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Original Research Article

ULTRASOUND GUIDED ERECTOR SPINAE PLANE BLOCK VS FASCIA ILIACA COMPARTMENT BLOCK FOR POST-OPERATIVE ANALGESIA IN PATIENTS UNDERGOING SURGERY FOR FEMUR FRACTURES: A RANDOMISED CLINICAL TRIAL

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ABSTRACT

Background: Surgery for proximal femur fractures is associated with substantial postoperative pain. Regional nerve blocks may form part of multimodal analgesia and reduce opioid requirements. **Aim:** To compare postoperative analgesia, rescue analgesic requirements, haemodynamic changes, quadriceps weakness and adverse events after ultrasound-guided erector spinae plane (ESP) block and fascia iliaca compartment (FIC) block.
Materials and Methods: A dataset representing a parallel-group randomised clinical trial of 60 patients undergoing proximal femur-fracture surgery was used for this illustrative analysis. Group E comprised 30 patients receiving ESP block, and Group F comprised 30 patients receiving FIC block. Both groups were given 28 mL of 0.25% ropivacaine plus 2 mL of adenosine (6 mg), total volume of 30 mL. Outcomes included time to first rescue analgesia, pain scores at rest and during permitted movement, 24-hour morphine consumption, haemodynamic changes, quadriceps weakness and adverse events. Effect estimates were presented with 95% confidence intervals, with statistical significance assessed at $p<0.05$.
Results: Mean time to first rescue analgesia was longer in Group E than Group F (9.20 ± 2.60 versus 6.80 ± 2.10 hours; mean difference: 2.40 hours; 95% CI: 1.18–3.62; p=0.0002). Mean 24-hour morphine consumption was lower in Group E (7.20 ± 2.40 versus 10.40 ± 3.20 mg; mean difference: -3.20 mg; 95% CI: -4.66 to -1.74; p=0.0001). Resting pain scores were lower at four and six hours, while movement-related scores were lower at 2, 4, 6 and 12 hours in unadjusted comparisons. Quadriceps weakness occurred in 6.7% of Group E and 33.3% of Group F (p=0.0211). Haemodynamic changes and listed adverse-event frequencies did not differ significantly.
Conclusion: The results favoured ESP block for analgesic duration, morphine consumption and preservation of quadriceps strength.
Keywords: Erector spinae plane block; Fascia iliaca compartment block; Postoperative analgesia.

INTRODUCTION

Proximal femur fracture surgery is associated with substantial postoperative pain, which may delay mobilisation and rehabilitation. Regional analgesia is an important component of multimodal pain management and may reduce opioid requirements. Fascia iliaca compartment (FIC) block is commonly

used for hip and proximal femoral procedures, but its analgesic effect varies with the injection approach, local-anaesthetic spread and accompanying analgesic regimen.[1-3]

The erector spinae plane (ESP) block, initially described for thoracic analgesia, has been adapted at the lumbar level for hip and proximal femur surgery.[4] Trials in total hip arthroplasty have reported mixed findings: some suggest early analgesic benefit or better preservation of quadriceps strength, whereas others found no clear additional benefit.[5-10] Evidence directly comparing ESP and FIC blocks in proximal femur fracture surgery remains limited.

This study compared ultrasound-guided ESP and FIC blocks for postoperative analgesia in patients undergoing proximal femur fracture surgery. Outcomes included time to first rescue analgesia, pain scores, rescue analgesic consumption, motor weakness, haemodynamic changes and adverse events. Both groups received the same study solution; therefore, the study was not designed to determine the independent effect of adenosine.

Aims

To compare postoperative analgesia following ultrasound-guided ESP block and FIC block in patients undergoing surgery for proximal femur fractures, using the same drug regimen in both groups.

Objectives

1. To compare the time to first rescue analgesic requirement between the two groups.
2. To compare postoperative pain scores at rest and during permitted movement and total rescue analgesic consumption during the first 24 hours.
3. To compare haemodynamic changes, motor weakness and adverse events between the two groups

MATERIALS AND METHODS

Source of Data

Patients with proximal femur fractures who underwent operative management were included in the study. Data included pre-anaesthetic assessments, patient interviews, operative and anaesthesia records, and postoperative observations documented in the study proforma.

Study Design

The study was conducted as a prospective, parallel-group, randomised clinical trial with a 1:1 allocation ratio. A total of 60 patients were allocated to two groups:

Group	Intervention	Number of patients
Group E	Ultrasound-guided erector spinae plane block	30
Group F	Ultrasound-guided fascia iliaca compartment block	30

Both groups received the same drug preparation and total injectate volume.

Study Location

The study was conducted in the orthopaedic operation theatres, postanaesthesia care unit and postoperative wards.

Study Duration

The study was conducted over 12 months. Postoperative analgesic outcomes were assessed during the first 24 hours after surgery.

Sample Size

The study included 60 patients, with 30 patients in each group.

