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Comparison of Peripheral Nerve Blocks and Spinal Anaesthesia for Proximal Femoral Nailing - A Randomized Controlled Study

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Abstract: ***Introduction**: Hip fractures due to osteoporosis are a major source of morbidity in the elderly. Proximal femoral nailing (PFN) is the preferred treatment for unstable intertrochanteric and subtrochanteric fractures. Spinal anesthesia (SA) is the most common regional technique, but Combined Peripheral Nerve Blocks (CPNB) are increasingly used. Evidence comparing these modalities remains limited. **Objectives**: To compare the need for rescue analgesia after CPNB and SA for PFN surgery. To evaluate postoperative recovery quality at 24 hours, ICU admission, and hospital stay. **Methods**: A randomized controlled trial was conducted on 60 patients undergoing PFN. Participants were allocated to receive either CPNB (Group A) or SA (Group B). All patients followed a standardized postoperative analgesic protocol. Time to first rescue analgesia, total rescue dose within 24 hours, quality of recovery at 24 hours, ICU admission, and hospital stay were recorded. Data were analyzed using Student's t-test and Chi-square test. **Results**: Mean postoperative analgesia lasted 5.5 hours with CPNB and 3.5 hours with SA, though the difference in time to rescue analgesia was not statistically significant. Hemodynamics were more stable in the CPNB group, with hypotension in 15.8% versus 53.8% in the SA group. ICU admission rates were similar between groups, but hospital stay was shorter with CPNB. **Conclusion**: CPNB provides more stable perioperative hemodynamics and reduces hospital stay compared to SA, though postoperative analgesia duration and ICU needs were not significantly different.*

Keywords: Combined peripheral nerve blocks, Spinal anesthesia, Proximal femoral nailing, Rescue analgesia, Quality of recovery, Hospital stay

1. Introduction

Hip fractures are a major cause of morbidity among the elderly, with incidence rising due to increased life expectancy in India (67.4 → 72.6 years). Most fractures occur in patients over 60, with women comprising 75% of cases. Nearly 98% require surgical fixation to allow early mobilization. Proximal femoral nailing (PFN) is now widely preferred due to reduced blood loss, shorter operative time, and better rehabilitation outcomes.

Choice of anesthesia significantly affects perioperative outcomes. Most patients are elderly, often ASA III–IV, with multiple comorbidities such as cardiovascular disease, diabetes, and respiratory illness. Scoring systems such as the Nottingham Hip Fracture Score help predict perioperative risk.

Spinal anesthesia (SA) is the most commonly used regional technique. However, it is associated with hypotension in 16–33% of elderly cases due to sympathetic blockade, contributing to morbidity such as dizziness, arrhythmias, or syncope. In contrast, peripheral nerve blocks (PNB), especially under ultrasound guidance, provide analgesia with less hemodynamic disturbance.

Combined Peripheral Nerve Blocks (CPNB), targeting femoral and obturator nerves, improve perioperative analgesia, reduce opioid use, and facilitate positioning for neuraxial procedures. With ultrasound and nerve stimulator guidance, their use has expanded as a safer alternative in high-risk patients.

2. Aim & Objectives

a) Aim:

To evaluate whether CPNB provides better postoperative analgesia compared to SA in PFN surgery.

b) Objectives:

- Compare the need for rescue analgesia between groups.
- Assess quality of recovery at 24 hours.
- Evaluate postoperative ICU admission rates and duration of hospital stay.

3. Review of Literature and Background

1) Peripheral Nerve Blocks (PNB)

Peripheral nerve blocks are well established in regional anesthesia, particularly for unilateral lower limb surgeries. They provide excellent perioperative analgesia, reduce opioid requirements, and minimize side effects such as postoperative nausea and vomiting [14–17]. The use of ultrasound has improved accuracy, reduced drug volumes, and lowered complication rates compared to landmark or nerve stimulator techniques [18–22].

