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Systematic review

## Comparative effectiveness of ultrasound-guided regional nerve blocks for hip fracture analgesia in the emergency department: a systematic review

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## Abstract

Hip fracture produces severe acute pain and complicates emergency assessment and transfers. Regional nerve blocks provide targeted analgesia within multimodal treatment. This review compared ultrasound-guided techniques for adults receiving emergency department care. PubMed, Scopus, Web of Science, and Cochrane CENTRAL were searched through 31 May 2026. Two authors independently screened studies and extracted data. Randomized trials comparing emergency department initiated single-injection blocks with another ultrasound-guided block, placebo, or systemic analgesia were synthesized narratively. Fourteen randomized trials evaluated femoral, fascia iliaca, and pericapsular nerve group blocks. Femoral blocks generally improved analgesia and reduced opioid exposure relative to systemic treatment, with neutral findings in one short-term fentanyl comparison. Femoral and fascia iliaca blocks produced similar pain reductions in a direct comparison. Supra-inguinal fascia iliaca block improved movement pain relative to the classical approach. Pericapsular nerve group block improved early pain relief relative to infra-inguinal fascia iliaca block and reduced rescue analgesia relative to sham. Opioid reduction varied across trials, including a fascia iliaca study reporting identical median six-hour morphine consumption. Ultrasound-guided blocks improve early hip fracture analgesia in emergency care. Technique selection depends on comparator, assessment timing, and patient characteristics. Data supports regional analgesia within multimodal pathways, without establishing one universally superior block.

## Keywords

Hip fracture; emergency department; ultrasound; regional analgesia; femoral nerve block; fascia iliaca block; pericapsular nerve group block.

## Introduction

Hip fractures impose international burden of disability, especially among older adults, and generate urgent demand for effective analgesia during emergency assessment and definitive treatment. The Global Burden of Disease analysis assessed hip fracture incidence alongside years lived with disability, highlighting the consequences of these injuries beyond the initial fracture diagnosis and surgical treatment (1). Observational study links inadequate analgesia and severe pain with delirium after hip fracture, supporting attention to pain relief rather than an exclusive focus on avoiding opioid administration in vulnerable older patients who present with differing cognitive and physiological reserves (2).

Pain management after hip fracture involves preoperative, intraoperative, and postoperative phases, with treatment decisions influenced by comorbidity, medication effects, and the competing demands of timely surgery and patient comfort across a population characterized by advanced age and substantial frailty. Multimodal analgesia incorporates regional techniques alongside

systemic medications, allowing targeted treatment of fracture-related pain while maintaining access to supplementary analgesics according to the patient's response and clinical condition (3). A Cochrane review found that peripheral nerve blocks reduced movement pain shortly after placement and reduced acute confusional states, although its broad perioperative scope encompassed techniques and settings beyond contemporary ultrasound-guided emergency practice (4).

An emergency department systematic review identified analgesic benefits from regional blocks, establishing a clinical rationale for incorporating these interventions into early hip fracture treatment pathways. Interpretation of that requires attention to nerve localization methods because landmark-based, nerve stimulator-guided, and ultrasound-guided procedures represent different approaches with distinct technical requirements and procedural contexts when transporting findings from older trials into current emergency practice (5). Anatomical dissection demonstrates contributions from femoral and obturator articular branches to the anterior hip capsule, with accessory

obturator involvement in some specimens, providing a basis for targeting proximal articular innervation during regional analgesia (6).

The pericapsular nerve group block was introduced as an ultrasound-guided approach targeting articular branches associated with the anterior capsule, extending the available options beyond established femoral and fascia iliaca techniques (7). Its initial description provided anatomical and clinical justification for subsequent comparative evaluation, without establishing superiority across fracture patterns, drug regimens, or emergency department populations from that early experience alone (7). The present review examines randomized evidence for emergency department initiated ultrasound-guided blocks, focusing on pain intensity, opioid exposure, movement-related outcomes, and adverse events, while distinguishing direct comparisons between techniques from comparisons against systemic analgesia or placebo.

