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Assessing The Spread Of Local Anaesthetic, Injection Bupivacaine 0.25% (30ml) Using Radiocontrast Dye In Pericapsular Nerve Group Block For Hip Surgeries – A Case Series

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Abstract
Background: *Hip fractures are associated with severe pain. Conventional regional techniques such as femoral nerve block and fascia iliaca compartment block are used to alleviate the pain. These often fail to provide complete analgesia due to inadequate obturator nerve coverage. The Pericapsular Nerve Group (PENG) block targets articular branches of the femoral, obturator and accessory obturator nerve and may provide superior analgesia. However objective evidence regarding the spread of local anesthetic remains limited.*
Objectives: *To assess the anatomical spread of local anaesthetic following ultrasound-guided PENG block using radiocontrast dye under C-ARM imaging and correlate it with clinical analgesic outcomes.*
Methods: *A prospective case series was conducted in 10 patients undergoing elective hip surgery under spinal anaesthesia. Patients received an ultrasound-guided PENG block using 20 mL of 0.25% bupivacaine combined with 10ml of radiocontrast dye. Spread of injectate was assessed using C-ARM imaging at 5, 10, and 20 minutes post-injection. Pain scores (VAS) and ease of positioning for SAB were recorded. Statistical analysis was performed using the Wilcoxon signed-rank test.*
Results: *C-ARM imaging demonstrated consistent cranial spread to L2–L3 vertebral levels, caudal spread into the subpectineal plane, and lateral distribution between the iliopubic eminence and anterior inferior iliac spine. Sensory loss was correlating with anatomical spread of the drug. Mean baseline VAS score was 7 which decreased to 3 immediately post-block and 1 at 20 minutes ($p < 0.001$). Ease of positioning improved significantly with median scores decreasing from 3.0 pre-block to 0 post-block ($p = 0.002$).*
Conclusion: *Ultrasound-guided PENG block using 20 mL of 0.25% bupivacaine provides significant analgesia and facilitates patient positioning for SAB in hip surgeries. 10ml of radiocontrast dye helps assess the injectate spread. Radiological imaging confirms predictable anatomical spread supporting its mechanism of action.*
Keywords: *PENG block, hip fracture analgesia, regional anaesthesia, C-arm imaging, bupivacaine.*

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I. Introduction

Hip fractures represent a major cause of morbidity and disability worldwide, particularly among elderly patients. Severe pain associated with these injuries significantly impairs mobility and often complicates positioning for spinal anaesthesia. Subarachnoid block remains the most commonly used anaesthetic technique for hip surgeries. However, intense preoperative pain frequently makes it difficult for patients to assume the required sitting or lateral position, thereby increasing procedural difficulty and patient discomfort.

Regional analgesic techniques such as femoral nerve block and fascia iliaca compartment block have traditionally been used to facilitate positioning.([1],[2]). Despite their utility, these techniques have limitations, primarily due to incomplete blockade of the obturator and accessory obturator nerves that contribute significantly to hip joint innervation.

The Pericapsular Nerve Group (PENG) block, first described by Girón-Arango et al.([3]) in 2018, targets the articular branches of the femoral nerve, accessory obturator nerve, and obturator nerve supplying the anterior hip capsule. Early clinical studies have demonstrated promising analgesic outcomes with this technique.

Most published studies have focused primarily on clinical outcomes such as pain reduction and improved positioning.([4]) Studies have been conducted on cadavers to assess the spread of the drug.([5]) However, there is limited objective evidence demonstrating the anatomical spread of the injectate in patients.

Radiological evaluation using C-ARM imaging can provide valuable insights into the distribution of local anaesthetic and improve understanding of the mechanism of analgesia. Therefore, the present study aims to evaluate both clinical efficacy and anatomical spread of the PENG block using radiocontrast dye.

II. Methods

A case series was conducted in the Department of Anaesthesiology at Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore. Institutional Ethics Committee approval was obtained (Approval No:SIMS & RC/EC-21/PG-06/2024-25) and registration with Clinical Trials

Registry India CTRI/2025/10/095811 was done. The study adhered to the Declaration of Helsinki guidelines, and written informed consent was obtained from all participants for participation in the study and use of patient data for research and educational purposes. The data collected were kept anonymous and study was conducted from 1st February 2025 to 30th September 2025.

Patients above 18 years of age scheduled for elective hip surgeries under spinal anaesthesia and belonging to ASA physical status I -III were included. Patients with known allergy to local anaesthetic, coagulopathy, infection at injection site, pre-existing neurological deficit of lower limbs, pregnant or lactating, acute kidney injury or chronic kidney disease, difficulty expressing pain scores and who refused to take part were excluded from study.