2) Peripheral Nerve Anatomy

Peripheral nerves consist of fascicles surrounded by connective tissue layers—the epineurium, perineurium, and endoneurium. Their vascular supply arises from adjacent vessels forming longitudinal anastomoses, crucial for nerve viability [23].

3) Femoral Nerve Block

The femoral nerve (L2–L4) emerges lateral to the psoas muscle and enters the thigh beneath the inguinal ligament, lateral to the femoral artery. Ultrasound-guided femoral nerve blocks, often part of a "3-in-1" technique with obturator and lateral femoral cutaneous nerves, are commonly used for analgesia in hip and knee surgeries. They provide good pain relief with low complication rates, although rarely sufficient as a sole anesthetic for hip surgery.

4) Obturator Nerve Block

Formed by L2–L4 roots, the obturator nerve divides into anterior and posterior branches, supplying adductor muscles and contributing to hip and knee joint innervation. Ultrasound-guided interfascial injection improves success rates and minimizes vascular puncture risk.

5) Lateral Femoral Cutaneous Nerve Block

The lateral femoral cutaneous nerve supplies the lateral thigh and can be identified between sartorius and tensor fascia lata muscles. Ultrasound-guided block provides supplementary analgesia but is rarely used in isolation for hip surgery.

6) Sciatic Nerve Block

The sciatic nerve arises from the lumbosacral plexus (L4–S3) and exits below the piriformis muscle. Ultrasound- or nerve stimulator-guided sciatic blocks provide analgesia for posterior thigh and lower limb surgeries, often combined with femoral or obturator blocks for hip fracture surgery.

7) Spinal Anesthesia

Spinal anesthesia, first performed by August Bier in 1898, remains the most widely used technique for hip fracture surgery [24]. It produces rapid, dense anesthesia using small doses of local anesthetics injected into the subarachnoid space. It reliably blocks sensory, motor, and autonomic fibers, though hypotension is a common complication in elderly patients (16–33%) [7].

- Indications: Procedures of the lower abdomen, pelvis, and lower limbs.
- Contraindications: Patient refusal, sepsis, coagulopathy, severe hypovolemia, and fixed cardiac output states.

8) Comparative Evidence: PNB vs Spinal Anesthesia

While spinal anesthesia provides reliable surgical conditions, it is frequently associated with perioperative hypotension and limited postoperative analgesia [7, 11]. Peripheral nerve blocks, particularly combinations of femoral, obturator, lateral femoral cutaneous, and sciatic blocks, offer better hemodynamic stability and prolonged analgesia [12, 13]. With ultrasound guidance, these blocks are increasingly preferred in elderly patients with cardiovascular comorbidities. However, high-quality evidence comparing outcomes between CPNB and spinal anesthesia in hip fracture surgery remains limited, justifying the present randomized controlled study.

4. Review of Literature

Hip fractures represent a major global health challenge, with an estimated 600,000 osteoporotic hip fractures annually in India alone (Kanis, 2004). With the proportion of elderly rising, this number is expected to increase significantly in the coming decades [24]. Risk stratification tools such as the Nottingham Hip Fracture Score (NHFS) have demonstrated predictive value, with three-month postoperative mortality reported as high as 22% in high-risk patients (NHFS ≥ 5), compared with lower-risk groups ($p=0.01$) [25].

Choice of anesthesia in hip fracture surgery remains a subject of debate. Regional techniques, particularly spinal and epidural anesthesia, are widely used and associated with lower perioperative morbidity compared to general anesthesia [26]. However, in patients with significant comorbidities or contraindications to neuraxial anesthesia, peripheral nerve blocks (PNBs) provide a valuable alternative [27]. PNBs offer hemodynamic stability, prolonged analgesia, and reduced opioid consumption, making them suitable for elderly or high-risk patients [28,29].