## Methods

This systematic review was organized according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses framework (Fig 1). The review question followed a population, intervention, comparator, and outcome structure addressing adults with hip fractures receiving emergency department analgesia. PubMed, Scopus, Web of Science, and the Cochrane Central Register of Controlled Trials were searched from database inception through 31 May 2026, including articles available online before the cutoff.

Search concepts included hip fracture, femoral neck fracture, intertrochanteric fracture, ultrasound, regional analgesia, femoral nerve block, fascia iliaca block, and pericapsular nerve group block. Emergency department and emergency medicine terms identified the relevant clinical setting. Controlled vocabulary and free-text terms were combined with Boolean operators and adapted to

each database. Bibliographic records were reconciled to identify duplicate reports and overlapping study populations.

Eligible studies were randomized controlled trials evaluating an initial single-injection ultrasound-guided block administered during emergency department care for radiologically confirmed hip fracture. Comparators comprised another ultrasound-guided block, sham injection, placebo block, or conventional systemic analgesia. Trials combining an initial emergency block with subsequent regional treatment were retained, with later outcomes interpreted as effects of the complete treatment pathway. Operating-room-only studies, elective arthroplasty studies, noncomparative reports, guidance-only comparisons, and mixed injury cohorts without separable hip fracture findings were excluded.

Two authors independently screened titles and abstracts and assessed full-text eligibility. Disagreements were resolved through discussion against the eligibility criteria. Two authors independently extracted study characteristics, sample sizes, fracture populations, block techniques, anesthetic regimens, comparators, follow-up intervals, pain results, opioid requirements, and reported adverse events.

The main outcome was pain intensity after treatment, with resting and movement-related measurements considered separately. Secondary outcomes included rescue analgesia, cumulative opioid consumption, time to additional analgesia, functional measures, and complications. Study appraisal examined randomization, allocation concealment, blinding, exclusions after allocation, completeness of outcome reporting, and applicability to cognitively impaired patients. Findings were grouped by block technique and comparator, retaining original measurement scales and distinguishing changes from baseline from between-group differences. A structured narrative

synthesis was used because regimens, assessment times, outcome definitions, and treatment pathways differed substantially. No pooled effect estimate or treatment ranking was calculated, and absence of statistical significance was interpreted separately. The analysis retained neutral findings and separated evidence of analgesic effectiveness from evidence concerning relative superiority between two active block techniques.

## Results

Beaudoin et al. evaluated 36 patients and found greater four-hour summed pain relief with ultrasound-guided femoral block plus morphine than with sham injection plus morphine, together with lower rescue morphine requirements (8). Morrison et al. randomized 161 patients to an emergency femoral block followed by continuous fascia iliaca analgesia or conventional treatment, reporting lower two-hour pain scores in the regional pathway (9). Jang et al. analyzed 32 patients and reported lower pain scores at four and twenty-four hours after femoral block alongside tramadol than after control treatment, extending assessment beyond the immediate procedural period (10).

Cooper et al. compared femoral and fascia iliaca blocks in 100 participants and found clinically important within-group pain reductions without a significant difference between techniques (11). Chen et al. reported 38 completed assessments, with supra-inguinal fascia iliaca block producing lower movement pain at six and twelve hours than the classical approach, alongside longer procedure and sleep durations (12). Mayel et al. studied 40 patients receiving femoral block or intravenous fentanyl and reported similar initial post-treatment pain severity at fifteen minutes, despite reductions from baseline in both groups (13).

Güllüpinar et al. analyzed 39 patients and found lower resting and movement pain following PENG block added to systemic treatment, with

assessments extending from thirty minutes to twenty-four hours (14). Gerlier et al. randomized 35 patients, of whom 30 completed the protocol, and reported lower preoperative opioid consumption after early femoral block, without a difference in time to pain relief (15). O'Connor et al. analyzed 53 participants after fascia iliaca block or saline placebo and found identical median six-hour morphine consumption, despite lower one-hour pain and delayed first opioid request with active treatment (16).

Calati et al. analyzed 32 participants and found lower hourly morphine consumption after PENG block plus standard treatment, with no significant differences in cumulative morphine use, pain scores, or emergency department stay (17). Di Pietro et al. randomized 64 patients and reported greater first-hour summed pain reduction with PENG than infra-inguinal fascia iliaca block, without a significant rescue opioid difference (18). Altunbaş et al. randomized 104 patients and found greater twenty-minute pain reduction and fewer rescue analgesia requirements after femoral block than intravenous fentanyl, including consistent benefit among participants with cognitive impairment (19).