In the preoperative room, pain score at rest (VAS – PREOP) and ease of positioning grading was recorded before giving the block. Patients were shifted to operating room and standard ASA monitors attached. Under strict aseptic precautions, local infiltration with 3 mL of 2% lidocaine was administered at the insertion site. A low-frequency ultrasound probe (Sonosite ST) was placed parallel to the inguinal crease at the level of the anterior superior iliac spine (ASIS) and moved caudally until the anterior inferior iliac spine (AIIS) was visualised. The probe was then rotated medially to identify the superior pubic ramus, iliopectineal eminence and psoas tendon. The target site was the fascial plane between these structures. Maintaining this view a 22-G 100mm needle was inserted using an in plane technique. A mixture of 30 mL of 0.25% bupivacaine with radiocontrast dye (OMNIPAQUE) was injected after confirming correct needle placement and negative aspiration.

Injectate spread was evaluated using C-ARM fluoroscopy at 5 minutes,10 minutes, 20 minutes post-injection. Spread was assessed relative to anatomical landmarks including Iliopubic eminence, Anterior inferior iliac spine and Psoas muscle. The maximum level of spread of the drug with reference to lumbar spine was recorded. Sensory loss over distribution of nerves involved was assessed.

(Fig.1)

Pain intensity was assessed using the Visual Analogue Scale (VAS) at Immediately post-block, 5minutes, 10 minutes and 20 minutes. Patients were made to sit for spinal anaesthesia after 20 minutes and comfort during sitting for spinal anaesthesia was assessed using 4 point scale. (0 – sitting without pain and minimal help; 1- mild pain detected by grimacing or verbal expression; 2- severe pain but tolerates positioning with help; 3- unable to sit).([6])

All patients received standard intraoperative care and monitoring. Patients were monitored for vascular puncture, local anaesthetic systemic toxicity, allergic reactions.

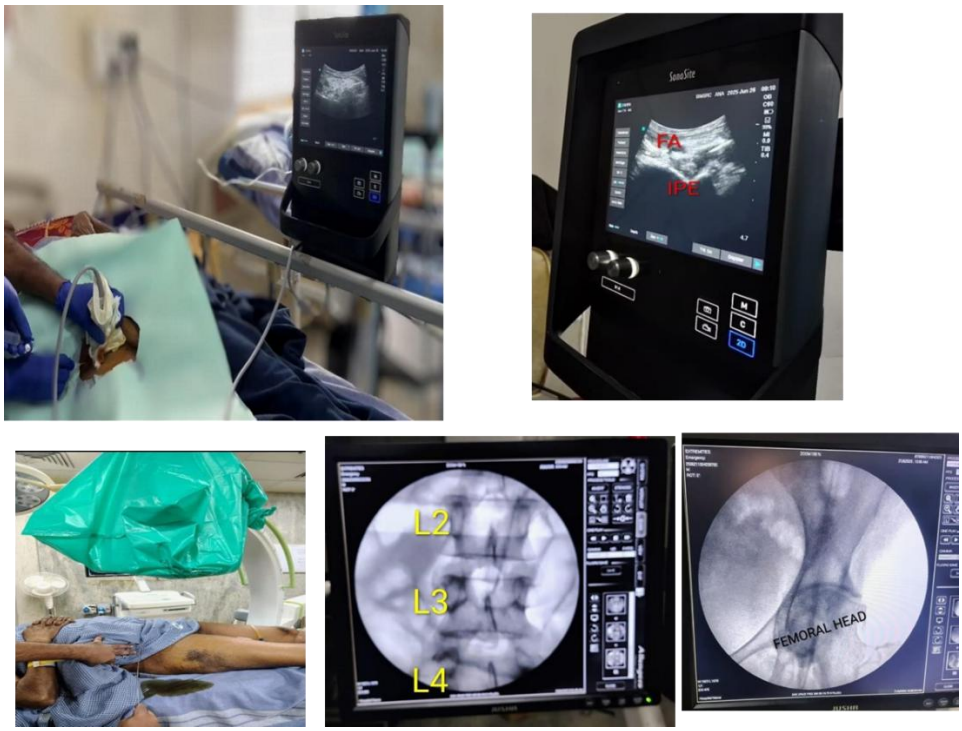


FIG 1

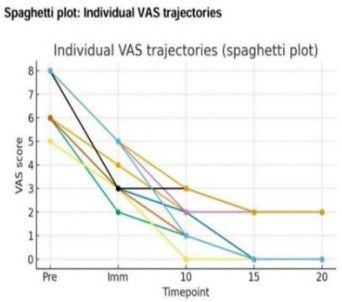
III. Results

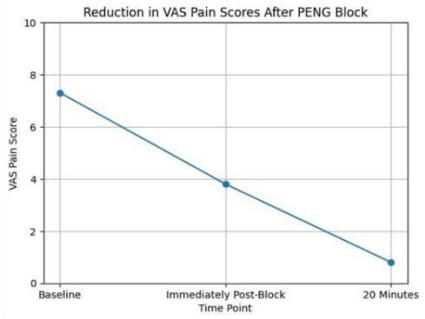
A total of 10 patients were chosen in our study. Demographic data in both groups showed no much difference. C-ARM imaging findings demonstrated a consistent pattern of spread. Cranial Spread, extension up to L2–L3 vertebral level, with one of case showing upto L1- L2 level. Caudal spread into the subpectineal plane involvement of the hip capsule and psoas region. Lateral sread along the fascial plane between the AIIS and iliopubic eminence. This pattern suggests probable involvement of the obturator nerve branches contributing to improved analgesia. No complications were observed.

