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ORIGINAL RESEARCH

Association of Preoperative Continuous Peripheral Nerve Blocks with Early Opioid Requirements and Pain in Older Adults with Hip Fracture: A Retrospective Cohort Study

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Purpose: To evaluate whether continuous peripheral nerve blocks (PNBs) are independently associated with reduced early opioid consumption and improved pain outcomes in older adults with hip fractures.

Methods: Patients aged ≥65 years admitted with hip fractures were included in this retrospective cohort study and categorized into a PNB group (continuous fascia iliaca compartment block or continuous femoral nerve block) and a control group without peripheral nerve block. The primary outcome was cumulative fentanyl-equivalent opioid consumption within 24 hours after admission. Secondary outcomes included pain intensity (Numeric Rating Scale [NRS]), postoperative opioid consumption within 24 hours after surgery, delirium, length of hospital stay, and catheter-related complications. Multivariable linear regression adjusted for age, sex, ASA physical status, fracture type, and time to surgery.

Results: In total, 203 patients were analyzed (PNB, n = 147; control, n = 56); 36.0% underwent surgery within 48 hours of admission. Opioid consumption within 24 hours after admission was lower in the PNB group (median [IQR]: 50 [0–90] μg vs 100 [60–150] μg; $p < 0.001$). After adjustment, continuous PNB remained independently associated with reduced opioid consumption within 24 hours after admission (adjusted β −43.8 μg; 95% CI −59.3 to −28.3; $p < 0.001$) and within 24 hours postoperatively (adjusted β −63.2 μg; 95% CI −79.7 to −46.7; $p < 0.001$). Pain scores improved after block placement and remained lower at 24 hours after admission and postoperatively. Longer time to surgery was independently associated with increased opioid consumption. Delirium, length of stay, and catheter-related complications did not differ significantly between groups.

Conclusion: In older adults with hip fractures, continuous peripheral nerve block was independently associated with reduced opioid consumption and improved perioperative pain control, and may support perioperative analgesia in healthcare settings where surgical delay is common.

Keywords: hip fracture, continuous peripheral nerve block, fascia iliaca block, femoral nerve block, opioid consumption, regional anesthesia

Introduction

Hip fractures in older adults are associated with substantial morbidity, functional decline, and increased short-term mortality.[1–3] Acute pain following hip fracture is frequently severe and, when inadequately controlled, contributes to immobility, pulmonary complications, delirium, and prolonged hospitalization.[4–6] Older adults are particularly vulnerable to opioid-related adverse effects, including sedation, respiratory depression, constipation, and delirium, making opioid-

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sparing strategies clinically important.[6–8] Consequently, multimodal analgesia is strongly recommended in this population.[8,9]

Peripheral nerve blocks have become an integral component of perioperative analgesia for hip fracture surgery. High-quality evidence demonstrates that single-injection femoral nerve block (FNB) or fascia iliaca compartment block (FICB) reduces early pain intensity and opioid consumption compared with systemic analgesia alone.[10–14] These findings are reflected in contemporary guideline recommendations, including the PROSPECT procedure-specific recommendations for hip fracture repair, which endorse single-shot FNB or FICB as part of basic multimodal analgesia.[15,16]

Despite their effectiveness, single-injection techniques have a limited duration of action, and breakthrough pain may occur once the block resolves, particularly when surgery is delayed. Continuous peripheral nerve block (CPNB) techniques, such as continuous fascia iliaca compartment block (C-FICB) and continuous femoral nerve block (C-FNB), may provide sustained analgesia throughout both the preoperative and early postoperative periods. However, current PROSPECT guidance does not recommend routine catheter use, citing limited incremental benefit in fast-track systems, while acknowledging that continuous techniques may be considered when surgery is expected to be delayed.[15]

Early surgery is widely recognized as a quality benchmark in hip fracture care. National and international guidelines recommend operative management within 36–48 hours of admission, based on evidence associating surgical delay with increased mortality and complications.[17–20] Despite institutional goals aligned with these benchmarks, delays to surgery remain common in many tertiary-care settings because of operating room availability and the need for preoperative medical optimization.[21,22] In such contexts, repeated systemic opioid administration during prolonged preoperative waiting periods may increase the risk of opioid-related adverse events. Continuous peripheral nerve blocks could address this analgesic gap by providing sustained, opioid-sparing pain control during the preoperative delay; however, real-world data evaluating their effectiveness in geriatric hip fracture populations remain limited.