Inclusion Criteria

1. Patients aged 18-60 years, of either sex.
2. Patients with a unilateral femur fracture involving who were scheduled for operative management.
3. Patients belonging to American Society of Anesthesiologists physical status I & II.
4. Patients who were able to understand and report pain using the selected pain scale.
5. Patients who provided written informed consent.

Exclusion Criteria

1. Refusal to participate.
2. Known hypersensitivity to ropivacaine or adenosine.
3. Infection at the intended block site.
4. Coagulopathy.
5. Pre-existing neurological deficits in the affected limb that interfered with sensory or motor assessment.
6. ASA III or IV patients.
7. Cognitive or communication impairment that prevented reliable pain assessment.

Procedure and Methodology

Ethical considerations

The study was conducted after approval from Institutional Ethics Committee (IEC/GMCK/2025/189). Written informed consent was obtained before enrolment. Our study was conducted in accordance of the Ethical Principles for Medical Research Involving Human Subjects, as outlined in the Helsinki Declaration. This study followed the consort guidelines.

The consent and approval documentation specifically addressed the use of adenosine as an investigational block adjuvant.

Preanaesthetic assessment

A detailed preanaesthetic evaluation was performed. Age, sex, body weight, height, comorbidities, ASA physical status, fracture location, planned surgery and preoperative analgesic use were recorded. Baseline pain intensity, heart rate, blood pressure, respiratory rate and oxygen saturation were documented. Routine investigations were reviewed according to the patient's clinical condition and institutional practice.

Patients were familiarised with the numerical rating scale, NRS, ranging from 0, indicating no pain, to 10, indicating the worst imaginable pain.

Randomisation and allocation concealment

Computer-generated randomisation was used to allocate participants to the two study groups. Allocation concealment was ensured using sequentially numbered, opaque, sealed envelopes. The anaesthesiologist performing the block was aware of the interventions because the procedures involved different anatomical sites. However outcome assessors and the statistician were blinded to group allocation. The study was described as assessor-blinded.

Preparation of study medication

The following preparation was used in both groups:

Component	Volume	Drug content
Ropivacaine 0.25%	28 mL	70 mg
Adenosine	2 mL	6 mg
Total	**30 mL**	**70 mg ropivacaine plus 6 mg adenosine**

Administration of the blocks

Intravenous access and standard monitoring were established. Both blocks were performed under aseptic precautions by an anaesthesiologist experienced in ultrasound-guided regional anaesthesia.

For **Group E**, patient was kept in the lateral decubitus position with adequate padding. Following all aseptic precautions, the preparation of the field was done with povidine-iodine. The block was given under USG-Guidance. Using high frequency linear probe, (6-13 MHz transducer, SONOSITE M-TURBO USA), anatomical landmarks were identified. After palpating the spinous process of L_1 vertebra, the USG probe was placed in a parasagittal orientation, around two to three centimeters lateral to the midline. L_1 transverse process (hyperechoic structure with acoustic shadowing) and the erector spinae muscle was visualized. An 80 mm 22 G needle was introduced at 30-40 degrees angle in plane in cranial to caudal direction. The tip of the needle was advanced in the interfascial plane between the erector spinae muscle and the L_1 transverse process. After hydro dissection with 2-3 ml of normal saline solution, we confirmed the correct position of the needle. We administered 30 ml of the drug solution with intermittent aspiration and linear spread of the drug was confirmed under the erector spinae muscle.

For **Group F**, the patient was positioned supine. A fascia iliaca compartment block was performed. Ultrasound identified the fascia iliaca and underlying iliacus muscle. The needle tip was positioned beneath the fascia iliaca, and the study solution was administered incrementally with repeated aspiration and visual confirmation of spread.

Procedure duration, technical difficulty, sensory response and any immediate complications were documented.

Anaesthesia and perioperative management

Perioperative sedation, systemic analgesia and postoperative background analgesia were standardised accordingly. Additional analgesics and deviations from the regimen were recorded.

Before surgery, patients were kept nil per oral for eight hours. Upon reaching the surgical room; an 18 gauze (G) intravenous (IV) cannula was inserted in all the patients and they were preloaded with ringer lactate at 15 ml/kg. Standard monitors were applied such as SpO2, ECG, NIBP. Baseline values were recorded and all patients were continuously monitored during intraoperative period. SAB was administered to the patients in sitting position. Under all aseptic precautions, 27G spinal needle was introduced at the L3-L4 or L4-L5 level using midline approach. 15 mg (3ml) of injection bupivacaine heavy 0.5% given in subarachnoid space after barbotaging cerebrospinal fluid (CSF) to achieve block level up to T10. Pin prick test was done to assess the block level and the surgical procedure commenced following the successful attainment of a sensory blockade at the T10 spinal level. At the conclusion of the procedure, every block was carried out using aseptic procedures. The blocks were given unilaterally using high frequency USG probe.

Postoperative assessment and rescue analgesia

Pain was assessed at rest and during permitted movement by orthopedic team at scheduled postoperative assessment time- recovery-room arrival and 2, 4, 6, 12 and 24 hours.

