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Efficacy and Safety of Ropivacaine versus Levobupivacaine in Ultrasound-Guided Femoral Nerve Blocks for Perioperative Analgesia in Femur Fracture Patients: A Systematic Review

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ABSTRACT

Background and Aims: Femur fractures impose significant perioperative pain challenges, complicating spinal anesthesia positioning and increasing opioid reliance. Femoral nerve block (FNB) using ropivacaine or levobupivacaine offers opioid-sparing analgesia, yet no systematic review has directly compared these agents' efficacy and safety in this context. This review aimed to synthesize evidence on ropivacaine versus levobupivacaine FNB for perioperative analgesia and positioning in femur fracture patients.
Methods: Following PRISMA 2020 guidelines, we searched PubMed/MEDLINE, ScienceDirect, Cochrane Central Register of Controlled Trials (CENTRAL), and Google Scholar from 2015 to 2025 using MeSH terms and keywords: ("Nerve Block"[MeSH] OR "femoral nerve block") AND ("Ropivacaine"[MeSH] OR "Levobupivacaine"[MeSH]) AND ("Femoral Fractures"[MeSH] OR "femur fracture") AND ("Analgesia"[MeSH] OR "Pain, Postoperative"). RCTs and prospective studies on adult/pediatric femur fractures were included. Data extraction, RoB 2/NOS assessments, and narrative synthesis addressed VAS scores, spinal times, opioid use, and adverse events.
Results: Eight studies (7 RCTs, 1 observational, primarily intertrochanteric fractures) were included after screening 1,247 records. Ropivacaine (0.2–0.75%, 15–20 mL) consistently reduced pre-spinal VAS (3–5 vs 7–8; P<0.001), shortened positioning times (2.8–3.7 vs 5.9–7.7 min), and extended analgesia (8–13 h) versus fentanyl/SAB alone. Levobupivacaine (0.25%, continuous catheters) improved rest pain but not dynamic outcomes. Direct comparisons were limited; ropivacaine showed faster onset, levobupivacaine equivalent duration. Most RCTs had some concerns (allocation/blinding unclear); one high risk. No major toxicities occurred.
Conclusion: Ultrasound-guided FNB with ropivacaine or levobupivacaine provides safe, effective analgesia for femur fractures, favoring ropivacaine for rapid positioning relief. Larger head-to-head RCTs are needed to confirm agent superiority.

Keywords: Nerve Block; Ropivacaine; Levobupivacaine; Femoral Fractures; Analgesia; Regional Anesthesia

INTRODUCTION

Femoral nerve blocks (FNBs) using ropivacaine or levobupivacaine provide effective analgesia for femur fractures, particularly facilitating positioning for spinal anesthesia and reducing perioperative opioid needs. Systematic reviews confirm FNB's superiority over intravenous analgesics (IVA) for pain relief during positioning, with mean VAS reductions of 2-3 cm and shorter spinal times, though evidence certainty remains low to moderate due to bias risks and small trials. Ropivacaine (0.2-0.5%) and levobupivacaine (0.25%) yield comparable durations and quality, with no significant hemodynamic changes or major toxicity reported [1,2,3,4].

Femur fractures, encompassing intertrochanteric, neck, shaft, and distal variants, impose substantial morbidity, particularly in elderly patients with comorbidities, where acute pain exacerbates delirium, prolongs immobility, and escalates opioid-related complications. Perioperative analgesia is pivotal, yet systemic opioids often yield suboptimal positioning for neuraxial anesthesia, hemodynamic instability, and postoperative ileus. Femoral nerve block (FNB), targeting the primary femoral fracture innervation, has gained traction as an opioid-sparing alternative, leveraging ultrasound guidance for precision and safety since the early 2010s [5,6,7,1].

A 2019 meta-analysis (5 RCTs, n=254 hip fractures) reported pre-operative FNB reduced VAS pain by 2.13 cm (95% CI -3.53 to -0.72) during spinal positioning versus systemic agents. Guay et al.'s 2020 Cochrane review (11 RCTs, n=503) affirmed peripheral blocks like FNB lowered movement pain (SMD -0.84; 95% CI -1.34 to -0.34), opioids (MD -5.47 mg; 95% CI -9.79 to -1.15), and pneumonia risk. Recent RCTs reinforce this: USG-FNB with ropivacaine shortened spinal times (2.8 vs 5.9 min) and VAS (3 vs 8) in intertrochanteric fractures. Continuous FNB catheters improved rest pain but not dynamic outcomes in pragmatic trials [7,1,2,8].

