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Original Research Article

# Comparative Evaluation of 0.5% Bupivacaine and 0.5% Ropivacaine with Dexamethasone in Ultrasound-Guided Pericapsular Nerve Group Block for HIP Fracture Surgery under Spinal Anaesthesia: A Prospective Randomised Double-Blinded Study

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**Conflict of interest: Nil**

**Abstract**

**Background:** The pericapsular nerve group (PENG) block provides motor-sparing analgesia for hip surgery, but direct comparisons of long-acting local anaesthetics are limited. We compared 0.5% bupivacaine and 0.5% ropivacaine with dexamethasone for ultrasound-guided PENG block.

**Methods:** In this prospective randomised double-blinded study, 60 ASA I-III patients aged over 30 years undergoing elective hip surgery under spinal anaesthesia received either 20 mL 0.5% bupivacaine plus dexamethasone 4 mg (Group A) or 20 mL 0.5% ropivacaine plus dexamethasone 4 mg (Group B). Primary outcomes were VAS scores and ease of positioning. Secondary outcomes included onset and duration of analgesia, rescue analgesic requirement, haemodynamics and adverse effects.

**Results:** Baseline variables and pre-block VAS were comparable. Group A had lower VAS at 10 minutes (4.07 ± 0.25 vs 4.47 ± 0.51; $p<0.001$) and 20 minutes (1.73 ± 0.79 vs 2.47 ± 1.22; $p=0.008$), and a better positioning score (2.30 ± 0.54 vs 1.83 ± 0.59; $p=0.002$). Onset was similar. Analgesia lasted longer (15.83 ± 2.98 vs 11.33 ± 1.63 hours; $p<0.001$) and total rescue doses were lower (1.33 ± 0.61 vs 1.90 ± 0.71; $p=0.002$) with bupivacaine. Haemodynamics were comparable and no adverse effects occurred.

**Conclusion:** Both agents were effective and safe; bupivacaine provided easier positioning, longer analgesia and lower total rescue requirement.

**Keywords:** Bupivacaine; Ropivacaine; PENG Block; Hip Fracture; Spinal Anaesthesia; Postoperative Analgesia.

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## Introduction

Hip fracture and hip arthroplasty cause severe perioperative pain. Inadequate analgesia makes positioning for spinal anaesthesia difficult, increases systemic analgesic use and may delay mobilisation. Opioids can produce nausea, sedation, respiratory depression and delirium in older patients; regional techniques therefore form an important part of multimodal analgesia. Girón-Arango et al. introduced the ultrasound-guided PENG block to target the articular branches of the femoral, obturator and accessory obturator nerves supplying the anterior hip capsule [1]. Studies subsequently

reported improved positioning, reduced postoperative pain and lower opioid use, with less quadriceps weakness than femoral or fascia iliaca blocks [2-5]. Injectate volume and spread may nevertheless influence femoral nerve involvement [3]. Bupivacaine provides dense, prolonged sensory blockade but has greater cardiotoxicity and motor-blocking potential. Ropivacaine is less lipid soluble and may offer greater sensory-motor differentiation. Previous PENG studies used different concentrations, adjuvants or combined blocks, limiting direct comparison [6-9]. We compared equal concentrations and volumes of both drugs with dexamethasone. Primary outcomes were pain reduction and ease of positioning; secondary outcomes were analgesia duration, rescue analgesic requirement, haemodynamics and adverse effects.

## Methods

**Trial Registration and Ethics:** Approval was obtained from the Institutional Ethics Committee of Sardar Patel Medical College, Bikaner. Trial registration, CTRI/2026/04/109285 [Registered on: 24/04/2026]. Written informed consent was obtained.

**Design and Participants:** This prospective hospital-based randomised double-blinded study was conducted within the period of three months after the CTRI registration. Patients of either sex, aged over 30 years, with ASA physical status I-III, scheduled for elective hip fracture fixation or hip replacement under spinal anaesthesia were included. Exclusion criteria were refusal, ASA IV-VI, drug allergy, neuromuscular disease or spinal deformity, coagulopathy, block-site infection, severe hypovolaemia and bilateral surgery.

**Sample Size and Allocation:** Using data from Salgado-García et al, [9] 27 patients per group were required to detect a VAS difference of 2.5 with 85% power and two-sided alpha 0.05. After allowing 10% attrition, 30 were enrolled per group. Computer-generated allocation was concealed in sequentially numbered opaque sealed envelopes. Patients and the postoperative assessor were blinded.

**Randomization and Blinding:** Sampling Technique Patients fulfilling the inclusion criteria and providing written informed consent were recruited. Participants were randomised and allocated equally into two study groups using a computer-generated randomisation table. Random allocation ensured unbiased group assignment. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes (SNOSE).