Several studies have compared spinal anesthesia with peripheral nerve blocks in hip and lower-limb surgeries. Kundu et al. [30] found that lumbar plexus-sciatic block provided effective unilateral anesthesia and superior postoperative analgesia compared to spinal bupivacaine with fentanyl. Ahmad et al. [31] demonstrated that combined femoral, sciatic, obturator, and lateral femoral cutaneous nerve blocks could provide adequate anesthesia for hip hemiarthroplasty. Similarly, Amiri et al. [32] reported that lumbar plexus block produced relaxation and analgesia comparable to spinal anesthesia, with longer postoperative pain relief. Case reports further highlight their utility in high-risk patients with cardiovascular disease [33].

Meta-analyses support the benefits of PNBs in orthopedic surgery, with analgesia comparable to epidural infusion but fewer complications such as hypotension, urinary retention, and nausea [34]. Continuous femoral nerve blocks have been shown to improve rehabilitation and shorten hospital stay [35].

Relevance of the Study

There is no established consensus on the optimal anesthetic technique for proximal femoral nailing (PFN). While spinal anesthesia is widely practiced, its hemodynamic instability and limited postoperative analgesia are concerns. Peripheral nerve blocks (PNBs) provide targeted analgesia with stable hemodynamics but have not been extensively compared to spinal anesthesia in PFN.

This study was designed to compare combined PNBs with spinal anesthesia in terms of postoperative analgesia and perioperative outcomes.

Hypothesis:

- Combined PNBs reduce postoperative pain compared to spinal anesthesia.
- Quality of recovery is superior with PNB

5. Methodology

Study Design & Setting

This was a prospective, single-center, single-blind randomized controlled trial conducted in the Department of Anesthesiology, Jubilee Mission Medical College & Research Institute, Kerala, over 18 months.

Research Question

Do combined peripheral nerve blocks provide better postoperative analgesia than spinal anesthesia in patients undergoing PFN surgery?

Hypotheses

- Null hypothesis: PNBs do not provide better postoperative analgesia compared to spinal anesthesia.
- Alternative hypothesis: PNBs provide better postoperative analgesia than spinal anesthesia.

Sample Size

Based on data from Kundu et al. with 95% confidence interval and 80% power, 30 patients were recruited per group (allowing for attrition).

Eligibility Criteria

- Inclusion: ASA I–III, age 60–100 years, weight 35–70 kg.
- Exclusion: Contraindications to regional anesthesia, refusal of regional anesthesia, neurological disorders affecting lower limb, inability to consent.
- Withdrawal: Change in surgical approach, perioperative mortality, discharge against medical advice.

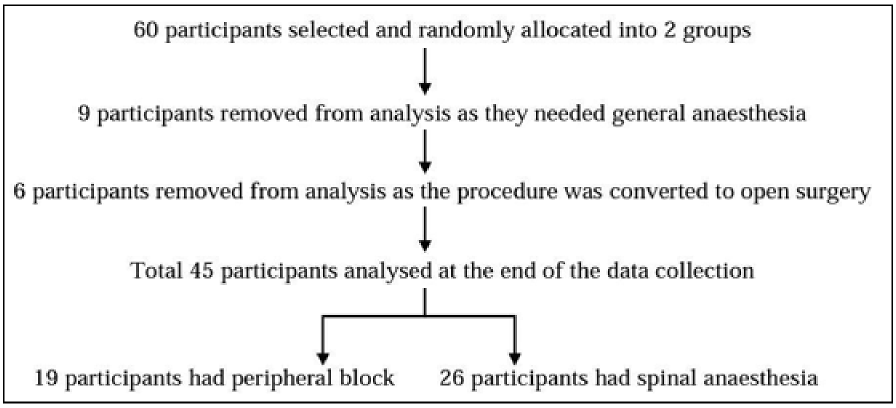
Randomization & Allocation

Sixty patients were randomized into two groups (n=30 each) using a computer-generated sequence in blocks of six, with allocation concealment via opaque sealed envelopes.