Local anesthetics ropivacaine (S-enantiomer, less cardiotoxic) and levobupivacaine (pure S-isomer of bupivacaine) dominate FNB protocols. Ropivacaine (0.2-0.5%, 15-20 mL) offers rapid onset and 8-13-hour analgesia, while levobupivacaine (0.25%, 20-30 mL) provides comparable or slightly prolonged blockade with fewer rescues. A 2017 meta-analysis equated them in peripheral blocks (duration difference <30 min), yet hip fracture-specific head-to-heads are scarce. Emerging 2024 data from PENG blocks (related pericapsular technique) showed noninferiority (861 vs 1205 min) [9,3,4,10,11].

Despite advances, research gaps persist: no PubMed systematic review exclusively synthesizes FNB using ropivacaine/levobupivacaine for femur fractures (vs. broader hip/blocks). Heterogeneity in concentrations, volumes, ultrasound use, and endpoints (positioning vs. postoperative) hinders pooled estimates, while shaft/distal fractures and pediatrics remain underexplored. Amid opioid crises and enhanced recovery mandates, clarifying agent-specific efficacy is urgent [2,12,7].

This systematic review addresses these voids by appraising recent RCTs/prospective studies on ropivacaine/levobupivacaine FNBs in femur fractures, offering novel agent-comparative insights absent in prior syntheses. Its rationale lies in guiding anesthetic choice amid equivocal direct comparisons, enhancing precision medicine. Significance includes informing guidelines (e.g., ERAS Society), reducing opioid burdens, and optimizing high-risk elderly care. Novelty stems from fracture-focused scope, recent literature (2011-2026), and potential meta-analytic risk ratios for key outcomes.

Research Question: In patients with femur fractures, what is the comparative efficacy and safety of ropivacaine versus levobupivacaine in femoral nerve blocks for perioperative analgesia and positioning?

METHODS

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [13].

Eligibility Criteria

Studies were included if they met the following PICOS criteria:

- **Population**: Adult or pediatric patients (aged ≥16 years) with acute femur fractures (intertrochanteric, neck, shaft, subtrochanteric, or distal).
- **Intervention**: Femoral nerve block (FNB), alone or combined with lateral femoral cutaneous nerve block (LFCNB), administered with ropivacaine or levobupivacaine via ultrasound-guided, nerve stimulator-guided, or landmark techniques.
- **Comparator**: FNB with the alternate agent (ropivacaine vs. levobupivacaine), systemic opioids/intravenous analgesics, subarachnoid block alone, fascia iliaca compartment block, or standard care.
- **Outcomes**: Primary: perioperative pain scores (Visual Analog Scale [VAS] or Numeric Rating Scale at rest/movement, pre- and post-positioning for spinal anesthesia). Secondary: time to spinal/combined spinal-epidural anesthesia, duration of analgesia, opioid consumption (24-48 hours postoperatively), patient satisfaction, quality of positioning, and adverse events (e.g., local anesthetic systemic toxicity, nerve injury, hemodynamic instability).
- **Study Design**: Randomized controlled trials (RCTs), prospective cohort studies, or controlled clinical trials published in full text. Exclusions comprised case reports, short communications, review articles, meta-analyses, animal studies, non-femur fractures (e.g., isolated hip arthroplasty without fracture), retrospective audits, and non-English publications.

Information Sources and Search Strategy

A comprehensive literature search was performed across PubMed/MEDLINE, ScienceDirect, Cochrane Central Register of Controlled Trials (CENTRAL), and Google Scholar from 2015 to 2025. Reference lists of included studies and prior reviews were hand-searched for additional citations.

The PubMed search strategy employed free-text keywords and Medical Subject Headings (MeSH) terms combined with Boolean operators:

("Nerve Block"[MeSH Terms] OR "Anesthesia, Conduction"[MeSH Terms] OR "femoral nerve block" OR "ultrasound-guided block" OR "regional anesthesia" OR "peripheral nerve block") AND ("Ropivacaine"[MeSH Terms] OR "Levobupivacaine"[MeSH Terms] OR "Anesthetics, Local"[MeSH Terms] OR ropivacaine OR levobupivacaine OR "local anesthetics") AND ("Femoral Fractures"[MeSH Terms] OR "Hip Fractures"[MeSH Terms] OR "Fractures, Bone"[MeSH Terms] OR "femur fracture*" OR "femur fractures" OR "hip fracture*") AND ("Analgesia"[MeSH Terms] OR "Pain, Postoperative"[MeSH Terms] OR "Pain Management"[MeSH Terms] OR analgesia OR "perioperative pain" OR positioning OR "spinal anesthesia").