Therefore, this retrospective cohort study aimed to evaluate the association between continuous peripheral nerve block use and early opioid requirements within 24 hours after admission, as well as perioperative pain intensity, in older adults admitted with hip fractures. We hypothesized that continuous PNBs would be associated with reduced early opioid consumption and improved pain control compared with no peripheral nerve block.

Patients and Methods

Study Design and Setting

This retrospective cohort study was conducted at Srinagarind Hospital, a tertiary university hospital in northeastern Thailand with a dedicated Acute Pain Service. Electronic medical records and the institutional Acute Pain Service database were reviewed for consecutive patients admitted with hip fractures between September 1, 2022, and October 31, 2023.

The study was designed and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[23]

Participants

Patients aged 65 years or older who were admitted with a diagnosis of femoral neck, intertrochanteric, or subtrochanteric fracture and subsequently underwent surgical management were eligible for inclusion.

Exclusion criteria were:

1. Incomplete medical records affecting primary outcome assessment.
2. Pre-existing chronic hip pain requiring long-term opioid therapy.
3. Pathological fractures related to malignancy.
4. Periprosthetic fractures.

A total of 210 patients were screened. Seven were excluded because of incomplete data, resulting in 203 patients included in the final analysis.

Institutional Analgesic Pathway

At our institution, the target time to surgery is within 48 hours from admission. However, because of operating room availability and the need for preoperative medical optimization, surgical delay beyond this timeframe occurs in a substantial proportion of patients.

Upon admission, an institutional geriatric hip fracture care pathway is activated, and the multidisciplinary care team—including anesthesiology and acute pain service providers—is notified. The Acute Pain Service provides catheter-based regional analgesia during daytime hours on weekdays. Accordingly, continuous peripheral nerve blocks are routinely considered early after admission when clinically appropriate, particularly in patients anticipated to experience surgical delay, with the goal of providing sustained preoperative analgesia and reducing systemic opioid requirements. When not contraindicated, catheter placement is typically performed soon after admission as part of the standardized perioperative analgesic strategy. Contraindications to catheter placement included infection at the planned insertion site and patient refusal.

Exposure and Group Allocation

Patients were categorized into two groups:

- PNB group: received continuous peripheral nerve block (continuous fascia iliaca compartment block [C-FICB] or continuous femoral nerve block [C-FNB])
- Control group: received standard systemic analgesia without peripheral nerve block

Block technique selection was based on clinical judgment, anatomical considerations, and resource availability. All blocks were performed under ultrasound guidance by anesthesiologists or supervised anesthesia trainees using standardized institutional protocols.

For continuous blocks, an initial bolus of local anesthetic (typically 0.25% bupivacaine with epinephrine 5 μg/mL) was administered at a volume of 20–30 mL depending on block type (detailed in Table 1), followed by continuous infusion of 0.1% bupivacaine through an indwelling catheter.

Table 1 Characteristics of Continuous Peripheral Nerve Blocks

Characteristics	Total (n = 147)	FICB (n = 127)	FNB (n = 20)	p-value
Time from admission to catheter insertion (h)	16.0 (5.0–21.0)	16.0 (5.0–21.0)	14.5 (11.0–19.5)	0.80
Type of bolus local anesthetic, n (%)				>0.999
0.25% bupivacaine + epinephrine 5 μg/mL	143 (97.3)	123 (96.9)	20 (100)	
0.25% levobupivacaine + epinephrine 5 μg/mL	4 (2.7)	4 (3.1)	0 (0)	
Bolus volume (mL)	30.0 (25.0–30.0)	30.0 (30.0–30.0)	20.0 (20.0–20.0)	<0.001
Type of continuous local anesthetic, n (%)				0.524
0.1% bupivacaine	142 (96.6)	123 (96.9)	19 (95.0)	
Others	5 (3.4)	4 (3.1)	1 (5.0)	
Infusion rate (mL/h)	6.0 (6.0–6.0)	6.0 (6.0–6.0)	4.0 (4.0–4.5)	<0.001
Catheter indwelling time (days)	4.0 (2.0–5.0)	4.0 (2.0–6.0)	4.5 (3.0–5.0)	0.716
Timing of catheter removal, n (%)				0.52
In operating room	54 (36.7)	46 (36.2)	8 (40.0)	
Postoperative day 1	17 (11.6)	12 (9.4)	5 (25.0)	
Postoperative day 2	19 (12.9)	17 (13.4)	2 (10.0)	
Postoperative day 3	15 (10.2)	14 (11.0)	1 (5.0)	
After postoperative day 3	15 (10.2)	14 (11.0)	1 (5.0)	

Notes: Data are presented as median (interquartile range) or number (%). Mann–Whitney *U*-test for continuous variables; Pearson chi-squared or Fisher's exact test for categorical variables.