Interventions

- Group A (Spinal): 1–1.5 ml of 0.5% heavy bupivacaine intrathecally.
- Group B (PNB): Ultrasound-guided femoral (~15 ml), obturator (~10 ml), lateral femoral cutaneous (~5 ml), and sciatic (~20 ml) blocks with 0.25% bupivacaine, within safe limits.

Procedures were performed under aseptic precautions by an experienced anesthetist. Failed blocks were recorded and converted to alternative anesthesia.



Perioperative Management

All patients were preloaded with Ringer's lactate (10 ml/kg). Standard monitoring (ECG, SpO_2, NIBP) was applied. Sedation was achieved with midazolam (1 mg) and propofol infusion (25–75 mcg/kg/min) titrated to Ramsay sedation score 2. Hemodynamic instability was managed with IV fluids, phenylephrine, and atropine as needed.

Postoperative Analgesia

All patients received paracetamol 1 g BD. Rescue analgesia was tramadol 50 mg IV on request, with total 24-hour consumption recorded.

Outcome Measures

a) **Primary outcomes:**
- Time to first request for rescue analgesia.
- Total tramadol consumption in 24 hours.

b) **Secondary outcomes:**
- Quality of Recovery (QoR-15) score at 24 hours.
- Hemodynamic changes: hypotension, bradycardia, hypoxia, phenylephrine and atropine use, fluid requirements.
- Intraoperative sedative and opioid requirements.
- Conversion to general anesthesia.
- ICU admission and duration of hospital stay.
- Perioperative complications (urinary retention, prolonged catheterization).

6. Results

A total of 60 patients were enrolled, with 30 randomized to the combined peripheral nerve block (CPNB) group and 30 to the spinal anesthesia (SAB) group. Nine patients required open surgery and six required conversion to general anesthesia, leaving 45 participants for analysis (CPNB: 19, SAB: 26)

Baseline Characteristics

The mean age of the study population was 74.6 ± 9.7 years (range 49–91), with no significant difference between CPNB (74.3 ± 12.8) and SAB (74.8 ± 7.6) groups (p=0.865). Females constituted 71.1% of the cohort, distributed proportionally across groups (CPNB: 14; SAB: 18; p=0.745). Thus, the two groups were comparable in terms of age and gender

Conversion to General Anesthesia

Of the 15 patients requiring conversion to general anesthesia, 7 were from the CPNB group and 2 from the SAB group; this difference was not statistically significant

Cardiovascular Parameters at Baseline
Preoperative hemodynamic parameters were similar across groups, with no significant differences in systolic blood pressure (CPNB 137.3 ± 20.1 vs SAB 143.7 ± 26.3; p=0.419), diastolic blood pressure (78.4 ± 12.6 vs 81.9 ± 12.1; p=0.396), mean arterial pressure (98.0 ± 14.3 vs 102.5 ± 12.9; p=0.319), or heart rate (77.8 ± 7.5 vs 83.4 ± 14.6; p=0.176)

Preoperative Cardiovascular and ASA Status
Baseline cardiovascular parameters (SBP, DBP, MAP, HR) were comparable between groups (Figure 11, Table 4). Distribution by ASA physical status (I–III) was also similar, with no statistically significant differences