Vijayan et al. randomized 80 patients and reported lower pain scores at thirty, sixty, and one hundred twenty minutes after PENG block than sham, together with reduced rescue morphine equivalents (20). Sri-on et al. analyzed 34 older adults and reported greater thirty-minute pain reduction after PENG block than intravenous morphine, adding another direct comparison against systemic analgesia (21). Across fourteen trials, analgesic benefit was frequent, opioid effects varied, and limited direct comparisons, small samples, selective exclusions, and short observation periods restricted interpretation of technique superiority, functional recovery, and uncommon complications (8–21). Within-group improvement was not treated as proof of superiority, and later benefits following combined regional pathways were distinguished

from outcomes attributable to the initial emergency block, preserving the separation between immediate procedural analgesia and subsequent inpatient treatment effects (9,11,13).

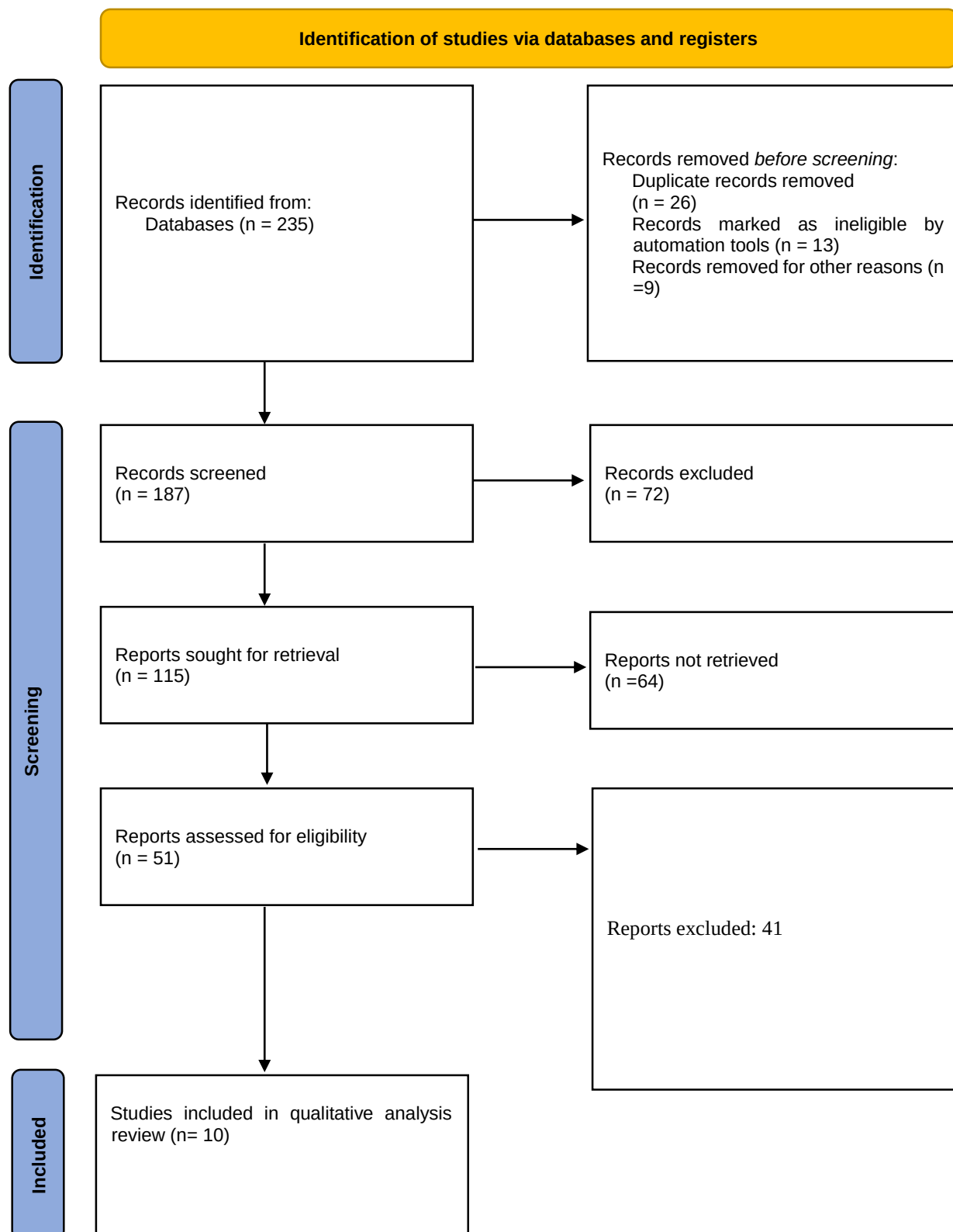


Figure 1: PRISMA flow chart

**Table 1. Characteristics of the included randomized trials**

| Study                | Country     | Reported sample              | Comparison                                             |
|----------------------|-------------|------------------------------|--------------------------------------------------------|
| Beaudoin 2013 (8)    | USA         | 36                           | FNB/morphine versus sham/morphine                      |
| Morrison 2016 (9)    | USA         | 161                          | FNB then continuous FICB versus conventional analgesia |
| Jang 2018 (10)       | South Korea | 32                           | FNB/tramadol versus placebo/tramadol                   |
| Cooper 2019 (11)     | Australia   | 100                          | FNB versus FICB                                        |
| Chen 2021 (12)       | China       | 38 completers                | Supra-inguinal versus classical FICB                   |
| Mayel 2022 (13)      | Iran        | 40                           | FNB versus IV fentanyl                                 |
| Güllüpinar 2022 (14) | Türkiye     | 39                           | PENG/systemic analgesia versus systemic analgesia      |
| Gerlier 2024 (15)    | France      | 35 randomized; 30 completers | FNB versus standard analgesia                          |
| O'Connor 2025 (16)   | Netherlands | 55 randomized; 53 analyzed   | FICB versus saline; morphine PCA                       |
