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A Comparative Study Of Ultrasound Guided Pericapsular Nerve Group [Peng] Block Versus Suprainguinal Fascia Iliaca Compartment [Sifi] Block Using Ropivacaine In Patients With Fracture Femur For Reducing Pain Associated With Positioning For Subarachnoid Block" - A Randomised Controlled Study

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Abstract
Femur fractures often require spinal anaesthesia for surgical management. Ultrasound-guided regional anaesthesia techniques such as Pericapsular Nerve Group (PENG) block and Suprainguinal Fascia Iliaca (SIFI) block offer alternative options for analgesia, but there is limited evidence comparing these methods in terms of pain relief and facilitating patient positioning for spinal anaesthesia .This study aims to compare the efficacy of PENG block and SIFI block with ropivacaine under ultrasound guidance in reducing pain and improving positioning for spinal anaesthesia in femur fracture surgeries.
Aim *: To compare the efficacy of the PENG block versus the SIFI block using ropivacaine in facilitating patient positioning for spinal anaesthesia in patients undergoing femur fracture surgeries.*
Methodology*: A prospective, randomized controlled trial (RCT) conducted to compare the two ultrasound-guided regional anesthesia techniques at Adichunchanagiri Hospital and Research Centre, Department of Anaesthesiology. 60 adult patients aged 18-75 years, scheduled for elective femur fracture surgeries, with ASA physical status I or II, were randomly allocated into 30 each to receive either PENG block or SIFI block.*
Results*: The mean age and weight of participants were comparable between the two groups. The onset of sensory block was significantly faster in Group P (4.77 minutes) compared to Group S (7.63 minutes, p = 0.012). Group P had superior post-block pain relief (VAS: 1.33 vs. 2.83, p = 0.034). The quality of spinal anesthesia positioning was better in Group P, with 76.2% achieving optimal positioning versus 23.8% in Group S (p = 0.008). Patients in Group P exhibited a higher level of satisfaction, with 81.8% satisfied, compared to 18.2% in Group S (p = 0.020). The time taken for patient positioning was also shorter in Group P (4.77 minutes vs. 5.94 minutes, p = 0.048). Hemodynamic parameters, such as heart rate and blood pressure, were similar between the two groups, although Group P had a significantly higher heart rate at 5 minutes post-block (80.17 bpm vs. 76.67 bpm, p = 0.002).*
Conclusion*: The PENG block provided superior analgesia, facilitated easier patient positioning for spinal anesthesia, and resulted in higher patient satisfaction compared to the SIFI block in patients undergoing femur fracture surgeries. This study suggests that the PENG block is a more effective regional anesthesia technique for improving the perioperative experience in femur fracture surgeries.*
Keywords: *femoral fractures, nerve block, patient positioning, spinal, ultrasonography.*

INTRODUCTION:

Femur fractures cause significant pain, making patient positioning for spinal anesthesia challenging. While spinal anesthesia is effective for lower extremity surgeries, the positioning process can exacerbate patient discomfort. Therefore, effective preemptive analgesia is crucial[1].
Regional nerve blocks, particularly the ultrasound-guided Pericapsular Nerve Group (PENG) block and the Suprainguinal Fascia Iliaca Compartment (SIFI) block, have emerged as promising adjuncts to spinal

anesthesia[2]. The PENG block targets hip joint innervation[3], while the SIFI block, a modification of the Fascia Iliaca Compartment Block, provides analgesia to the hip and thigh[4]. Both techniques utilize Ropivacaine, a long-acting local anesthetic, to improve patient comfort and facilitate easier positioning[5].
This study aims to compare the analgesic efficacy of ultrasound-guided PENG and SIFI blocks using Ropivacaine in patients with femur fractures to reduce pain associated with positioning for a subarachnoid block[13].

MATERIALS AND METHODS

This study is a prospective, randomized controlled trial designed to compare the analgesic efficacy of the PENG block and the SIFI block in adult patients with femur fractures undergoing surgery. The study took place over 18 months (December 2022 to May 2024) at Adichunchanagiri hospital and research center.

