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Research Article

"Ropivacaine With or Without Dexamethasone for Ultrasound-Guided Pericapsular Nerve Group Block in Hip Surgery: A Comparative Study"

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ABSTRACT
Background: The pericapsular nerve group (PENG) block is a novel, ultrasound-guided regional anaesthesia technique targeting the articular branches of the femoral, obturator, and accessory obturator nerves. It has demonstrated efficacy in providing analgesia for hip surgeries while preserving motor function. Adjuvants such as dexamethasone have been explored to prolong analgesic duration and improve outcomes when combined with local anaesthetics. Aim of this study is to compare the efficacy and duration of analgesia of ultrasound-guided PENG block using 0.5% Ropivacaine alone versus 0.5% Ropivacaine with Dexamethasone in patients undergoing hip surgery.
Methods: A prospective, randomized, double-blind clinical study was conducted on 60 patients aged 18 to 65 years belonging to ASA I–II scheduled for elective hip surgery between June 2023 and May 2024 in the Department of Anaesthesiology at Sri Balaji Medical College and Hospital, Tirupati. Patients were randomly divided into two groups (n=30 each): Group A: Received 20 ml of 0.5% Ropivacaine. Group B: Received 20 ml of 0.5% Ropivacaine + 8 mg Dexamethasone. The PENG block was performed under ultrasound guidance preoperatively. Patients were monitored for 24 hours postoperatively for visual analogue scale (VAS) pain scores, duration of analgesia (time to first rescue analgesic), total analgesic consumption, motor function, and any complications.
Results: The duration of analgesia was significantly longer in Group B (mean: 18.2 ± 2.4 hours) compared to Group A (mean: 11.6 ± 1.8 hours, $p < 0.001$). VAS scores at 6, 12, and 18 hours postoperatively were significantly lower in Group B ($p < 0.05$). Total rescue analgesic consumption was reduced in the dexamethasone group. No significant motor blockade or adverse effects were observed in either group.
Conclusion: The addition of dexamethasone to ropivacaine in ultrasound-guided PENG block significantly prolongs the duration of analgesia and reduces postoperative pain and analgesic requirements without increasing adverse effects. This combination may enhance perioperative pain management in hip surgeries.

Keywords: PENG Block, Ultrasound-Guided Nerve Block, Hip Surgery, Ropivacaine, Dexamethasone, Regional Anaesthesia, Postoperative Analgesia.

INTRODUCTION

Hip fractures represent a significant cause of morbidity, mortality, and healthcare burden, particularly among the elderly population. In India, the annual incidence of hip fractures is estimated to be over 200,000 cases, with one-year mortality rates ranging from 20% to 42%, especially in individuals over the age of 60.[1,2] Pain control remains a cornerstone of perioperative management in hip surgeries. Poorly managed pain can lead to complications such as delirium, delayed mobilization, and increased opioid consumption, especially in geriatric patients.[3,4] Traditional methods of analgesia, including systemic opioids, are associated with several adverse effects. Regional anaesthesia techniques such as the fascia iliaca block (FIB) and femoral nerve block (FNB) have been widely used to improve analgesia while reducing systemic opioid requirements.[5,6,7] However, these blocks may provide incomplete coverage of the hip joint's sensory innervation and can also cause significant motor blockade.[8,9] The Pericapsular Nerve Group (PENG) block, first described by Girón-Arango et al. in 2018, targets the articular branches of the femoral, obturator, and accessory obturator nerves, offering improved analgesia with reduced motor impairment.[10] Recent studies and meta-analyses support its efficacy and safety in various hip surgeries.[11-14] Ropivacaine, a long-acting amide local

anaesthetic, is commonly used in peripheral nerve blocks. The addition of dexamethasone as an adjuvant has been shown to prolong the duration of analgesia and reduce postoperative pain.[15] However, limited data exist comparing ropivacaine alone to its combination with dexamethasone in the context of the PENG block for hip surgery.

Aims and Objectives

Primary Objective

- To compare the duration of postoperative analgesia in patients undergoing hip surgery receiving a PENG block with ropivacaine alone versus ropivacaine with dexamethasone.

Secondary Objectives

- To compare postoperative pain scores using the Visual Analogue Scale (VAS).
- To evaluate total postoperative analgesic requirements.
- To assess motor function preservation postoperatively.
- To identify any complications related to the block or the drugs used.

METHODOLOGY

Study Design

A prospective, randomized, double-blind clinical trial.