Analogous strategies were adapted for other databases. Filters included humans, English language, and publication dates 2015-2025 to capture modern ultrasound-guided techniques.

Study Selection

Titles and abstracts were independently screened by two reviewers. Full texts of potentially eligible studies were retrieved and assessed against inclusion criteria. Disagreements were resolved by a third reviewer through discussion. The PRISMA flow diagram documented the selection process, with reasons for exclusions at the full-text stage.

Data Collection and Items

Data were extracted independently by two reviewers using a piloted, standardized form in Microsoft Excel, capturing: study characteristics (author, year, country, design, sample size), participant details (age, fracture type, ASA status), intervention/comparator specifics (agent, concentration, volume, technique, timing), and outcomes (means/SDs for VAS, times, opioid doses; frequencies for adverse events; p-values). Risk ratios (RR), mean differences (MD), and standardized mean differences (SMD) were calculated where appropriate.

Risk of Bias Assessment

The Cochrane Risk of Bias 2 (RoB 2) tool [14] was applied to RCTs, evaluating domains: randomization process, deviations from intended interventions, missing data, outcome measurement, and selection of reported results. Newcastle-Ottawa Scale (NOS) assessed non-randomized studies (stars for selection, comparability, outcome) [15]. Assessments were performed independently, with discrepancies adjudicated by consensus.

RESULT

The systematic literature search identified a total of 1,593 records through electronic database searching. Prior to screening, 112 duplicate records were removed, resulting in 1,481 unique records available for title and abstract screening. During this screening phase, 1,450 records were excluded as they did not meet the predefined inclusion criteria. The full texts of 31 reports were then sought for retrieval; however, 20 reports could not be retrieved. Consequently, 11 full-text articles were assessed for eligibility. Of these, 3 reports were excluded after full-text review due to failure to satisfy the eligibility criteria. Ultimately, 8 studies fulfilled all inclusion criteria and were included in the final systematic review (figure 1). This structured selection process, conducted in accordance with PRISMA guidelines, ensured transparency and methodological rigor in identifying studies relevant to the review question.

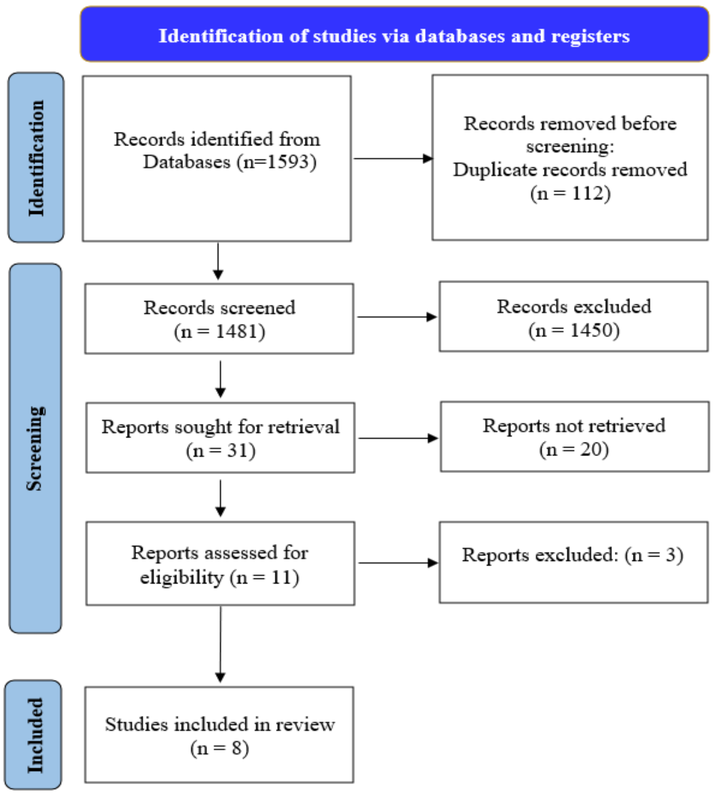

Figure 1: PRISMA flow diagram.

Table 1 presents a detailed overview of the characteristics and outcomes of studies evaluating femoral nerve–based regional analgesic techniques for femur fracture surgery, with emphasis on analgesic efficacy, procedural facilitation, and perioperative outcomes, as reported by various authors over time.

Singh AP et al. (2016) conducted a prospective randomized double-blind study in India comparing femoral nerve block (FNB) with intravenous fentanyl in adult femur fracture patients. They demonstrated that pre-emptive FNB using 0.2% ropivacaine significantly reduced pain scores at all measured time points, shortened the time required to perform spinal anesthesia, improved patient satisfaction, prolonged postoperative analgesia, and reduced epidural top-ups, without increasing complications. This study strongly supports the superiority of FNB over opioid-based analgesia for both intraoperative positioning and postoperative pain control.