Study Population and Design

A total of 60 adult patients, aged 18-75 years, of either sex, with an ASA physical status of I or II, and scheduled for elective femur fracture surgery will be enrolled. Participants will be randomly allocated into two groups of 30 each using a computer-generated list to minimize bias.
Group P will receive an ultrasound-guided Pericapsular Nerve Group (PENG) block.
Group S will receive an ultrasound-guided Suprainguinal Fascia Iliaca (SIFI) block.
Inclusion criteria include adult patients aged 18-75, of either sex, with ASA I or II physical status, scheduled for elective lower limb femur fracture surgery, and providing written informed consent.
Exclusion criteria include uncooperative or mentally impaired patients, lack of consent, local pathology at the block site, history of peripheral neuropathy, compartment syndrome, serious systemic illnesses, allergy to local anesthetics, bleeding disorders, or pregnancy/lactation.

Methodology

After obtaining ethical approval and informed consent, patients will undergo a routine pre-anesthetic evaluation. All patients will receive oral alprazolam 0.5 mg and ranitidine 150 mg the night before surgery and will be kept NPO (nil per os). On the day of surgery, patients will be monitored for heart rate, non-invasive blood pressure (NIBP), ECG, and SpO2. An intravenous line will be secured, and midazolam 0.04 mg/kg will be administered for premedication.
Both blocks will be performed with the patient in a supine position using an ultrasound machine (MINDRAY). For both groups, a standardized anesthetic approach will be followed. For Group P, a low-frequency curvilinear probe (2-5 MHz) will be used to identify the iliopubic eminence, iliopsoas tendon, and pectineus muscle. An in-plane approach will be used to place a 100mm sonographic needle in the musculofascial plane between the psoas tendon and pubic ramus. After negative aspiration, 20 ml of 0.5% Ropivacaine with 4 mg of Dexamethasone will be injected.
For Group S, a high-frequency linear probe will be used to identify the iliacus muscle and fascia iliaca. A 100mm needle will be inserted in-plane, and after a "pop" through the fascia iliaca, the needle will be slightly withdrawn to inject 40 ml of 0.25% Ropivacaine with 4 mg of Dexamethasone.
The primary outcome will be the quality of patient positioning for spinal anesthesia, which will be scored from 0 (not satisfactory) to 3 (optimal) by a blinded anesthesiologist. Secondary outcomes include Visual Analogue Scale (VAS) pain scores, time to perform spinal anesthesia, sensory block level (assessed by pinprick), patient satisfaction, and hemodynamic changes.

Sample Size and Statistical Analysis

The sample size of 30 patients per group (N=60 total) was calculated to detect a clinically significant difference in outcomes, such as VAS score and time required for subarachnoid block, with a power of 80% and a significance level of 0.05. Statistical analysis will be performed using SPSS and EPINFO. Descriptive statistics will summarize patient demographics. Parametric data will be analyzed using the Student's t-test (Z-test), and non-parametric data will be analyzed using the Chi-square test. A p-value of <0.05 will be considered statistically significant[6].

Results and Observations

The study's results are presented here, summarizing the demographic characteristics and clinical data of the two groups. A single table consolidates the key findings for an overview.

Consolidated Results Table: Demographics and Baseline Characteristics

Variable	Group P (Mean/Count)	Group P (SD/%)	Group S (Mean/Count)	Group S (SD/%)	P-Value
Age	49.63 years	16.59	49.40 years	16.18	0.924
Weight	60.57 kg	7.09	62.73 kg	8.12	0.227
Gender (Female)	12	63.2%	7	36.8%	0.165
Gender (Male)	18	43.9%	23	56.1%	
Diagnosis					
Femur Fracture	4	36.4%	7	63.6%	
Femur Fracture with Infected Implant In Situ	3	75.0%	1	25.0%	0.393
Femur Neck Fracture	7	58.3%	5	41.7%	
Femur Shaft Fracture	9	45.0%	11	55.0%	
Surgical Procedures					
CRIF with IM Nailing	7	70.0%	3	30.0%	0.065
Hemiarthroplasty	3	50.0%	3	50.0%	
Implant Removal & Refixing	6	50.0%	6	50.0%	
ORIF with Plating	3	42.9%	4	57.1%	
Total Patients	30	50%	30	50%	

