain is the cornerstone of managing femoral fractures, which often requires the use of intravenous opioid (IVO) analgesics in the emergency department (ER). However, many of these patients remain under-medicated in overcrowded ER with limited resources for monitoring [1]. In addition, the use of sedatives and analgesics, along with opioid analgesics, may lead to postoperative neurocognitive disorder, nausea, and vomiting, thereby increasing the risk of anesthesia-related complications [2].

Under the standard pain management protocol, when a patient experiences pain, they seek assistance from a nurse. The nurse then assesses the pain and reports the situation to a physician. If

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IVO administration is required, the medication must be retrieved and administered. After IVO administration, the nurse must reassess the patient's pain level and monitor for complications within 30 to 60 minutes. This process is time-consuming and complex.

The ER is a fast-paced, high-pressure work environment where any method that can streamline medical procedures for healthcare providers should be explored. The use of preoperative femoral nerve blocks (FNB) in the ER has not been widely discussed, and few studies have compared their use with the frequency of IVO administration.

The purpose of this article is not only to evaluate the analgesic efficacy of FNB, but also to investigate whether its administration can reduce the frequency of opioid use, thereby alleviating the workload of healthcare professionals in the ER.

2. Materials and Methods

2.1. Study Design and Settings

This retrospective comparative analysis was conducted from April 2021 to September 2023. Pain severity was assessed using an 11-point Numerical Rating Scale (NRS) (0 = no pain; 10 = worst imaginable pain), with scores recorded before and 60 minutes after the pain control intervention (PCI). Trained nurses, independent of the ER physician performing the procedure, collected the NRS data, while all participants underwent continuous monitoring of blood pressure, heart rate, and oxygen saturation to detect any potential adverse effects—including local anesthetic systemic toxicity. This study included patients over 18 years of age who presented to the ER with femoral fractures (including fractures of the head, neck, intertrochanteric region, shaft, and distal part) and an NRS score of ≥7. All FNB procedures were performed by a single experienced physician. Once a diagnosis was confirmed, the Hospital Information System notified the physician, and the FNB was performed promptly. In cases where the NRS remained above 7 after the intervention, rescue IVO was administered. The following parameters were recorded: patient demographics, fracture locations, Injury Severity Score (ISS), triage grade, number of IVO administrations, emergency room stay time (ERS, in hours), pre- and post-PCI NRS, and the reduction in NRS. Patients were excluded if they had cognitive impairment, multiple fractures, pathological fractures, coagulopathy, a skin infection at the nerve block site, allergies to local anesthetics, pregnancy or lactation, obesity (BMI > 30 kg/m^2), unstable vital signs, or altered mental status. Group 1 comprised patients who received an FNB in the ER, while an equivalent number of patients who received standard PCI with intravenous tramadol at 1 mg/kg were selected as Group 2.

2.2. Procedure Steps

A high-frequency linear ultrasound probe (8–18 MHz) was used to identify the location of the femoral nerve, which is typically situated below the inguinal ligament, just inferior to the inguinal crease. The following landmarks were identified: the common femoral artery, the iliopsoas muscle, the sartorius muscle, and the fascia iliaca. An in-plane approach was used to confirm the position of the tip of a 21-gauge needle. The goal was to deposit the anesthetic in close proximity to the femoral nerve. Subsequently, 20 mL of 0.25% bupivacaine was injected. Negative blood aspiration was performed after each 5 mL injection of local anesthetic to ensure correct needle placement.

2.3. Data Analysis

Data were entered into Microsoft Excel 2007 (Windows) and analyzed using SPSS 27 (IBM). Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as the mean ± standard deviation (SD) or median. Normality was assessed using the Shapiro-Wilk test. Chi-square or Fisher's exact tests were used to examine categorical associations, while the independent t-test or Mann-Whitney U test was used to compare means between the two groups. Pearson's correlation coefficient was used to assess relationships between variables. Linear regression analyses, including univariate and multivariable models, were employed to identify

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associations. Graphical representations were used for data visualization. A p-value of < 0.05 was considered statistically significant.

2.4. Outcome Measures

The primary outcome of the study was the improvement in the NRS score 60 minutes after the intervention between the two groups. The secondary outcome was a comparison of the frequency of opioid use between the two groups. Additionally, adverse events and block-related complications were recorded.

3. Results

Across demographics and baseline characteristics of study participants, including sex, age, triage, and femoral fracture location, there are no statistically significant differences between Group 1 and Group 2. (Table 1)

Table 1. N=248, Demographics and Baseline Characteristics of Study Participants.

	Group1 (n=134)	Group2 (n=114)	*p* value
Sex			0.413
Female	79(59.0%)	73(64.0%)	
Male	55(41.0%)	41(36.0%)	
Age	68.90±23.11	66.06±22.43	0.330
triage			0.423
1	2(1.5%)	3(2.6%)	
2	33(24.6%)	21(18.4%)	
3	99(73.9%)	90(79.0%)	
femoral fracture location			0.195
upper third	87(64.9%)	84(73.7%)	
middle third	29(21.6%)	22(19.3%)	
low third	18(13.4%)	8(7.0%)	

Chi-square test or Independent t test, Mean (SD). *p<0.05.