| Calati 2025 (17)     | France      | 35 randomized; 32 analyzed   | PENG/standard analgesia versus standard analgesia      |
| Di Pietro 2025 (18)  | Italy       | 64                           | PENG versus infra-inguinal FICB                        |
| Altunbaş 2026 (19)   | Türkiye     | 104                          | FNB versus IV fentanyl                                 |
| Vijayan 2026 (20)    | India       | 80                           | PENG versus sham; standard IV analgesia                |
| Sri-on 2026 (21)     | Thailand    | 34                           | PENG versus IV morphine                                |

**Table 2. Analgesic and opioid findings**

| Study           | Pain finding                                            | Opioid or additional finding                              |
|-----------------|---------------------------------------------------------|-----------------------------------------------------------|
| Beaudoin (8)    | Four-hour SPID: 11.0 versus 4.0; P=0.001                | Rescue morphine: 0 versus 5 mg; P=0.028                   |
| Morrison (9)    | Two-hour pain: 3.5 versus 5.3; P=0.002                  | Subsequent outcomes reflect the combined regional pathway |
| Jang (10)       | Four-hour VAS: 3.63 versus 7.06; P<0.001                | Twenty-four-hour VAS: 4.50 versus 5.75; P<0.001           |
| Cooper (11)     | Pain reduction: 2.30 versus 2.62; P=0.408               | No significant between-block difference                   |
| Chen (12)       | Lower movement VAS at six and twelve hours              | No significant oral analgesic consumption difference      |
| Mayel (13)      | Fifteen-minute median NRS: 4 versus 4                   | Similar post-treatment pain severity                      |
| Güllüpinar (14) | Thirty-minute movement NRS: 3.06 versus 5.24            | Resting NRS: 1.78 versus 3.38                             |
| Gerlier (15)    | No difference in time to pain relief                    | Preoperative opioid: 6 versus 15 IV MME; P<0.001          |
| O'Connor (16)   | One-hour NRS difference: -1.5; P=0.02                   | Six-hour morphine: 3 versus 3 mg; P=0.46                  |
| Calati (17)     | No significant NRS difference                           | Morphine: 0.2 versus 0.4 mg/hour; P=0.03                  |
| Di Pietro (18)  | First-hour percentage SPID: 62.7% versus 38.0%; P<0.001 | No significant rescue opioid difference                   |