**Block Technique:** Standard monitoring was applied. With the patient supine, a curvilinear probe was placed over the anterior inferior iliac spine and rotated to visualise the iliopubic eminence, pubic ramus and psoas tendon. A 22-gauge 100-mm needle was advanced in-plane from lateral to medial between the psoas tendon and Iliopubic eminence. Group A received 20 mL 0.5% bupivacaine with dexamethasone 4 mg; Group B received 20 mL 0.5% ropivacaine with dexamethasone 4 mg. Psoas tendon elevation confirmed spread. VAS was recorded before block and at 10 and 20 minutes. Patients were then positioned sitting; ease of positioning was graded 0-3. Spinal anaesthesia was administered at L3-L4 or L4-L5 with 2.5 mL 0.5% hyperbaric bupivacaine and fentanyl 25 micrograms.

**Outcomes:** Primary outcomes were serial preoperative VAS and ease of positioning. Secondary outcomes were sensory onset, duration of analgesia, VAS every two hours for 24 hours, Rescue analgesic requirement, MAP, pulse, SpO2 and adverse effects. Duration was measured from block placement to the time of first rescue analgesic request. Paracetamol 1 g IV was given for VAS above 3; tramadol 100 mg IV was added if pain persisted after one hour. All patients received oxygen at 2-4 L/min. After surgery, they were observed in PACU for two hours and then in the orthopaedic ward. VAS, MAP, pulse and SpO2 were recorded. Postoperative motor recovery was assessed with the modified Bromage scale after regression of spinal anaesthesia, although quadriceps strength attributable specifically to PENG block was not quantified.

**Statistics**: SPSS version 23.0 was used. Continuous data are mean ± SD and categorical data number (%). Independent t-test, chi-square or Fisher's exact test and repeated-measures ANOVA were applied as appropriate. $p<0.05$ was significant.

**Results:** Sixty-two patients were enrolled and 60 analysed, 30 per group. Reasons for excluding two patients: (1 Un-cooperative, 1 Block-failure) Baseline demographic and clinical variables were comparable (Table 1). The groups were also comparable for sex, ASA grade, fracture diagnosis and operative procedure, reducing the likelihood that baseline clinical differences explained the observed analgesic outcomes.

**Table 1: Baseline characteristics**

| Parameter | Group A (n=30) | Group B (n=30) | p-value |
|---|---|---|---|
| Age (years) | 62.67 ± 16.88 | 61.90 ± 16.07 | 0.858 |
| Height (cm) | 165.63 ± 9.93 | 165.57 ± 10.04 | 0.979 |
| Weight (kg) | 64.00 ± 8.73 | 65.53 ± 11.69 | 0.062 |
| BMI (kg/m²) | 23.33 ± 2.15 | 23.91 ± 2.48 | 0.337 |
| Male/female | 21/9 | 18/12 | 0.417 |
| ASA I/II/III | 10/15/5 | 11/16/3 | 0.478 |
| Diagnosis: intertrochanteric/neck of femur | 14/16 | 17/13 | 0.438 |
| Procedure: bipolar/THR/CC/DHS/PFN | 8/2/2/1/17 | 5/3/3/0/19 | 0.698 |

Values are mean ± SD or counts. THR, total hip replacement; CC, cannulated cancellous; DHS, dynamic hip screw; PFN, proximal femoral nail. Group A had lower VAS at 10 and 20 minutes (post block) and a higher positioning score. Sensory onset was comparable, whereas duration was about 4.5 hours longer and Total rescue analgesic doses requirement were lower with bupivacaine.

**Table 2: Block and analgesic outcomes**

| Outcome | Group A | Group B | p-value |
|---|---|---|---|
| Pre-block VAS | 6.67 ± 0.66 | 6.57 ± 0.50 | 0.513 |
| VAS at 10 min (post block) | 4.07 ± 0.25 | 4.47 ± 0.51 | <0.001* |
| VAS at 20 min (post block) | 1.73 ± 0.79 | 2.47 ± 1.22 | 0.008* |
| Positioning score | 2.30 ± 0.54 | 1.83 ± 0.59 | 0.002* |
| Sensory onset (min) | 12.20 ± 1.35 | 12.57 ± 1.70 | 0.546 |
| Analgesia duration (h) | 15.83 ± 2.98 | 11.33 ± 1.63 | <0.001* |
| Total rescue doses/24 h | 1.33 ± 0.61 | 1.90 ± 0.71 | 0.002* |
| Paracetamol doses | 1.20 ± 0.41 | 1.40 ± 0.62 | 0.146 |
| Paracetamol plus tramadol doses | 0.07 ± 0.25 | 0.23 ± 0.43 | 0.074 |

**Values are mean ± SD. *p<0.05.**

All patients were pain free through six hours. VAS-category distributions differed from 8 to 20 hours, but direction varied after rescue treatment; time to first rescue and total rescue requirement were as charted in outcomes of (Table 3). MAP, pulse and SpO2 were comparable throughout (Table 4). No toxicity, neurological complication or other adverse effect occurred.