Perioperative Analgesia and Opioid Conversion

Systemic analgesia consisted of paracetamol and intravenous opioids (fentanyl or morphine) administered as needed. Non-steroidal anti-inflammatory drugs were used selectively, depending on renal function and comorbidities, consistent with geriatric pain management recommendations.[8,9]

All opioid doses were converted to intravenous fentanyl-equivalent doses to allow standardized comparison across patients. Conversion ratios were derived from established equianalgesic tables,[24] assuming that 10 mg of intravenous morphine is approximately equivalent to 100 μg of intravenous fentanyl.

Outcome Measures

Primary Outcome

The primary outcome was cumulative fentanyl-equivalent opioid consumption within 24 hours after hospital admission.

Secondary Outcomes

Secondary outcomes included:

- Numeric Rating Scale (NRS) pain scores:
  a. Before and after block placement (PNB group only)
  b. At 24 hours after admission (rest and movement)
  c. At 24 hours postoperatively (rest and movement)
- Postoperative cumulative fentanyl-equivalent opioid consumption within 24 hours after surgery
- Length of hospital stay
- Incidence of in-hospital delirium
- Opioid-related adverse events (nausea, vomiting, sedation, respiratory depression)
- Catheter-related complications (infection, hematoma, displacement)

Pain intensity was assessed using an 11-point Numeric Rating Scale (0 = no pain; 10 = worst imaginable pain).

Delirium was identified based on documented clinical diagnosis made by attending geriatricians during hospitalization. At our institution, geriatricians routinely use the Confusion Assessment Method (CAM) as part of standard clinical assessment, and documentation-based diagnosis was used to reflect real-world practice in geriatric hip fracture patients, in whom delirium is a common and clinically important complication.[6,7]

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA).

Continuous variables were assessed for normality using the Shapiro–Wilk test and visual inspection of histograms. Normally distributed variables are presented as mean ± standard deviation (SD), whereas non-normally distributed variables are presented as median with interquartile range (IQR). Categorical variables are expressed as counts and percentages.

Between-group comparisons were conducted using the independent *t*-test or Mann–Whitney *U*-test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables, as appropriate.

Because pain intensity measurements involved repeated observations within individuals, generalized estimating equations (GEE) were used to account for within-subject correlation. A Gaussian distribution with identity link function and an exchangeable working correlation structure were specified.

For opioid consumption outcomes, multivariable linear regression models were constructed to estimate adjusted regression coefficients (β) with 95% confidence intervals (CI). Models were adjusted a priori for clinically relevant covariates, including age, sex, ASA physical status, fracture type, and time from admission to surgery (hours). Time to surgery was analyzed as a continuous variable.

Multicollinearity was assessed using variance inflation factors (VIF), with values >5 considered indicative of significant collinearity. All VIF values in the final regression models were below 1.12 (range 1.02–1.11), indicating no evidence of multicollinearity among covariates.

As this was a retrospective cohort study utilizing all eligible consecutive patients over the study period, a formal prospective sample size calculation was not performed. The final analytic sample of 203 patients reflects complete case availability. To contextualize the adequacy of the sample, a post hoc power analysis was conducted for the primary outcome using the observed group means (PNB: 52.2 μg; control: 98.5 μg), pooled standard deviation (49.6 μg), and actual group sizes (n = 147 and n = 56), corresponding to a large effect size (Cohen's d = 0.93). Based on a two-sided alpha of 0.05 and the observed group size ratio, a minimum total sample of approximately 48 patients (35 PNB and 13 control) would be required to achieve 80% power. The enrolled sample of 203 patients substantially exceeded this requirement, yielding an estimated post hoc power exceeding 99.9%. It is acknowledged that post hoc power estimates are inherently circular and should be interpreted cautiously; the precision of effect estimates is more reliably reflected by the 95% confidence intervals reported for each outcome.