Intraoperative Parameters
a) **Duration of Surgery:** The mean duration of surgery was 56.8 ± 19.6 minutes in the CPNB group and 57.8 ± 16.5 minutes in the SAB group, with no significant difference (p=0.858)
b) **Onset of Sensory Block:** SAB demonstrated a significantly faster onset of sensory block (2.5 ± 0.8 min) compared to CPNB (16.3 ± 8.8 min; p<0.001)
c) **Cardiovascular Changes Within Groups:** In the CPNB group, no significant changes were observed in SBP, MAP, or HR before and after block administration. However, DBP increased significantly post-intervention (85.0 vs 78.4 mmHg, p=0.036)
d) **Cardiovascular Stability Between Groups:** Intraoperatively, SAB patients demonstrated significantly lower hemodynamic values compared to CPNB. The lowest recorded HR (59.4 vs 77.1 bpm), SBP (99.1 vs 126.3 mmHg), DBP (60.0 vs 85.0 mmHg), and MAP (73.1 vs 98.8 mmHg) were all significantly reduced in the SAB group (all p<0.001). Oxygen saturation remained similar (SAB 97.2% vs CPNB 96.7%, p=0.684)
e) **Incidence of Hypotension:** Hypotension occurred in 14 participants (53.8%) in the SAB group compared to only 3 participants (15.8%) in the CPNB group, a statistically significant difference (p=0.01)

Postoperative Parameters
a) **Analgesic Requirement:** The mean time to first postoperative analgesic request was 230 ± 94.3 min in the CPNB group and 212.6 ± 57.9 min in the SAB group, with no statistically significant difference (p=0.471)
b) **Sedation (RASS Score):** Most patients were alert and calm in both groups (57.9% in CPNB vs 61.5% in SAB). The proportion of drowsy patients was similar (42.1% in CPNB vs 30.8% in SAB), with no significant difference between groups (p=0.854).
c) **ICU Admission:** Postoperative ICU admission occurred in 7 participants (36.8%) in the CPNB group and 5 participants (19.2%) in the SAB group. Duration of ICU stay was 1.86 ± 0.69 days in CPNB and 1.6 ± 0.55 days in SAB, with no statistically significant differences (p=0.187 and p=0.963, respectively)
d) **Duration of Ambulation and Hospital Stay:** The mean time to ambulation was slightly longer in the CPNB group (2.56 ± 1.1 days) compared to SAB (2.13 ± 1.1 days), and hospital stay was slightly shorter in the CPNB group (6.94 ± 1.31 days) versus SAB (7.09 ± 1.51 days); neither difference was statistically significant (p=0.464 and p=0.199, respectively)
e) **Quality of Recovery (QoR Score):** The 24-hour postoperative QoR-15 score was higher in the CPNB group (61.1 ± 12.5) than in the SAB group (57.1 ± 10.5), but this difference did not reach statistical significance (p=0.286)
f) **Hypotension:** Intraoperative hypotension occurred in 3 participants (15.8%) in the CPNB group compared to 14 participants (53.8%) in the SAB group, a statistically significant difference (p=0.01)
g) **Summary:** Overall, CPNB was associated with better intraoperative hemodynamic stability, while postoperative analgesia, sedation, ICU admission, ambulation, hospital stay, and QoR scores were comparable between the groups.

7. Discussion

Hip fractures affect approximately 4.5 million people per year worldwide, a number projected to rise to 21 million over the next 40 years (49). Optimized, evidence-based perioperative management is crucial for improving outcomes in elderly patients with hip fractures.

The choice of anesthesia is closely related to postoperative morbidity and mortality in hip fracture patients, and the ideal technique remains debated. Regional anesthesia (spinal or epidural) and general anesthesia are the most commonly employed techniques (50). Peripheral nerve blocks (PNBs) share many advantages with spinal anesthesia, including opioid-sparing effects, reduced opioid-related adverse events, and lower risks of cognitive dysfunction, pneumonia, and hemodynamic instability (51).

In this prospective, single-blind randomized controlled study, 60 patients undergoing proximal femoral nailing were randomized to receive either combined peripheral nerve blocks (CPNB, n=30) or spinal anesthesia (SAB, n=30). Fifteen participants were excluded due to conversion to general anesthesia or open surgical procedures, resulting in 45 patients analyzed (CPNB, n=19; SAB, n=26). Baseline demographics, ASA physical status, and duration of surgery were comparable between groups. The mean age was 74.6 ± 9.7 years, and 71.1% of participants were female.