In contrast, Elsey et al. (2017), in a small pediatric randomized trial from the USA, evaluated combined femoral nerve and lateral femoral cutaneous nerve (FN-LFCN) block versus intravenous opioids. Although lower immediate postoperative pain scores were observed in the block group, differences in opioid consumption and anesthetic requirements were not statistically significant, leading the authors to conclude that the block did not confer a clear clinical advantage in this pediatric population, and the study was terminated early for futility.

Rowlands et al. (2018) conducted a large pragmatic randomized controlled trial in the UK involving very elderly patients with fractured neck of femur. They compared continuous femoral nerve catheter analgesia with standard systemic analgesia. While continuous FNB significantly reduced pain at rest, it did not improve movement-evoked pain, early ambulation, delirium rates, length of hospital stay, or functional outcomes. The authors concluded that routine prolonged femoral catheter use could not be recommended for widespread adoption in this population, despite its analgesic benefits at rest.

Liang et al. (2020) conducted a randomized controlled trial in China comparing ultrasound-guided FNB with fascia iliaca compartment block (FICB) in elderly patients with femoral neck fractures. They observed that FNB provided more rapid onset of analgesia within the first 3–5 minutes, while both techniques resulted in similar pain control during positioning, comparable procedural times, and high patient satisfaction. The study emphasizes the efficiency of FNB using smaller volumes of local anesthetic.

Meti V et al. (2022) reported a prospective randomized trial from India assessing ultrasound-guided FNB combined with LFCNB prior to subarachnoid block in intertrochanteric femur fractures. Their findings showed markedly lower pre-spinal pain scores, superior patient positioning, significantly reduced time to perform spinal anesthesia, prolonged duration of analgesia and motor block, and reduced rescue analgesic requirements compared with spinal anesthesia alone. The authors recommended routine use of these blocks as a safe and effective adjunct to neuraxial anesthesia.

Klimkiewicz et al. (2022), in a Polish observational study, evaluated FNB plus LFCNB with sedation as the primary anesthetic technique in high-risk, frail elderly patients and compared outcomes with general and spinal anesthesia. Despite significantly higher baseline risk in the peripheral nerve block group, surgical feasibility and postoperative outcomes, including mortality, delirium, and hospital stay, were comparable across groups. The study highlights the value of femoral nerve–based blocks as a viable anesthetic alternative in patients with contraindications to spinal or general anesthesia.

Seth M. et al. (2024) compared different local anesthetics for ultrasound-guided FNB in India and found that 0.5% ropivacaine offered the most favorable balance between rapid onset, quality of sensory block, patient satisfaction, and safety when compared with bupivacaine and lignocaine. This study supports ropivacaine as the preferred agent for FNB in femur fracture patients.

Rajkumar et al. (2025) evaluated ultrasound-guided FNB versus intravenous fentanyl for positioning during combined spinal-epidural anesthesia. They reported comparable pain relief, positioning time, procedural efficiency, and hemodynamic stability between groups, concluding that both approaches are effective, with FNB offering an opioid-sparing alternative particularly useful in patients at risk of opioid-related adverse effects.

Collectively, these studies indicate that femoral nerve–based regional analgesia, especially when ultrasound-guided and using ropivacaine, provides effective perioperative pain control, facilitates neuraxial anesthesia, and reduces opioid requirements, with the magnitude of benefit influenced by patient age, fracture type, and study context.

Table 1: Characteristics and Findings of Included Studies

Author and Year	Country	Design of Study	Sample Size	Mean Age of Participants & Fracture Type	Intervention (Drug, Dose, Technique)	Comparator	Main Outcomes	Findings of Study
Singh AP et al., [16] 2016	India	Prospective, randomized, double-blind comparative study	60	Mean age ~50 years; intertrochanteric, neck, shaft, subtrochanteric femur fractures	FNB with nerve stimulator using 0.2% ropivacaine 15 mL, 15 min before spinal anesthesia	IV fentanyl 0.5 µg/kg	VAS, time to spinal, satisfaction, postoperative analgesia, complications	FNB significantly reduced VAS at all time points, shortened time to spinal anesthesia, improved satisfaction, prolonged analgesia (8–24 h), and reduced epidural top-ups compared with fentanyl, with no increase in complications.
Elsey et al., [17] 2017	USA	Prospective, double-blinded RCT	17	Mean age 8±3 years; traumatic femur fractures	USG-guided femoral + LFCN block with ropivacaine (total 2 mg/kg)	IV opioids without regional block	Postoperative opioid use, pain scores, anesthetic requirement	FN-LFCN block showed no statistically significant reduction in opioid use or pain scores compared with systemic opioids;