|               |                                                          |                                       |
|---------------|----------------------------------------------------------|---------------------------------------|
| Altunbaş (19) | Twenty-minute pain reduction: 4 versus 2 points          | Rescue analgesia: 21.1% versus 61.5%  |
| Vijayan (20)  | Sixty-minute NRS difference: -3.1; 95% CI -4.1 to -2.1   | Rescue opioid difference: -4.6 mg MME |
| Sri-on (21)   | Thirty-minute pain reduction: 6 versus 3 points; P=0.001 | Rescue analgesia: 0% versus 5.9%      |

## Discussion

Our findings ultrasound-guided regional analgesia is an effective component of emergency hip fracture care, with the clearest recurring benefits involving early pain relief and reduced exposure to rescue opioids in several trials (8,9,15,19,20). This pattern agrees with Exsteen et al., whose systematic review addressed ultrasound-guided preoperative blocks and found lower pain scores and opioid requirements relative to conventional analgesia across a broader preoperative setting (22). The consistency of direction in these sources strengthens the rationale for regional treatment, while differences in drugs, cointerventions, and assessment windows prevent a single effect size from describing every emergency department pathway (8–22).

The comparative question concerns the relative performance of individual blocks, and direct evidence supports a more restrained conclusion than generalized endorsement of regional analgesia alone (11,12,18). Hayashi et al.'s network meta-analysis favored several block techniques over no block and identified a strong analgesic signal for PENG, drawing on trials across preoperative settings rather than exclusively emergency department interventions (23). Those indirect comparisons provide supportive context, while the emergency trial by Di Pietro et al. establishes a specific first-hour advantage over infra-inguinal fascia iliaca block, without demonstrating superiority over supra-inguinal fascia iliaca block or every femoral block regimen (18,23).

Anatomical differences offer an explanation for variation between fascia iliaca approaches, with the supra-inguinal technique designed to promote proximal spread beneath the fascia iliaca toward relevant nerve territories (24). Chen et al.'s lower movement pain after the supra-inguinal approach supports treating fascia iliaca techniques as distinct interventions when interpreting comparative

effectiveness and planning future trials (12,24). PENG's targeted articular approach also requires careful interpretation of motor outcomes because a scoping review documented quadriceps weakness after PENG and related its occurrence to injectate spread, challenging assumptions of guaranteed motor preservation despite the technique's anatomical rationale (7,25).

Pain reduction and opioid reduction represent related outcomes with different determinants, as demonstrated by positive early pain findings alongside neutral cumulative opioid findings in the O'Connor and Di Pietro trials (16,18). Calati et al.'s lower hourly morphine use without significantly lower total consumption further illustrates the influence of observation time and variable treatment exposure on opioid endpoints (17).

Safety interpretation depends on sample size, follow-up, and eligibility exclusions, particularly when trials exclude patients receiving anticoagulants or experiencing cognitive impairment (9,12,18). Antithrombotic guidelines distinguish superficial procedures from deeper blocks according to bleeding risk, compressibility, medication exposure, and renal function, making individualized procedural assessment integral to clinical implementation (26).

## Conclusion

Ultrasound-guided regional nerve blocks provide effective analgesia for hip fractures in emergency department care. Femoral and fascia iliaca blocks remain supported options, and PENG demonstrates favorable results against systemic analgesia, sham treatment, and infra-inguinal fascia iliaca block in selected trials. Current data does not establish universal superiority of one technique across patients, fracture patterns, anesthetic regimens, and observation periods. Opioid reduction varies between studies, and short follow-up limits

assessment of uncommon complications and functional recovery.

## Abbreviations

CI, confidence interval; ED, emergency department; FICB, fascia iliaca compartment block; FNB, femoral nerve block; IV, intravenous; MME, morphine milligram equivalents; NRS, numerical rating scale; PCA, patient-controlled analgesia; PENG, pericapsular nerve group; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SPID, summed pain-intensity difference; VAS, visual analogue scale.

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