**Table 3: Postoperative pain-free patients**

| Interval | Group A VAS=0, n (%) | Group B VAS=0, n (%) | p-value† |
|---|---|---|---|
| 2-6 h | 30 (100%) | 30 (100%) | Not computed |
| 6-8 h | 29 (96.7%) | 25 (83.3%) | 0.126 |
| 8-10 h | 28 (93.3%) | 16 (53.3%) | 0.005* |
| 10-12 h | 27 (90.0%) | 8 (26.7%) | <0.001* |
| 12-14 h | 14 (46.7%) | 14 (46.7%) | 0.002* |
| 14-16 h | 10 (33.3%) | 25 (83.3%) | 0.001* |
| 16-18 h | 21 (70.0%) | 21 (70.0%) | 0.001* |
| 18-20 h | 25 (83.3%) | 18 (60.0%) | 0.014* |
| 20-22 h | 24 (80.0%) | 27 (90.0%) | 0.314 |
| 22-24 h | 28 (93.3%) | 30 (100%) | 0.150 |

**†p-values represent the complete VAS-category distribution. *p<0.05.**

**Table 4: Selected haemodynamic measurements**

| Parameter | Group A | Group B | p-value |
|---|---|---|---|
| MAP baseline (mmHg) | 83.37 ± 8.00 | 80.60 ± 7.67 | 0.177 |
| MAP postoperative 24 h | 93.67 ± 3.68 | 93.70 ± 4.52 | 0.975 |
| Pulse baseline (beats/min) | 80.27 ± 9.47 | 82.53 ± 7.04 | 0.297 |
| Pulse postoperative 24 h | 79.37 ± 7.74 | 79.63 ± 8.21 | 0.897 |
| SpO2 baseline (%) | 98.40 ± 0.62 | 98.30 ± 0.75 | 0.576 |
| SpO2 postoperative 24 h | 99.40 ± 0.50 | 99.00 ± 0.00 | 0.214 |

**Values are mean ± SD. MAP, mean arterial pressure; SpO2, peripheral oxygen saturation.**

## Discussion

Both agents produced effective PENG block, but bupivacaine gave better, easier positioning, longer analgesia and fewer total rescue doses. Haemodynamic stability and safety were similar.

Movement causes severe pain during positioning for spinal anaesthesia after proximal femur fracture. The lower 10 min and 20 min (post-block) VAS score and higher positioning score with bupivacaine indicate a clinically useful advantage. Girón-Arango et al. first demonstrated rapid reduction in dynamic pain after PENG block[1]. Chaudhary et al. reported better positioning with PENG than femoral nerve block [4], and Sharma et al. found that 20 mL bupivacaine improved positioning compared with a smaller volume [10]. Pascarella et al. demonstrated lower postoperative pain, reduced opioid use and earlier ambulation after PENG block for total hip arthroplasty [2]. Vamshi et al. reported lower morphine consumption and less quadriceps weakness than suprainguinal fascia iliaca block [5]. These studies support PENG block in multimodal hip analgesia, while the present trial addresses the less studied choice between two long-acting local anaesthetics.

Sensory onset was similar, suggesting effective spread with either drug. Bupivacaine prolonged analgesia by about 4.5 hours, possibly because of greater lipid solubility and tissue binding. Karthick Raj et al. found faster onset with ropivacaine but similar duration in a combined PENG-lateral femoral cutaneous block [7], whereas Shynee et al. reported longer analgesia with ropivacaine using unequal concentrations [8]. Variation in concentration, accompanying blocks and adjuvants may explain these differences.

Total rescue requirement was lower with bupivacaine, although separate paracetamol and tramadol components were comparable. Yu et al. found that PENG block improves postoperative analgesia but that opioid reduction varies across trials[6]. Our result should therefore be described as fewer total rescue doses, not a definite opioid-sparing effect. Changing VAS distributions after 14 hours may reflect rescue timing; duration to first rescue is the clearer efficacy measure.

No difference occurred in MAP, pulse or SpO2, and no adverse effect was recorded. The sample, however, was not powered for rare toxicity. High-volume PENG spread can reach the femoral nerve[3], but quadriceps strength was not objectively measured.

**Strengths and Limitations:** Strengths were randomisation, concealed allocation, blinded postoperative assessment, equal concentration and volume, identical dexamethasone dosing and standardised rescue treatment. Limitations were the single-centre design, modest sample, 24-hour follow-up, absent objective motor assessment, no functional recovery or hospital-stay outcomes, and rescue-dose counts rather than morphine-equivalent consumption.

## Conclusion

Both 0.5% bupivacaine and 0.5% ropivacaine with dexamethasone were effective and haemodynamically stable for ultrasound-guided PENG block. Bupivacaine provided better ease of positioning, longer duration of analgesia and lower total rescue analgesic requirement. Larger multicentre trials with objective motor assessment are needed.

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