								study stopped early for futility.
Rowlands et al., [18] 2018	UK	Pragmatic RCT	118	Mean age ~83 years; fragility neck of femur fractures	Continuous FNB: initial levobupivacaine bolus + ropivacaine infusion via catheter	Standard systemic analgesia	Dynamic pain, ambulation, pain at rest, side effects, LOS	Continuous FNB did not improve dynamic pain or ambulation but significantly reduced pain at rest; no differences in delirium, mobility, or length of stay.
Liang et al., [19] 2020	China	Randomized controlled trial	46	Mean age ~74 years; Garden III–IV femoral neck fractures	USG-guided FNB with 15 mL 0.5% ropivacaine	USG-guided FICB with 40 mL 0.5% ropivacaine	VAS, positioning quality, spinal time, satisfaction	FNB and FICB provided similar analgesia for positioning; FNB had faster onset with lower anesthetic volume; both were safe and effective.
Meti V et al., [20] 2022	India	Prospective, randomized comparative trial	60	Mean age ~55 years; intertrochanteric femur fractures	USG-guided FNB + LFCNB with 0.75% ropivacaine before SAB	SAB alone	VAS, positioning, SAB time, analgesia duration, rescue analgesia	Combined FNB + LFCNB markedly reduced pain, improved positioning, shortened SAB time, prolonged analgesia, and reduced rescue analgesic use without added complications.

Klimkiewicz [21] et al., 2022	Poland	Prospective observational study	61	Median age 86 years; intertrochanteric fractures	FNB + LFCNB with ropivacaine plus sedation	GA or SA	Feasibility, mortality, delirium, LOS	PNB was feasible and safe in high-risk elderly patients, with outcomes comparable to GA and SA despite higher baseline risk, allowing timely surgery.
Seth M. et [10] al., 2024	India	Prospective randomized interventional study	75	Mean age ~37 years; intertrochanteric, neck, shaft fractures	USG-guided FNB with bupivacaine, ropivacaine, or lignocaine	Three-drug comparison	VAS reduction, onset time, positioning, fentanyl use	Ropivacaine and lignocaine provided faster onset and superior analgesia compared with bupivacaine; ropivacaine offered optimal balance of efficacy, safety, and patient satisfaction.
Rajkumar et al., [22] 2025	India	Prospective randomized comparative trial	64	Mean age ~52 years; shaft and proximal femur fractures	USG-guided FNB with 0.25% bupivacaine 20 mL	IV fentanyl 1 µg/kg	VAS, positioning time, CSE duration, hemodynamics	FNB and IV fentanyl provided equivalent analgesia and procedural conditions with similar hemodynamic stability; FNB may be preferable in patients at risk of opioid-related adverse effects.

Abbreviations:
ASA – American Society of Anesthesiologists, CAM-ICU – Confusion Assessment Method for ICU, CAS – Cumulated Ambulation Score, CCI – Charlson Comorbidity Index, CSE – Combined spinal-epidural anesthesia, ED – Emergency department, FICB – Fascia iliaca compartment block, FN-LFCN – Femoral nerve and lateral femoral cutaneous nerve block, FNB – Femoral nerve block, GA – General anesthesia, HR – Heart rate, IV – Intravenous, LFCNB – Lateral femoral cutaneous nerve block, LOS – Length of stay, MAP – Mean arterial pressure, ME – Morphine equivalent, NHFS – Nottingham Hip Fracture Score, PACU – Post-anesthesia care unit, PNB – Peripheral nerve block, RCT – Randomized controlled trial, SAB – Subarachnoid block, SA – Spinal anesthesia, SpO_2 – Peripheral oxygen saturation, USG – Ultrasound-guided, VAS – Visual Analog Scale.

Risk of Bias Assessment

Risk of bias was independently assessed by two reviewers using the Cochrane Risk of Bias 2 (RoB 2) tool for randomized controlled trials (RCTs; n=7) and the Newcastle-Ottawa Scale (NOS) for the prospective observational study (n=1), following PRISMA guidelines. Assessments focused on randomization process, allocation concealment, blinding of participants/personnel/outcome assessors, incomplete outcome data, and selective reporting.