Table 2 describes the duration of patients' stay in the emergency department, the frequency of IVO use, and pain scores. There is no significant difference in the NRS before PCI or ERS. The difference in the number of times IVO was administered during ERS approaches significance, with 1.35 times in Group 1 and 1.64 times in Group 2 (p = 0.063). There are significant differences between Group 1 and Group 2 in the NRS after PCI. After PCI, the NRS for Group 1 is 3.0, whereas that for Group 2 is 4.04. The reduction in NRS is 4.96 in Group 1 and only 3.99 in Group 2, indicating that Group 1 achieved better outcomes. In our data, among the 134 individuals in Group 1, only 49 patients (36.6%) were prescribed additional IVO after FNB during ERS. In this group, the average time to administration of extra IVO after FNB was 6.49 hours, with some cases requiring additional pain medication as late as 18.8 hours.

Table 2. the duration of patients' stay in the emergency department, the frequency of IVO use, and pain scores.

	Group1 (n=134)	Group2 (n=114)	*p* value
emergency room stay time (ERS, hour)	13.56±8.54	11.98±7.11	0.114
How many times IVO administered during ERS	1.35±1.37	1.64±1.01	0.063
NRS before PCI	7.96±0.59	8.04±0.69	0.375
NRS after PCI	3.00±1.21	4.04±2.28	<0.001**
NRS reduction	4.96±1.22	3.99±2.26	<0.001**

Chi-square test or Independent t test, Mean (SD). *p<0.05.

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Table 3 displays the Pearson correlation coefficients for various variables across all patients' datasets (n = 248). Each dataset examines the correlations between ERS, age, triage, the number of times IVO was administered during the ERS, the duration until the next IVO administration after the first PCI (hours), NRS before PCI, NRS after PCI, and NRS reduction.

Table 3.

	ERS	Age	triage	How many times IVO during ERS	duration to next IVO after the first PCI	NRS before PCI	NRS after PCI	NRS reduction
ERS (hour)	--							
Age	.133*	--						
Triage	-.046	.347**	--					
How many times IVO during ERS	.460**	-.082	-.172**	--				
duration to next IVO after the first PCI	.370**	.042	.058	.116	--			
NRS before PCI	.014	-.061	-.226**	.075	-.040	--		
NRS after PCI	.053	-.042	-.144*	.225**	-.199*	.196**	--	
NRS reduction	-.048	.021	.067	-.201**	.190*	.150*	-.940**	--

Pearson Correlation Coefficient.*p<0.05, **p<0.01.

Notably, older patients were associated with more severe triage levels, which often reflect more critical cases, but are linked to fewer pain control administrations. The number of times IVO was administered during the ERS showed a negative correlation with NRS reduction, suggesting that less effective pain control after PCI may lead to an increased need for additional pain management. Additionally, patients with higher initial NRS tended to experience less pain improvement. NRS reduction was inversely correlated with NRS after FNB ($r = -0.940$, $p < 0.01$), indicating effective pain management with FNB alone.

Furthermore, ERS time was positively correlated with the frequency of IVO administration ($r = 0.460$, $p < 0.01$), suggesting that patients with more severe pain or higher medication needs may require an extended ER stay.

4. Discussion

Femoral bone fractures, especially hip fractures, are among the most severe, painful, and life-threatening emergencies. The majority of these patients are in the elderly age group. In such patients, severe pain alone is known to be associated with a higher risk of delirium, increased immobilization time, extended hospital stays, and poor health outcomes [3–5].This study evaluates the efficacy of FNB compared to standard intravenous opioid treatment for pain management in patients with femoral fractures, focusing on pain reduction, opioid use, and related factors. The results will provide valuable insights into optimizing pain control strategies in emergency care settings.

Optimized pain control is critical for patients with fractures, particularly for elderly patients, for whom pain management can be challenging [6]. Opioid use is associated with many adverse effects, ranging from nausea and vomiting to respiratory depression and delirium [7–9].Some studies have shown that the use of peripheral nerve blocks and multimodal analgesia techniques may reduce the incidence of delirium and facilitate early mobilization, thus ultimately reducing morbidity and post-op 1-year mortality after hip surgery [10,11].

Primary Outcome: Pain Reduction

The primary outcome of the study was the difference in NRS reduction between the two groups recorded 60 minutes after intervention. Patients receiving FNB (Group 1) demonstrated significantly

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greater pain reduction compared to those receiving IVO (Group 2). The mean reduction in pain scores was 4.96 ± 1.22 in Group 1 versus 3.99 ± 2.26 in Group 2 ($p < 0.001$). Additionally, the NRS after intervention was significantly lower in Group 1 (3.00 ± 1.21) compared to Group 2 (4.04 ± 2.28, $p < 0.001$). These findings underscore the superior analgesic efficacy of FNB in acute pain management for femoral fractures.

Among the 134 individuals in Group 1, only 49 patients (36.6%) were prescribed additional IVO after FNB during ERS. Group 1's complete absence of IVO use highlights a subgroup of patients who may be adequately managed with FNB alone. Identifying predictors of successful single-modality pain control will help reduce opioid exposure.