Study Population

Inclusion Criteria

Patients aged 18 – 65 years, ASA I–II, scheduled for elective hip surgery under spinal anaesthesia.

Exclusion Criteria

Allergy to study drugs, infection at injection site, coagulopathy, severe hepatic/renal impairment, refusal to consent, pre-existing neurological deficits in the lower limb.

Sample Size Calculation:

Based on previous studies[1,15], assuming a mean difference of 5 hours in analgesia duration between groups, with a standard deviation of 4 hours, alpha = 0.05 and power = 80%, the required sample size was calculated to be 27 per group. To account for dropouts, 30 patients were included in each group.

Randomization and Blinding

Participants were randomly assigned to:

- **Group A:** 20 ml of 0.5% ropivacaine.
- **Group B:** 20 ml of 0.5% ropivacaine + 8 mg dexamethasone.

Randomization was done using computer-generated numbers, and the anaesthesiologist performing the block and the postoperative assessor were blinded to group allocation.

Block Technique

Under ultrasound guidance, the PENG block was administered preoperatively with the patient in the supine position, using a curvilinear probe placed in the sagittal plane medial to the anterior superior iliac spine. Local anaesthetic was deposited between the psoas tendon and pubic ramus.[10]

Postoperative Assessment

- **VAS Scores:** were recorded at 2, 6, 12, 18, and 24 hours.
- **Duration of Analgesia:** Time from block to first rescue analgesic.
- **Rescue Analgesia:** IV paracetamol 1g.
- **Motor Function**: Assessed via quadriceps strength using the modified Bromage scale.
- **Complications:** Nausea, vomiting, hypotension, local anesthetic toxicity or motor block was monitored and treated.

Statistical Analysis

Data were analyzed using SPSS version 22**.** Continuous variables were compared using Independent t-tests, and categorical variables using the Chi-square test; significance was set at $p < 0.05$.

RESULTS

Table 1: Demographic Data of the Participants

Parameter	Group A (n=30)	Group B (n=30)	p-value
Age (years)	68.3 ± 6.2	69.1 ± 5.7	0.53
Gender (M/F)	14/16	13/17	0.79
ASA I/II	6/17/7	5/18/7	0.91

Table 2: Comparison of Duration of Analgesia

Group	Mean Duration (hrs)	SD	p-value
Ropivacaine (A)	11.6	±1.8	<0.001

Ropivacaine + Dex (B)	18.2	±2.4	

Table 3: VAS Scores at Various Time Points

Time (hrs)	Group A	Group B	p-value
2	2.1	1.9	0.41
6	3.5	2.1	<0.01
12	4.2	2.6	<0.01
18	4.8	2.9	<0.01
24	3.1	2.4	0.03

Table 4: Other Outcomes

Outcome	Group A	Group B	p-value
Total Rescue Analgesic (mg)	2.3 ± 0.6	1.1 ± 0.3	<0.001
Motor Blockade (Bromage ≥ 1)	2	1	0.55
Nausea/Vomiting	3	2	0.64

DISCUSSION

Effective pain management in patients undergoing hip surgery is a significant challenge, particularly in the elderly population who are more prone to complications such as delirium, immobility, and adverse drug reactions.[1,3] Traditionally, systemic opioids have been the mainstay for postoperative analgesia. However, they are associated with several adverse effects including respiratory depression, nausea, vomiting, constipation, and the risk of delirium, especially in geriatric patients.[3,4] The need for a safer, more targeted analgesic technique has led to increased interest in regional anaesthesia, specifically nerve blocks that can provide superior analgesia with fewer systemic complications.

PENG Block and Its Analgesic Efficacy

The Pericapsular Nerve Group (PENG) block, first introduced by Girón-Arango et al. in 2018, offers a novel approach by targeting the articular branches of the femoral nerve, obturator nerve, and accessory obturator nerve which contribute significantly to the sensory innervation of the anterior hip capsule.[10,17] The unique anatomical targeting of the PENG block allows for effective analgesia with minimal motor blockade—unlike femoral nerve or fascia iliaca blocks, which can compromise quadriceps strength and delay postoperative mobilization.[7,18,19] Recent studies have further validated the nerve supply to the hip joint and support the use of PENG block for hip surgeries.[11,20] These findings have paved the way for studies evaluating the block's efficacy in clinical scenarios, showing reduced opioid consumption, better pain scores, and earlier ambulation.[10,12]