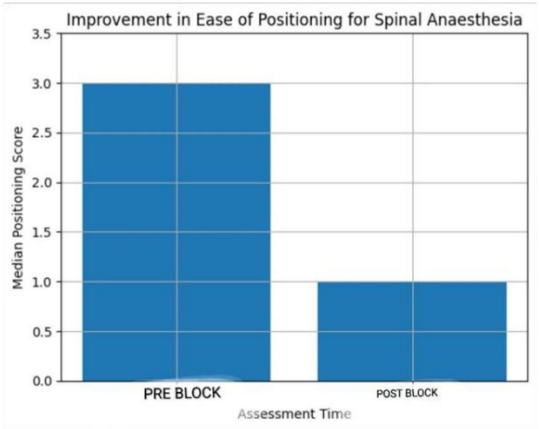
The baseline VAS score was similar. Mean of the baseline VAS was 7 and immediately post block was 3 and at 20 minutes reduced to 1. There was a statistically significant reduction in pain scores. By 20 minutes, 90% of the patients achieved VAS ≤ 3, indicating clinically meaningful analgesia.

Ease of positioning had 10 cases at grade 3 in preop and post block at 20 minutes improved to grade 1 in 5 individuals and grade 0 in 5 individuals. Hence it showed significant improvement in ease of positioning.

PARAMETER	VALUE
TOTAL PATIENTS	10
MALE : FEMALE	6:4
MEAN AGE (YEARS)	62.4
ASA I:II:III	3:5:2
FRACTURE TYPE a) Neck of femur fracture b) Pubic ramus fracture c) Intertrochanteric fracture	 a) 4 b) 3 c) 3
MEAN BASELINE VAS	7.5
MEAN VAS AT 20 MINUTES	1
EASE OF POSITIONING a) Pre block b) At 20 minutes	 a) Grade 3 in 10 b) Grade 1in 5 and grade 0 in 5
SPREAD OF LOCAL ANAESTHETIC	Upto L2 - L3 levels in 9 patients.







IV. Discussion

The anterior hip capsule is innervated by articular branches of the femoral nerve, accessory obturator nerve and obturator nerve, whereas the sciatic nerve innervates the posterior capsule([4]) The mechanoreceptor (nociceptive), responsible for pain, is mainly present in the anterior capsule.([8]) PENG block is an interfacial block providing adequate analgesia by blocking articular branches of the femoral nerve, accessory obturator nerve and obturator nerve. Articular branches of these nerves are between the psoas muscle and the pubic ramus.([4]) Therefore, PENG block has the propensity to provide more complete and better analgesia. Various case series and randomised studies in the literature support this.([3])

The findings of this study demonstrate that the ultrasound-guided PENG block provides significant analgesia in patients undergoing hip surgery. The radiological findings provide important anatomical insights into the mechanism of the PENG block. The observed cranial spread to L2–L3 levels suggests involvement of the articular branches of the femoral nerve and obturator nerve. Caudal spread into the subpectineal plane corresponds to the region containing capsular branches supplying the anterior hip joint. This anatomical distribution likely explains the comprehensive analgesia observed in our patients. Our observations are consistent with cadaveric findings reported by Smits et al.([5]), who demonstrated similar patterns of injectate spread using methylene blue dye. Similarly, the scoping review by Kaur et al. ([7]) highlighted the theoretical advantages of PENG block in providing targeted hip capsule analgesia. In one of the studies conducted by Rachel Smits et al ([5]) on cadavers using methylene blue dye showed staining of the obturator nerve and femoral nerve with total mean horizontal spread of 6.4cm and total mean vertical spread of 10.4cm. The present study provides in-vivo radiological confirmation supporting these anatomical hypotheses.

A marked reduction in VAS scores was observed within minutes of block administration, and most patients achieved clinically meaningful pain relief within 20 minutes. Improved ease of positioning for spinal anaesthesia further highlights its clinical utility. Adequate analgesia before SAB placement reduces patient distress and procedural difficulty.

V. Strengths And Limitations

This study aimed to assess the spread of the local anaesthetic in PENG block so as to assess the nerves it would cover. The strength of the study is that it is first study combining clinical outcomes with radiological confirmation of injectate spread providing real time in vivo anatomical distribution.

The limitations of the study is that it was only a case series with small sample size of 10 individuals. Further randomised controlled trials with larger sample size comparing PENG block with other regional techniques are needed to determine optimal drug volume, concentration and long term outcomes.

VI. Conclusion

Ultrasound-guided Pericapsular Nerve Group (PENG) block using 20 mL of 0.25% bupivacaine with 10ml of radiocontrast dye provides effective analgesia in patients undergoing hip surgery. The block significantly reduces pain and improves ease of positioning for spinal anaesthesia.

Radiological evaluation using C-ARM confirms a consistent and predictable spread pattern, supporting the anatomical rationale of the PENG block.

This technique has the potential to become a standard preoperative analgesic strategy in hip fracture management.

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Nil.

Conflict of interest
There are no conflicts of interest.

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