Several factors likely contribute to the observed differences. The localized effect of FNB directly targets pain pathways, providing immediate and sustained relief. In contrast, IVO may take longer to achieve systemic distribution and can be less effective in addressing localized pain associated with fractures.

Secondary Outcome: Opioid Use

This study also aims to explore whether effective pain management can reduce the frequency of medication administration and patient assessments by emergency department healthcare providers. Hayashi analyzed 63 randomized studies (4,778 participants) and found that peripheral nerve blocks, including femoral nerve block, 3-in-1 block, fascia iliaca compartment block, and pericapsular nerve group block, significantly reduced pain two hours post-placement compared to no block. However, morphine consumption and hospital stay duration showed no significant differences [12].

Geizhals conducted a retrospective study comparing femoral nerve blocks (FNB) and standard opioid-based pain control for hip fracture patients. Among 180 adults analyzed, preoperative opioid use (measured in morphine milligram equivalents, MMEs) was lower in the FNB group (10.3 MMEs) compared to the control group (14.0 MMEs), though not statistically significant (P=0.13) [13].

While there has been extensive discussion about nerve blocks (NB) in the postoperative setting for such patients, a study of 407 elderly patients in Switzerland with hip fractures showed a significant reduction in the amount of postoperative intravenous opioid analgesic (IVO) usage compared to those who did not receive blocks [14].

Three studies have highlighted the benefits of FNB in hip fracture management. Beaudoin demonstrated that ultrasound-guided FNB provided superior pain relief compared to opioids alone, with fewer rescue analgesics and no significant adverse effects. Gerlier found that early FNB reduced preoperative opioid use by 60% and lowered opioid-related adverse events without delaying pain relief. These findings support FNB as an effective strategy for pain management in hip fractures [12,15,16].

This study evaluated whether preoperative femoral nerve block (FNB) reduces pain and opioid use in elderly hip fracture patients, including those with dementia. A randomized trial involving 266 patients found that FNB significantly lowered pain scores (VAS) and opioid consumption compared to standard care. Patients with dementia also experienced reduced pain and opioid use. These findings support FNB as an effective preoperative pain management strategy for this population [17].

A key secondary outcome was the frequency of opioid administration. Group 1 required significantly fewer opioids during their ER stay, with only 36.6% of patients needing additional IVO after receiving an FNB. The time to IVO after FNB was notably delayed, averaging 6.49 hours, with some cases exceeding 18 hours. In contrast, Group 2 relied solely on IVO for pain control, resulting in more frequent administrations and higher cumulative opioid use. Although the difference in opioid administration frequency approached significance (1.35 in Group 1 vs. 1.64 in Group 2, $p = 0.063$), the trend favors reduced opioid use in Group 1.

These findings highlight the potential of FNB to reduce opioid dependency, an important consideration given the current opioid crisis. Reduced opioid use not only minimizes the risk of side effects and dependency but also reduces the burden on healthcare professionals in medication administration, including the medication process and subsequent evaluations.

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In Correlation and Regression Analysis, the study's correlation analysis revealed important relationships among key variables. A negative correlation between the frequency of IVO and NRS reduction suggests that less effective pain control necessitates additional pain management measures. Conversely, the strong positive correlation between ERS time and opioid frequency underscores the resource implications of suboptimal pain control. Prolonged ERS was correlated with more frequent IVO, suggesting that more severe or persistent pain may necessitate additional interventions. Streamlining pain management protocols could reduce the need for prolonged ERS.

5. Conclusions

The results of this study strongly support the use of femoral nerve block for managing acute pain associated with femoral fractures, as it not only provides superior pain relief but is also associated with a lower incidence of related complications. Further studies are warranted to evaluate whether its use can reduce the frequency of intravenous opioid administration, thereby alleviating the workload of emergency department staff.

Author Contributions: Conceptualization, Kuo-Chen Chung, Shih Chieh Yang and Chih-Cheng Wu.; methodology, Hsiu-E Chen and Subeq Yi-Maun.; software, Chia-Hung Yeh; validation, Chia-Hung Yeh and Chih-Cheng Wu.; data curation, Subeq Yi-Maun; writing—original draft preparation, Kuo-Chen Chung.; writing—review and editing, Chih-Cheng Wu.; supervision, Chih-Cheng Wu.; project administration, Subeq Yi-Maun.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of Taichung Veterans General Hospital (No. CE22273B-1, 18 July 2024).

Informed Consent Statement: Patient consent was waived because this study is a retrospective comparative analysis and does not involve any identifiable participating patients.

Data Availability Statement: Data sharing is not applicable.

Acknowledgments: The authors thank the Biostatistics Group, Department of Medical Research, Taichung Veterans General Hospital and Mr. Chen, Jun-Peng for statistical analysis.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

NRS	numerical rating scale
IVO	intravenous opioid
ER	emergency department
FNB	femoral nerve blocks
PCI	pain control intervention
ISS	Injury Severity Score
ERS	emergency room stay time

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