Ropivacaine in Regional Blocks

Ropivacaine, a long-acting amide-type local anaesthetic, is commonly preferred in regional anaesthesia for its favourable safety profile and reduced motor blockade compared to bupivacaine. It provides excellent sensory blockade and is often chosen for procedures requiring prolonged analgesia with early postoperative mobility, such as hip surgeries.[15,21]

Role of Dexamethasone as an Adjuvant

The addition of dexamethasone to local anaesthetics in peripheral nerve blocks is well-documented to enhance the quality and prolong the duration of analgesia. Its mechanism is thought to involve inhibition of nociceptive C-fibre transmission, anti-inflammatory effects, and possible vasoconstriction that reduces local anaesthetic absorption.[1,15] In our study, the addition of 8 mg dexamethasone to 0.5% ropivacaine in the PENG block resulted in a significant extension in analgesic duration (mean of 18.2 ± 2.4 hours) compared to ropivacaine alone (11.6 ± 1.8 hours), consistent with the findings of Apte et al.[15] and Balasubramaniam et al.[1] Apte et al. compared ropivacaine with dexamethasone versus fentanyl in PENG blocks and concluded that dexamethasone provided significantly longer analgesia and lower rescue analgesic requirements.[15] Balasubramaniam et al. similarly observed a prolonged duration of analgesia and reduced VAS scores when dexamethasone was added to ropivacaine in PENG blocks.[1] These results are in agreement with our findings and reinforce the analgesic-enhancing effects of dexamethasone in regional blocks.

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Pain Scores and Opioid-Sparing Effect

Our study also showed significantly lower VAS scores in the RD group (ropivacaine + dexamethasone) at 6, 12, 18, and 24 hours postoperatively. This not only reflects superior analgesic efficacy but also correlates with a substantial reduction in the need for rescue analgesia. The opioid-sparing effect of PENG blocks, especially with adjuvants, is particularly important in the elderly population, where opioid-related side effects can be detrimental.[3,11,14] A study by Huda and Ghafoor, a meta-analysis on PENG blocks, showed that patients receiving PENG blocks required significantly fewer opioids postoperatively and had better satisfaction scores compared to traditional blocks or systemic analgesics.[11] Similarly, Yadav et al. reported that ultrasound-guided PENG blocks significantly reduced IV opioid usage in hip fracture pain management.[14]

Motor-Sparing Advantage

One of the key advantages of the PENG block is its motor-sparing nature, which allows patients to participate in early mobilization and physiotherapy. This feature is critical for improved postoperative outcomes, especially in elderly patients where immobility can lead to complications such as deep vein thrombosis, pulmonary embolism, pneumonia, and increased mortality.[16,22]

Unlike femoral nerve blocks that can cause significant quadriceps weakness,[6,7] the PENG block targets purely sensory articular branches, sparing the main motor components. In our study, both groups demonstrated preservation of motor function, as assessed by the modified Bromage scale, with no significant difference in motor blockade. This is supported by Jaeger et al., who emphasized the importance of motor-sparing blocks in lower limb surgeries for early mobilization and rehabilitation.[18]

Bravo et al. compared PENG blocks to periarticular local infiltration in total hip arthroplasty and found significantly improved functional recovery in the PENG group, largely due to better pain control without impairing motor function.[23]

Safety and Complications

No significant block-related complications such as vascular puncture, local anaesthetic systemic toxicity (LAST), or prolonged motor blockade were observed in either group in our study. The incidence of nausea and vomiting was low and comparable in both groups, likely due to the opioid-sparing effect of the regional block. The safety profile of the PENG block has been well established in multiple studies, and our findings support its continued use as a safe technique for hip surgeries.[10,13,19]

Clinical Implications

The clinical implications of our study are clear: combining dexamethasone with ropivacaine for the PENG block provides superior, longer-lasting analgesia while preserving motor function, making it a preferred choice for perioperative pain management in hip surgery. This technique may be particularly beneficial as part of Enhanced Recovery after Surgery (ERAS) protocols, allowing for reduced opioid consumption, early mobilization, and improved patient outcomes.

Limitations

While our findings are promising, there are several limitations:

- This was a single-centre study with a modest sample size.
- Plasma concentrations of ropivacaine or dexamethasone were not measured to evaluate systemic absorption.

Future multicentre trials with larger sample sizes and longer follow-up could further validate and expand on these findings.

CONCLUSION

The addition of dexamethasone to ropivacaine in ultrasound-guided PENG block provides superior and prolonged analgesia for patients undergoing hip surgery without increasing side effects or motor impairment. This combination offers a promising alternative to conventional analgesic regimens, supporting enhanced recovery protocols.

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