A two-sided p-value < 0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the Khon Kaen University Ethics Committee for Human Research (Reference No. HE671408). The requirement for informed consent was waived because of the retrospective design. The study was conducted in accordance with the Declaration of Helsinki.[25]

Results

Study Flow

During the study period, 210 patients aged ≥65 years with hip fractures were screened. Seven patients were excluded because of incomplete data relevant to the primary outcome, leaving 203 patients for final analysis (Figure 1). Of these, 147 patients (72.4%) received continuous peripheral nerve blocks (PNB group), including continuous fascia iliaca compartment block (C-FICB) in 127 patients and continuous femoral nerve block (C-FNB) in 20 patients, while 56 patients (27.6%) received no peripheral nerve block (control group).

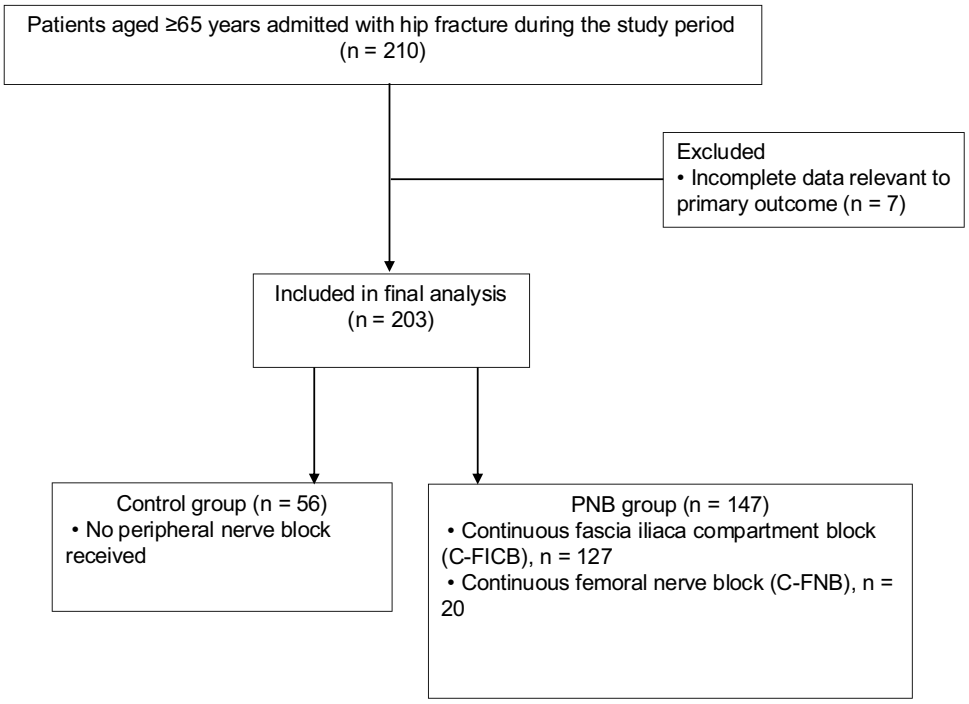

Figure 1 Study flow diagram of patient selection.
Abbreviations: PNB, peripheral nerve block; C-FICB, continuous fascia iliaca compartment block; C-FNB, continuous femoral nerve block.

Baseline Characteristics

Baseline demographic and clinical characteristics are summarized in Table 2. The mean age of the cohort was 78.8 ± 8.1 years, and 145 patients (71.4%) were female. Most patients had ASA physical status II or III. Fracture types included femoral neck (41.4%), intertrochanteric (56.2%), and subtrochanteric (2.5%) fractures. Baseline characteristics were generally comparable between groups. The median time from admission to surgery was 56.0 hours (IQR 42.5–74.5). Overall, 73 patients (36.0%) underwent surgery within 48 hours of admission, whereas 130 patients (64.0%) experienced surgical delay beyond 48 hours.

Peripheral Nerve Block Characteristics

Characteristics of continuous peripheral nerve blocks are presented in Table 1. The median time from admission to catheter insertion was 16.0 hours (IQR 5.0–21.0). Most patients received an initial bolus of 0.25% bupivacaine with epinephrine followed by continuous infusion of 0.1% bupivacaine. Continuous femoral nerve block used lower bolus volumes and infusion rates compared with continuous fascia iliaca compartment block.