The two groups, Group P (PENG block) and Group S (SIFI block), were well-matched in terms of demographics. The mean age and weight were statistically similar, with p-values of 0.924 and 0.227, respectively. The gender distribution also showed no significant difference (p = 0.165), confirming the comparability of the study groups. However, a closer look at the diagnosis and surgical procedures revealed some heterogeneity between the groups. While both groups had a mix of various fracture types, certain diagnosis and surgeries were disproportionately distributed. For example, "CRIF with IM Nailing" was more prevalent in Group P (70.0%) compared to Group S (30.0%), with a p-value of 0.065, which is close to the significance threshold. Other procedures, such as Hemiarthroplasty and Implant Removal & Refixing, were more evenly distributed. These variations in surgical and diagnostic profiles should be considered when evaluating the study's primary outcomes related to pain management and positioning.

Key Results and Observations: PENG vs. SIFI Blocks

Feature	Group P (PENG Block)	Group S (SIFI Block)	P-Value
Baseline HR (bpm)	81.73 ± 8.81	81.60 ± 9.65	0.815
Baseline SBP (mmHg)	120.87 ± 13.34	126.20 ± 11.73	0.365
Baseline VAS Score	7.17 ± 1.02	7.40 ± 0.97	0.776
Onset of Sensory Block (min)	**4.77 ± 0.86**	**7.63 ± 1.38**	**0.012**
Post-Block VAS Score	**1.33 ± 1.27**	**2.83 ± 1.82**	**0.034**
Optimal Positioning	**76.2%**	23.8%	**0.008**
Patient Satisfaction	**Satisfactory: 57.1%**	**Satisfactory: 42.9%**	**0.020**
Time for SAB (min)	**4.77 ± 0.47**	**5.94 ± 0.74**	**0.048**
First Rescue Analgesic (hr)	5.82 ± 0.70	3.96 ± 0.74	0.958

This study compared the analgesic efficacy of the Pericapsular Nerve Group (PENG) block and the Suprainguinal Fascia Iliaca (SIFI) block in patients with femur fractures undergoing spinal anesthesia. The results indicate that both blocks provided effective pain relief, but the PENG block demonstrated significant advantages across multiple key metrics.

The PENG block was superior in terms of speed of action and pain control. It had a significantly faster onset of sensory block (4.77 min vs. 7.63 min; p=0.012) and resulted in lower post-block pain scores (VAS score of 1.33 vs. 2.83; p=0.034). This enhanced analgesia translated directly into improved procedural outcomes. Patients who received the PENG block were easier to position, with 76.2% achieving an optimal position compared to only 23.8% in the SIFI group (p=0.008). The time required to perform the spinal anesthesia was also significantly shorter for the PENG group (4.77 min vs. 5.94 min; p=0.048).

Furthermore, the superior pain control and procedural efficiency of the PENG block led to higher patient satisfaction (p=0.020). Despite these benefits, both blocks maintained stable baseline hemodynamic parameters and similar overall cardiovascular stability throughout the procedure.

In conclusion, the PENG block is a highly effective and efficient regional anesthesia technique for managing pain in femur fracture patients, leading to faster procedural onset, better analgesia, improved positioning, and higher patient satisfaction compared to the SIFI block.

DISCUSSION

This study's findings provide a robust comparative analysis of two regional anesthesia techniques, the pericapsular nerve group (PENG) block and the suprainguinal fascia iliaca compartment (SIFI) block, for managing pain in femur fracture patients during spinal anesthesia. The results strongly support the PENG block as a superior option, confirming its clinical efficacy and patient-centered benefits.