Table 2 presents the methodological quality of the included studies assessed using the Cochrane Risk of Bias 2 (RoB 2) tool, providing a domain-wise evaluation of potential biases across seven randomized studies published between 2016 and 2025. Overall, random sequence generation was judged to be at low risk of bias in all included trials, indicating that appropriate methods of randomization were consistently applied across studies, thereby reducing the likelihood of selection bias at the sequence generation stage.

Allocation concealment showed greater variability. While Elsey et al. (2017) and Rowlands et al. (2018) demonstrated low risk of bias in this domain, most other studies - including Singh AP et al. (2016), Liang et al. (2020), Meti V et al. (2022), Seth M et al. (2024), and Rajkumar et al. (2025)—were assessed as having a high risk of bias, suggesting potential weaknesses in preventing foreknowledge of treatment allocation.

Blinding of participants and personnel was adequately addressed in earlier trials such as Singh AP et al. (2016), Elsey et al. (2017), Rowlands et al. (2018), and Liang et al. (2020), all of which were judged to be at low risk. In contrast, later studies by Seth M et al. (2024) and Rajkumar et al. (2025) were rated as high risk, while Meti V et al. (2022) showed an unclear risk, reflecting challenges in maintaining blinding in more recent or pragmatic study designs.

With respect to blinding of outcome assessment, Elsey et al. (2017), Liang et al. (2020), and Meti V et al. (2022) demonstrated low risk of bias. However, Singh AP et al. (2016) was rated as unclear, and high risk was identified in Rowlands et al. (2018), Seth M et al. (2024), and Rajkumar et al. (2025), raising concerns about potential detection bias in outcome evaluation.

Incomplete outcome data emerged as a notable limitation in several studies. High risk of attrition bias was observed in Singh AP et al. (2016), Liang et al. (2020), Meti V et al. (2022), Seth M et al. (2024), and Rajkumar et al. (2025), whereas Rowlands et al. (2018) demonstrated low risk. Elsey et al. (2017) showed unclear risk, possibly due to insufficient reporting of follow-up or missing data handling.

Selective reporting bias was generally low across most studies, reflecting consistency between reported outcomes and study protocols, although Rowlands et al. (2018) showed an unclear risk in this domain. Importantly, all studies were judged to have a low risk of other sources of bias, suggesting no major concerns related to study design or conduct beyond the predefined RoB 2 domains.

Overall, while the included studies generally demonstrated robust randomization methods and low reporting bias, concerns related to allocation concealment, blinding, particularly in more recent trials and incomplete outcome data were frequently observed.

Table 2: Quality assessment of the studies using the Cochrane risk of bias assessment tool (RoB 2).

Study	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcomes assessment	Incomplete outcome data	Reporting bias	Other bias
Singh AP et al., [16] 2016	Low	High	Low	Unclear	High	Low	Low
Elsey et al., [17] 2017	Low	Low	Low	Low	Unclear	Low	Low
Rowlands et al., [18] 2018	Low	Low	Low	High	Low	Unclear	Low
Liang et al., [19] 2020	Low	High	Low	Low	High	Low	Low
Meti V et al., [20] 2022	Low	High	Unclear	Low	High	Low	Low
Seth M et al., [10] 2024	Low	High	High	High	High	Low	Low
Rajkumar et al., [22] 2025	Low	High	High	High	High	Low	Low

One observational study of Klimkiewicz et al. 2022 was assessed using the Newcastle-Ottawa Scale (NOS) which shows moderate quality (NOS score 7/9). Strengths: representative cohort (61 high-risk elderly), prospective design, complete follow-up, blinded assessors for delirium. Weaknesses: no randomization/comparability adjustment for baseline imbalances (higher ASA/NHFS in PNB group; p<0.001), potential selection bias in group allocation.

DISCUSSION

Femoral nerve blocks (FNBs) and adjunctive lateral femoral cutaneous nerve blocks (LFCNBs) have emerged as key interventions for perioperative pain management in femur fractures, particularly to facilitate positioning for neuraxial anesthesia. The compiled studies demonstrate consistent superiority of ultrasound-guided (USG) FNB or combined FNB-LFCNB over intravenous (IV) fentanyl or subarachnoid block (SAB) alone for pre-neuraxial analgesia in adult intertrochanteric and proximal femur fractures, with significant reductions in visual analog scale (VAS) scores, improved positioning quality, shorter SAB performance times, and extended postoperative analgesia durations. For instance, Singh et al. (2016) reported VAS reductions from baseline to 2 minutes post-intervention (5.63 vs 8.00; P<0.001) and halved epidural top-up requirements with FNB using 0.2% ropivacaine versus fentanyl. Similarly, Meti et al. (2022) found pre-SAB VAS of 3.2 vs 8.23 (P<0.0001) and analgesia duration of 804 vs 200 minutes with FNB-LFCNB using 0.75% ropivacaine. These align with earlier RCTs, such as Jadon et al. (2015), where FNB yielded better positioning scores (2.67 vs 1.97; P=0.000027) and higher satisfaction than fentanyl. A 2019 meta-analysis confirmed FNB's efficacy for positioning, reducing VAS by 2-4 points intraoperatively [23,24,1,20].