Primary Outcome: Opioid Consumption Within 24 Hours After Admission

Unadjusted cumulative fentanyl-equivalent opioid consumption within 24 hours after admission was significantly lower in the PNB group compared with the control group (median [IQR]: 50 [0–90] μg vs 100 [60–150] μg; $p < 0.001$) (Table 3).

Table 2 Baseline Demographic and Clinical Characteristics

Characteristics	Total (n = 203)	Control (n = 56)	PNB Group (n = 147)	p-value
Age (years), mean ± SD	78.8 ± 8.1	78.4 ± 8.4	79.0 ± 8.0	0.66
Sex, n (%)				0.487
Male	58 (28.6)	14 (25.0)	44 (29.9)	
Female	145 (71.4)	42 (75.0)	103 (70.1)	
Body weight (kg), median (IQR)	50 (45–60)	50 (45–60)	50 (45–60)	0.954
Height (cm), median (IQR)	155 (150–164)	155 (150–165)	155 (150–163)	0.942
BMI (kg/m^2), median (IQR)	21.4 (19.5–23.4)	21.7 (19.9–23.8)	21.3 (19.4–23.3)	0.555
ASA-PS, n (%)				0.799
II	110 (54.2)	29 (51.8)	81 (55.1)	
III	92 (45.3)	26 (46.4)	66 (44.9)	
IV	1 (0.5)	1 (1.8)	0 (0)	
Fracture type, n (%)				0.781
Femoral neck fracture	84 (41.4)	22 (39.3)	62 (42.2)	
Intertrochanteric fracture	114 (56.2)	33 (58.9)	81 (55.1)	
Subtrochanteric fracture	5 (2.5)	1 (1.8)	4 (2.7)	
Time from admission to surgery (h), median (IQR)	56.0 (42.5–74.5)	58.5 (44.0–76.0)	55.0 (41.0–73.0)	0.68

Notes: Data are presented as mean ± standard deviation, median (interquartile range), or number (%), as appropriate. †PNB group included patients who received continuous fascia iliaca compartment block or continuous femoral nerve block.
Abbreviations: ASA-PS, American Society of Anesthesiologists Physical Status; BMI, body mass index; IQR, interquartile range.

Table 3 Cumulative Fentanyl-Equivalent Opioid Consumption (μg) at 24 Hours After Admission and 24 Hours Postoperatively

Cumulative Fentanyl Consumption (μg)	Total (n = 203)	Control (n = 56)	PNB Group (n = 147)	p-value
24 h after admission	60 (25–100)	100 (60–150)	50 (0–90)	<0.001
24 h postoperatively	30 (0–90)	95 (40–150)	25 (0–60)	<0.001

Notes: Data are presented as median (interquartile range). Comparisons were performed using the Mann–Whitney *U*-test.

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In the multivariable linear regression model adjusted for age, sex, ASA physical status, fracture type, and time from admission to surgery (hours), receipt of continuous PNB remained independently associated with reduced opioid consumption within 24 hours after admission (adjusted β −43.8 μg; 95% CI −59.3 to −28.3; p < 0.001) (Table 4).

Time to surgery was independently associated with increased opioid consumption; each additional hour of delay was associated with an increase of 0.50 μg in fentanyl-equivalent opioid use (95% CI 0.19 to 0.81; p = 0.002).

Secondary Outcomes

Pain Intensity

In the PNB group, pain scores decreased substantially after block placement (Table 5). NRS at rest decreased from a median (IQR) of 5 (3–6) before block placement to 0 (0–0) after block placement, while NRS on movement decreased from 8 (6–10) to 2 (0–3).

Table 4 Multivariable Linear Regression Models for Opioid Consumption

Variable	24h After Admission β (95% CI)	p-value	24h Postoperatively β (95% CI)	p-value
Continuous PNB (yes vs no)	−43.8 (−59.3 to −28.3)	<0.001	−63.2 (−79.7 to −46.7)	<0.001
Age (per year)	−0.15 (−1.06 to 0.76)	0.744	−0.15 (−1.09 to 0.80)	0.758
Male (vs female)	−6.40 (−22.0 to 9.20)	0.42	−11.8 (−28.3 to 4.77)	0.162
ASA III (vs II)	15.0 (1.30 to 28.7)	0.032	2.63 (−12.0 to 17.2)	0.723
ASA IV (vs II)	−59.3 (−159.2 to 40.6)	0.243	−61.4 (−165.7 to 42.9)	0.247
Femoral neck fracture	−3.10 (−17.6 to 11.4)	0.672	−28.0 (−43.4 to −12.5)	<0.001
Subtrochanteric fracture	−12.5 (−62.6 to 37.6)	0.621	8.65 (−44.7 to 62.0)	0.75
Time to surgery (per hour)	+0.50 (0.19 to 0.81)	0.002	+0.49 (0.15 to 0.82)	0.004