Our study demonstrated that the PENG block provides significantly faster and more effective pain relief than the SIFI block. The mean onset of sensory blockade was 4.77 minutes in the PENG group, nearly 3 minutes quicker than the SIFI group's 7.63 minutes (p=0.012). This rapid onset is a critical clinical advantage, as it allows for swift pain relief and a more efficient transition to patient positioning for the subarachnoid block. The superior analgesic effect of the PENG block was further confirmed by the post-block VAS scores, which were significantly lower in the PENG group (1.33) compared to the SIFI group (2.83) (p=0.034).

These findings align with the existing literature. [7]Jadon et al. (2021) similarly reported that the PENG block led to significantly lower pain scores during passive limb movements, directly contributing to the ease of positioning.[8] Vamshi et al. (2023) also found that PENG block patients had lower postoperative pain scores and reduced opioid consumption, further underscoring its superior analgesic profile. The ability of the PENG block to provide focused pain relief to the hip joint, where the pain from a femur fracture is most severe during

positioning, appears to be the key to its effectiveness[9]. The SIFI block, while effective, may not consistently provide the same degree of coverage to the obturator nerve branches, which are crucial for hip joint innervation. The clinical benefits of the PENG block extended beyond simple pain relief to improve the overall procedural experience. The enhanced analgesia resulted in a statistically significant improvement in the quality of patient positioning, with 76.2% of patients in the PENG group achieving "Optimal" positioning versus only 23.8% in the SIFI group (p=0.008). This is consistent with [7] Jadon et al. (2021), who also found that the PENG block significantly improved the ease of spinal positioning. Better patient cooperation not only reduces patient discomfort but also decreases the likelihood of multiple spinal puncture attempts, thereby lowering the risk of complications[10].

The PENG block also contributed to procedural efficiency, with a significantly shorter time required for positioning (4.77 minutes vs. 5.94 minutes; p=0.048). This is a valuable benefit in a busy operating room, as it can streamline workflow and reduce overall time spent in the surgical suite[11].

Despite the clear differences in analgesic and procedural outcomes, both techniques proved to be safe. Both groups maintained overall cardiovascular stability, with no clinically significant differences in systolic blood pressure or mean arterial pressure. This is consistent with other studies by Keskes et al. (2023)[10] and Kamel et al. (2024)[11], which also found both techniques to be hemodynamically safe. The minor variations in heart rate and diastolic blood pressure observed at specific time points were not clinically concerning.

A crucial finding of this study is the significant increase in patient satisfaction with the PENG block (p=0.020). Only 18.2% of PENG patients reported dissatisfaction compared to 81.8% in the SIFI group. This marked difference underscores that the improved pain control and smoother procedural experience directly led to greater patient contentment. This patient-centered outcome is paramount and reinforces the PENG block as a preferred choice[12].

LIMITATIONS

While the study offers compelling evidence, it is not without limitations. The small sample size and single-center design may limit the generalizability of the findings. The heterogeneity in fracture types, while reflecting real-world practice, could introduce confounding variables. Furthermore, the short-term follow-up means the long-term benefits of the PENG block on postoperative pain and rehabilitation were not assessed.

Future research should address these limitations through multicenter randomized controlled trials with larger and more diverse patient populations. Such studies could provide a more robust comparison of the PENG and SIFI blocks. Exploring the cost-effectiveness of the PENG block, considering factors like reduced procedural time and lower opioid use, would also be a valuable area of investigation. Additionally, integrating advanced imaging and monitoring could further enhance the precision of block placement and outcome measurement, refining our understanding of these techniques.

CONCLUSION

The PENG block is superior for femur fracture patients, offering faster onset, better pain relief, and improved patient satisfaction and positioning. While both blocks provide similar post-operative analgesia duration, the PENG block's efficiency and enhanced outcomes make it the preferred choice for positioning during spinal anesthesia.

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