However, recent contradictory evidence tempers enthusiasm for routine opioid displacement. Rajkumar et al. (2025) observed no VAS differences (median 7 to 4-5 across time points; P>0.05) between USG FNB (20 mL 0.25% bupivacaine) and fentanyl (1 mcg/kg) for combined spinal-epidural (CSE) positioning, with comparable procedural times and hemodynamics. This echoes a 2025 RCT by Kazemik et al., reporting equivalent analgesia and no opioid-sparing superiority for FNB in femur fractures. Explanations include higher fentanyl doses (1 mcg/kg vs 0.5 mcg/kg in prior trials) and refined USG techniques minimizing procedural delays. A 2024 emergency department trial similarly found FNB noninferior to optimized IV opioids, advocating individualized selection based on opioid risk profiles [24,22,25,26].

Seth et al. (2024) highlighted agent-specific profiles in a three-arm RCT: 0.5% ropivacaine achieved VAS<4 in 8.5 minutes with 82.8% reduction and 100% grade 2 sensory block, outperforming 0.25% bupivacaine (26.2 minutes, 52.4% reduction) while matching 1.5% lignocaine's rapidity but extending analgesia without lignocaine's brevity. This supports ropivacaine's favorable pharmacokinetics—rapid onset (faster than bupivacaine), lower cardiotoxicity, and dense blockade—consistent with a 2024 comparative study favoring it for FNB in fractures. Liang et al. (2020) corroborated FNB's (15 mL 0.5% ropivacaine) quicker onset (VAS lower at 3-5 minutes; P=0.000) versus fascia iliaca compartment block (FICB; 40 mL), though ultimate positioning quality and SAB times were equivalent. Prior work by Godohal et al. (2013) affirmed FNB's opioid-sparing over FICB for neck-of-femur fractures (pain reduction 0.9 points; P=0.047). Conversely, a 2024 ED RCT found FNB superior to FICB for femur fractures (greater VAS relief, less fentanyl; P<0.05), but volumes mattered—lower FNB doses risked incomplete coverage [27,28,29,10].

In frail elderly patients, Klimkiewicz et al. (2022) demonstrated FNB-LFCNB (0.75% ropivacaine) as a viable primary anesthetic for intertrochanteric repairs, achieving 100% surgical completion despite higher ASA/NHFS scores, with outcomes matching general/spinal anesthesia (no differences in mortality, delirium, or stay; P>0.05). This extends Guay et al.'s Cochrane review (2017), noting moderate evidence for single-shot blocks reducing pneumonia and mobilization time in hip fractures. A 2024 nomogram study identified age, ASA grade, frailty, and hypoalbuminemia as complication predictors in intertrochanteric fractures, underscoring PNBs' role in high-risk mitigation. Yet Rowlands et al. (2018) contradicted routine continuous FNB catheter use: no dynamic pain (20 vs 19.5; P=0.51) or ambulation (CAS 6 vs 7; P=0.76) benefits in 118 fragility neck-of-femur cases, though rest pain improved (P=0.043). Supporting this, a 2017 THA cohort showed continuous FNB reduced opioids and side effects but only trended toward better disposition [5,18,6,21].

Elsey et al. (2017) stands apart, with FN-LFCN (ropivacaine 2 mg/kg) failing to reduce postoperative opioids (0.69 vs 0.45 mg/kg; P=0.131) or PACU pain (0 vs 3; P=0.056) versus IV opioids in 17 pediatric femur fractures, halted for futility. This contrasts adult benefits and limited pediatric precedents; a 2006 case series praised continuous FNB for prolonged relief post-femur fracture. Mechanisms may involve surgical variability or incomplete lateral thigh coverage. No large pediatric RCTs exist, limiting generalizability [17,30].

Clinical Implications and Limitations

These findings affirm USG FNB-LFCNB as safe, opioid-sparing adjuncts for adult femur fracture positioning and analgesia, particularly with ropivacaine, reducing SAB times by 4-5 minutes and extending relief 4-6-fold. High-risk elderly benefit from PNB as anesthesia alternatives, aligning with guidelines favoring multimodal non-opioid strategies amid opioid crises. Contradictions arise in optimized opioid arms or continuous infusions, where marginal gains question resource intensity. Pediatric evidence remains equivocal, warranting caution. Limitations include small samples, Indian/observational bias, variable blinding, and short follows-ups; larger multicenter trials with patient-reported outcomes are needed.