Onset of Sensory Block: The onset of sensory blockade was significantly faster with SAB (2.46 ± 0.81 min) compared to CPNB (16.32 ± 8.79 min, p<0.05). This aligns with previous studies showing rapid onset of intrathecal hyperbaric bupivacaine (3–5 min) with a duration of 1.5–3 hours (51). Longer onset times with PNBs are attributed to the high connective tissue content in proximal plexuses and the ratio of non-neuronal to neuronal tissue (52).

Block Failure and Conversion to GA: Among CPNB patients, seven cases required conversion to general anesthesia compared to two in the SAB group. Reasons included prolonged procedure and failed blocks. The observed 36% failure rate in CPNB is consistent with prior reports (10–40%) (52).

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Intraoperative Hemodynamics: Hemodynamic parameters demonstrated greater stability with CPNB. SAB patients experienced significantly lower heart rate, SBP, DBP, and MAP intraoperatively, with 53.8% developing hypotension, compared to 15.8% in the CPNB group ($p<0.05$). These findings are consistent with previous meta-analyses demonstrating reduced hypotension and fewer adverse effects with PNBs compared to spinal anesthesia (27). Spinal hypotension is primarily due to sympathetic blockade causing arteriolar vasodilation and reduced systemic vascular resistance (52).

Postoperative Analgesia: The mean duration of analgesia was longer with CPNB (5.5 hours) than SAB (3.5 hours), though the difference in time to first rescue analgesia was not statistically significant. Total 24-hour tramadol consumption was significantly lower in the CPNB group (96 ± 32.6 mg) compared to SAB (136 ± 26.5 mg, $p<0.05$), reflecting improved postoperative analgesia. Anatomical considerations, including sparing of the superior gluteal nerve in CPNB, explain why PNBs alone may be inadequate for hip surgery (32). Similar studies demonstrate reduced opioid consumption and prolonged analgesia with PNBs (54–57).

Quality of Recovery and Hospital Stay: QoR-15 scores were slightly higher in the CPNB group (61 ± 12.5) versus SAB (57 ± 10.5), though not statistically significant. ICU admission rates and duration were comparable. Length of hospital stay was marginally shorter in the CPNB group (6.9 vs. 7.5 days), likely reflecting better analgesia, earlier mobilization, and reduced complications such as cognitive dysfunction and urinary retention (61,62).

Clinical Implications: While SAB remains efficient as a sole anesthetic technique, it is associated with significant hemodynamic fluctuations, which can be detrimental in elderly patients. CPNB provides a valuable adjunct, offering improved hemodynamic stability and postoperative analgesia, though lumbar plexus blocks may provide more complete blockade at the cost of technical difficulty and risk (63).

Strengths and Limitations: Strengths include a randomized controlled design, single-blind allocation, and a focus on a discrete surgical procedure, minimizing confounding. Limitations include a relatively small sample size for secondary outcomes and lack of long-term follow-up for postoperative morbidity and mortality.

8. Conclusion

In elderly patients undergoing proximal femoral nailing:

1) Postoperative Analgesia: CPNBs provided longer mean analgesia (5.5 hrs) than SAB (3.5 hrs), though time to first rescue analgesia was not significantly different. Total opioid consumption in the first 24 hours was significantly lower with CPNB.
2) Hemodynamic Stability: CPNBs were associated with significantly better intraoperative hemodynamic stability and fewer episodes of hypotension.
3) ICU Admission and Hospital Stay: No significant differences were observed in postoperative ICU admission or length of hospital stay, although CPNB patients showed a trend toward shorter hospital stay.
4) Quality of Recovery: QoR-15 scores were slightly higher in the CPNB group, indicating improved early recovery, though not statistically significant.

Overall, CPNBs represent a safe and effective adjunct for hip surgery, offering superior hemodynamic stability and postoperative analgesia, and may be particularly beneficial in elderly patients with comorbidities.

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