Notes: Values are presented as adjusted regression coefficients (β) with 95% confidence intervals from multivariable linear regression models. The dependent variable was cumulative fentanyl-equivalent opioid consumption (μg). Models were adjusted for age, sex, ASA physical status, fracture type, and time to surgery. Variance inflation factor values for all covariates were low across models (range 1.02–1.11), indicating no multicollinearity.
Abbreviations: PNB, peripheral nerve block; ASA, American Society of Anesthesiologists; CI, confidence interval; VIF, variance inflation factor.

Table 5 Pain Intensity Before and After Peripheral Nerve Block, and at 24 Hours After Admission and Postoperatively

Time Point	Control Group (n = 56)	PNB Group (n = 147)	p-value
Before block placement*			
NRS at rest	—	5 (3–6)	—
NRS on movement	—	8 (6–10)	—
After block placement*			
NRS at rest	—	0 (0–0)	—
NRS on movement	—	2 (0–3)	—
24 h after admission			
NRS at rest	3 (0–5)	0 (0–3)	0.003
NRS on movement	7 (5–8)	5 (2–6)	<0.001
24 h postoperatively			
NRS at rest	0 (0–3)	0 (0–0)	<0.001
NRS on movement	5 (3–7.5)	3 (0–5)	<0.001

Notes: Data are presented as median (interquartile range). Comparisons between groups were performed using the Mann–Whitney *U*-test. *Before and after block placement data were available only in the PNB group. Therefore, no between-group statistical comparison was performed for these measurements.
Abbreviations: NRS, Numeric Rating Scale; PNB, peripheral nerve block.

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At 24 hours after admission, the PNB group reported significantly lower NRS scores compared with controls both at rest (median [IQR]: 0 [0–3] vs 3 [0–5]; p = 0.003) and on movement (5 [2–6] vs 7 [5–8]; p < 0.001).

At 24 hours postoperatively, pain scores remained lower in the PNB group both at rest (0 [0–0] vs 0 [0–3]; p < 0.001) and during movement (3 [0–5] vs 5 [3–7.5]; p < 0.001).

Postoperative Opioid Consumption

Postoperative fentanyl-equivalent opioid consumption within 24 hours after surgery was significantly lower in the PNB group than in the control group (median [IQR]: 25 [0–60] μg vs 95 [40–150] μg; p < 0.001) (Table 3).

After multivariable adjustment including time to surgery, continuous PNB remained independently associated with reduced postoperative opioid consumption (adjusted β −63.2 μg; 95% CI −79.7 to −46.7; p < 0.001) (Table 4).

Longer time to surgery was also associated with increased postoperative opioid consumption (adjusted β +0.49 μg per hour; 95% CI 0.15 to 0.82; p = 0.004). Variance inflation factor (VIF) values for all covariates across models were low (range 1.02–1.11), confirming the absence of multicollinearity.

Delirium and Length of Hospital Stay

The incidence of in-hospital delirium did not differ significantly between groups (PNB: 5.4% vs control: 10.7%). Length of hospital stay was also comparable (median [IQR]: 10 [8–15] days in the PNB group vs 9.5 [8–15] days in the control group).

Block-Related and Opioid-Related Complications

Catheter-related complications were uncommon. Catheter dislodgement occurred in 24 patients (16.3%), and catheter-related infection occurred in 1 patient (0.7%). Timing of planned catheter removal is summarized in Table 1. No major neurological or hematoma-related complications were documented.

Opioid-related adverse events were infrequent and similar between groups.

Discussion

In this retrospective cohort study of older adults admitted with hip fractures, continuous peripheral nerve blocks were associated with significantly reduced opioid consumption within the first 24 hours after admission and during the early postoperative period. After adjustment for age, sex, ASA physical status, fracture type, and time to surgery, continuous PNB use was associated with a 43.8 μg reduction in fentanyl-equivalent opioid consumption during the first 24 hours after admission and a 63.2 μg reduction within 24 hours postoperatively. These findings suggest a clinically meaningful opioid-sparing effect in routine clinical practice and support the potential role of catheter-based regional analgesia in perioperative pain management for geriatric hip fracture patients.