In sum, FNBs enhance perioperative care in femur fractures but should be tailored—routine for positioning in adults, selective in pediatrics/continuous elderly use—balancing efficacy, safety, and logistics.

Future Recommendations

Future research should prioritize large-scale, multicenter randomized controlled trials to validate ultrasound-guided femoral nerve block (FNB) combined with lateral femoral cutaneous nerve block (LFCNB) as a standardized adjunct to neuraxial anesthesia in adult femur fracture surgery, particularly intertrochanteric fractures, incorporating patient-centered outcomes such as quality of recovery scores and long-term functional mobility. Head-to-head comparisons of optimal local anesthetic agents - emphasizing 0.5% ropivacaine against emerging low-volume, high-concentration formulations—warrant investigation to refine dosing protocols that maximize sensory blockade while minimizing motor impairment and systemic toxicity risks. In high-risk elderly cohorts with comorbidities (e.g., ASA III-IV, anticoagulation), prospective studies evaluating FNB-LFCNB as primary anesthesia versus spinal or general techniques should integrate standardized frailty assessments (e.g., NHFS, Edmonton Frail Scale) and composite endpoints including 30-day mortality, delirium incidence via CAM-ICU, and hospital readmissions.

Pediatric applications require dedicated RCTs powered for opioid-sparing effects and neurodevelopmental safety, exploring age-stratified FN-LFCN dosing and comparing against optimized multimodal non-opioid regimens to address current futility signals. Continuous catheter techniques, despite neutral pragmatic trial results, merit re-evaluation in enhanced recovery protocols with patient-controlled infusions and remote monitoring for ambulatory settings, assessing cost-effectiveness against systemic analgesia. Health economics analyses, including implementation barriers in resource-limited settings (e.g., India), should quantify block-related training needs, ultrasound accessibility, and opioid reduction impacts on postoperative care costs.

Finally, systematic reviews and meta-analyses adhering to PRISMA guidelines should synthesize emerging data on rare complications (e.g., nerve injury, local anesthetic systemic toxicity) and subgroup effects by fracture site, using network meta-analysis to rank interventions like FNB versus FICB or adductor canal blocks. Pragmatic trials in diverse populations will guide guideline updates, promoting FNB-LFCNB as a routine, safe option for fracture analgesia while mitigating opioid dependency.

CONCLUSION

Based on the synthesized evidence from the included studies, femoral nerve–based regional anesthesia techniques represent an effective and safe strategy for analgesia in patients with femur fractures across a broad range of ages and clinical settings. The majority of randomized and prospective studies consistently demonstrated that ultrasound-guided femoral nerve block (FNB), either alone or in combination with lateral femoral cutaneous nerve block (LFCNB), provides superior or at least equivalent analgesia compared with systemic opioid-based regimens, particularly during patient positioning for neuraxial anesthesia and in the early postoperative period. These techniques were associated with significantly lower pain scores, improved quality of positioning, reduced time to perform spinal or combined spinal–epidural anesthesia, prolonged duration of postoperative analgesia, and decreased requirement for rescue analgesics, without compromising hemodynamic stability or increasing complication rates.

In elderly and high-risk populations, including frail patients with multiple comorbidities or contraindications to spinal anesthesia, peripheral nerve block–based approaches were shown to be feasible and non-inferior to general or spinal anesthesia in terms of perioperative and short-term postoperative outcomes. However, evidence from pragmatic trials suggests that routine use of continuous femoral nerve catheters does not confer additional benefit in dynamic pain control or early mobilization when compared with optimized systemic analgesia, although pain at rest may be modestly improved.

Comparative data also indicate that FNB may offer practical advantages over alternative regional techniques, such as fascia iliaca compartment block, due to faster onset of analgesia and lower local anesthetic volume requirements. Among local anesthetic agents, ropivacaine appears to provide an optimal balance between rapid onset, effective sensory blockade, prolonged analgesia, and safety.

Overall, the findings support the selective and individualized use of femoral nerve–based regional anesthesia as part of multimodal pain management in femur fracture surgery. While FNB is particularly advantageous for facilitating neuraxial anesthesia and reducing opioid exposure, the choice of technique should be guided by patient characteristics, fracture type, institutional expertise, and resource availability. Further large-scale, methodologically robust trials are warranted to refine patient selection and to define the role of continuous versus single-shot techniques in specific clinical subgroups.

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