Importantly, time to surgery was independently associated with opioid consumption. Each additional hour of delay was associated with approximately a 0.5 μg increase in fentanyl-equivalent opioid consumption. This finding provides mechanistic support for the hypothesis that prolonged preoperative intervals increase analgesic demand and highlights the potential role of sustained regional analgesia during surgical delay. In healthcare systems where operating room access or preoperative optimization may delay surgery, prolonged preoperative pain exposure may lead to repeated systemic opioid administration. Continuous peripheral nerve blocks may therefore function as a bridging analgesic strategy during unavoidable delays to surgery.

Hip fractures in older adults are associated with substantial morbidity and excess mortality,[1–3] and inadequate pain control has been linked to worse functional recovery and increased delirium risk.[4–7] Given the heightened susceptibility of older patients to opioid-related adverse effects,[6–9] reducing systemic opioid exposure is a central goal of perioperative care. Multimodal analgesic strategies incorporating regional anesthesia have therefore become an important component of hip fracture management.

High-quality evidence supports single-injection femoral nerve block and fascia iliaca compartment block for acute pain control in hip fracture patients.[10–14] Multiple systematic reviews and meta-analyses confirm that peripheral nerve blocks reduce early pain intensity and opioid consumption compared with systemic analgesia alone.[26–28] These findings

underpin contemporary guideline recommendations, including PROSPECT.[15,16] However, PROSPECT does not recommend routine catheter placement in fast-track surgical systems, citing limited incremental benefit over single-injection techniques.[15] Importantly, the same guidance acknowledges that continuous techniques may be appropriate when surgery is expected to be delayed.[15] Our findings provide real-world evidence supporting this context-specific recommendation, particularly in healthcare environments where early surgery cannot always be achieved. It should be noted that in our institutional setting during the study period, single-shot peripheral nerve blocks were not routinely offered as a standalone analgesic strategy; the clinical decision was therefore between catheter-based continuous PNB and systemic opioid analgesia alone. While single-shot blocks are endorsed as standard of care by major international societies, an opioid-only comparator group remains clinically relevant in settings where resource constraints limit consistent access to regional anesthesia. Comparison of continuous PNB against single-shot blocks would be an important question for future prospective trials.

Early surgical management is widely regarded as a quality benchmark in hip fracture care. NICE recommends surgery within 36 hours of admission,[17] while the Australian and New Zealand Hip Fracture Registry targets surgery within 48 hours, with several centers aiming for even earlier intervention.[18] The American Academy of Orthopaedic Surgeons similarly recommends operative management within 48 hours based on moderate-quality evidence linking early surgery with reduced mortality and complications.[19] Observational meta-analyses consistently demonstrate worse outcomes with surgical delay.[20–22,29] Despite these international benchmarks, only 36.0% of patients in our cohort underwent surgery within 48 hours of admission, reflecting persistent system-level constraints in real-world practice.

In such contexts, prolonged preoperative waiting periods may necessitate repeated opioid administration, thereby increasing cumulative opioid exposure. Our finding that surgical delay independently increased opioid consumption strengthens the rationale for considering continuous peripheral nerve blocks as a strategy to mitigate opioid exposure during extended preoperative intervals. Implementation studies have demonstrated that structured regional analgesia pathways can be safely integrated into hip fracture care and may improve analgesic consistency in real-world settings.[30,31]

Although continuous PNB use was associated with significant reductions in opioid consumption and improved pain scores, we did not observe statistically significant differences in delirium or length of hospital stay. Delirium is multifactorial and influenced by baseline frailty, cognitive impairment, and perioperative stressors beyond analgesic modality alone.[6,7] Furthermore, several studies evaluating peripheral nerve blocks have shown inconsistent effects on delirium incidence despite reductions in opioid use.[26,32] These findings suggest that while regional analgesia may contribute to improved pain control, broader multidisciplinary strategies remain essential for reducing postoperative delirium and improving overall outcomes in geriatric hip fracture patients.

The safety profile observed in this cohort was acceptable. Catheter-related complications were infrequent and no major neurological events occurred. Previous studies evaluating continuous peripheral nerve blocks have similarly reported low rates of serious complications, with infection and catheter dislodgement occurring infrequently when performed under appropriate aseptic and ultrasound-guided conditions. Within the PNB group, a descriptive comparison between C-FICB (n = 127) and C-FNB (n = 20) showed similar opioid consumption at 24 hours after admission (median [IQR]: 50 [0–90] μg vs 30 [0–55] μg) and postoperatively (25 [0–60] μg vs 15 [0–55] μg), as well as comparable pain score reductions after block placement (NRS at rest: 0 [0–0] vs 0 [0–0]; NRS on movement: 2 [0–3] vs 3 [0–3]). No statistically significant differences between block types were observed in pain scores at any time point by GEE analysis (all $p > 0.05$). However, given the small sample size of the C-FNB subgroup, these observations are hypothesis-generating and insufficient to support formal conclusions regarding the comparative effectiveness of the two techniques; adequately powered prospective studies are required.[27,28,33] These findings support the feasibility of selective continuous catheter use when appropriate expertise and monitoring are available.

Finally, several methodological considerations should be acknowledged when interpreting these findings. Because catheter placement occurred after hospital admission, the potential for timing-related bias cannot be completely excluded. However, opioid consumption was measured from the time of admission in both groups, meaning that patients in the PNB group could receive systemic opioids prior to catheter placement. This would tend to bias the results toward underestimating rather than exaggerating the opioid-sparing effect of continuous peripheral nerve blocks.

Strengths

This study reflects real-world implementation of continuous peripheral nerve blocks in a tertiary-care setting with substantial preoperative surgical delay. Unlike many randomized trials conducted in expedited surgical pathways, our cohort captures the clinical reality of delayed operative management. The inclusion of time to surgery in multivariable modeling strengthens the internal validity of the observed association between continuous PNB use and reduced opioid consumption and provides insight into the interaction between system-level delay and analgesic demand.

Future Directions

Several directions merit further investigation. First, future prospective studies may further evaluate analgesic trajectories beyond the early perioperative period, including outcomes in patients with extended preoperative waiting times, to more comprehensively characterize the role of continuous PNB in this context. Second, randomized controlled trials comparing continuous PNB against single-shot peripheral nerve block as an active comparator would more rigorously address the incremental benefit of catheter-based analgesia and would align with evolving standard-of-care recommendations. Third, adequately powered prospective studies comparing C-FICB and C-FNB directly are needed, as the current analysis was limited by the small C-FNB subgroup (n = 20) and could only provide descriptive, hypothesis-generating comparisons between techniques.

Limitations

The retrospective design introduces potential selection bias and residual confounding. Block allocation was not randomized and may have been influenced by clinical factors not captured in the dataset. Although multivariable adjustment was performed, unmeasured confounders cannot be excluded. Patients in the control group did not receive peripheral nerve blocks primarily because of contraindications (infection at the insertion site or patient refusal), patient preference, or service availability, as the Acute Pain Service operated during daytime hours on weekdays only; while these factors are unlikely to directly confound the primary analgesic outcome, their potential influence on secondary outcomes cannot be entirely excluded. Additionally, data on the type of anesthesia used for surgery (neuraxial versus general anesthesia) were not available in the current dataset; as anesthetic technique may independently influence postoperative pain, this represents a potential source of residual confounding for postoperative secondary outcomes. The primary and secondary outcomes were assessed within the first 24 hours after admission; while this captures the early perioperative period, it does not fully characterize analgesic benefit across the entire preoperative waiting period in patients with the longest surgical delays. Pain assessments and delirium diagnoses were based on routine clinical documentation rather than standardized research screening instruments. Finally, this was a single-center study, and generalizability to high-throughput fast-track systems may be limited.

Conclusion

In older adults admitted with hip fractures, continuous peripheral nerve blocks were independently associated with reduced early opioid consumption and improved perioperative pain control. These findings suggest that catheter-based regional analgesia may support perioperative pain management in healthcare settings where surgical delay is common, though prospective studies are needed to more directly evaluate analgesic outcomes across the full preoperative waiting period.

Data Sharing Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Consent for Publication

Patient consent for publication was waived because this study involved retrospective analysis of anonymized data and contained no identifiable personal information.

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Disclosure

The authors report no conflicts of interest in this work.

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