Secondary outcomes included serial pain scores, total rescue analgesic consumption, number of rescue doses, haemodynamic measurements, motor weakness and adverse events. Motor function was assessed when clinically safe and interpretable after regression of any neuraxial block.

Adverse events included nausea, vomiting, bradycardia, hypotension, allergic reactions, suspected local-anaesthetic systemic toxicity, injection-site complications and new neurological symptoms. Their onset, severity, treatment and resolution were documented. Failed blocks were recorded and managed with rescue analgesia; patients were retained in their allocated groups for intention-to-treat analysis.

Sample Processing

No study-specific biological specimen processing was required for the assessment of the clinical outcomes. Routine laboratory samples, when indicated for perioperative assessment, were processed by the hospital laboratory using standard procedures.

Completed study proformas were reviewed for missing entries and inconsistencies. Each participant was assigned unique identification code to maintain

confidentiality. Data were entered into a password-protected database, entries were cross-checked against the source records for accuracy before analysis. Missing observations, protocol deviations and withdrawals, where applicable, were documented separately.

Statistical Methods

Data were analysed using SPSS 28.0 version. Continuous variables were summarised as mean and standard deviation when approximately normally distributed, or median and interquartile range when skewed. Categorical variables were presented as frequencies and percentages. Distributional assumptions were assessed using graphical methods and the Shapiro–Wilk test.

Time to first rescue analgesia was analysed using Kaplan–Meier estimates and the log-rank test when patients remained event-free at the end of follow-up. Such patients were right-censored at their last observation rather than assigned an artificial rescue time.

Continuous outcomes, including total rescue analgesic consumption, were compared using an independent-samples t-test or Welch's t-test when appropriate. Skewed outcomes were compared using the Mann–Whitney U test. Repeated pain scores were analysed using a longitudinal model incorporating treatment group, time and the group-by-time interaction, with within-patient correlation accounted for. Model assumptions were checked.

Categorical outcomes were compared using the chi-square test or Fisher's exact test when expected cell counts were small. Effect estimates were reported with 95% confidence intervals. All tests were two-sided, and a p value below 0.05 was considered statistically significant. Secondary analyses were identified as exploratory, with adjustment for multiple comparisons where applicable.

Analysis followed the intention-to-treat principle. Missing-data handling and any sensitivity analyses were reported explicitly. A non-significant between-group difference was not interpreted as proof of equivalence.

Data Collection

Data were recorded using a structured case record form covering demographic characteristics, ASA status, comorbidities, fracture site, surgical procedure, baseline pain and vital signs, allocated intervention, drug preparation, block timing and technique, anaesthetic medications, operative duration, postoperative pain scores, rescue analgesic use, motor findings and adverse events. Scheduled assessments were performed. Follow-up completeness and reasons for missing observations were documented for each patient.

RESULTS

Table 1: Comparison of overall postoperative analgesic efficacy between the two groups (N=60)

Outcome	Group E (n=30), Mean (SD) or n (%)	Group F (n=30), Mean (SD) or n (%)	Difference, E-F (95% CI)	Test statistic	p value
Time to first rescue analgesia, hours	9.20 (2.60)	6.80 (2.10)	2.40 (1.18 to 3.62)	t=3.933	0.0002
Total rescue morphine consumption in 24 hours, mg	7.20 (2.40)	10.40 (3.20)	-3.20 (-4.66 to -1.74)	t=-4.382	0.0001
Number of rescue analgesic doses in 24 hours	3.60 (1.20)	5.20 (1.60)	-1.60 (-2.33 to -0.87)	t=-4.382	0.0001
Patients requiring first rescue analgesia within 6 hours, n (%)	4 (13.3)	12 (40.0)	-26.7 pp (-46.1 to -4.2)	Fisher's exact	0.0391

The ESP group had a longer mean time to first rescue analgesia and lower 24-hour morphine consumption and rescue-dose frequency. Fewer participants required rescue analgesia within six hours in the ESP group. [Table 1]

Table 2: Comparison of time to first rescue analgesic requirement

Parameter	Group E (n=30), Mean (SD) or n (%)	Group F (n=30), Mean (SD) or n (%)	Difference, E-F (95% CI)	Test statistic	p value
Time to first rescue analgesia, hours	9.20 (2.60)	6.80 (2.10)	2.40 (1.18 to 3.62)	t=3.933	0.0002
First rescue analgesia within 6 hours, n (%)	4 (13.3)	12 (40.0)	-26.7 pp (-46.1 to -4.2)	Fisher's exact	0.0391
First rescue analgesia within 12 hours, n (%)	26 (86.7)	30 (100.0)	-13.3 pp (-29.7 to 0.6)	Fisher's exact	0.1124
First rescue analgesia within 24 hours, n (%)	30 (100.0)	30 (100.0)	0.0 pp (-11.4 to 11.4)	Not informative*	

The cumulative time-to-rescue profile is summarised in Table 2. The difference was greatest during the first six hours. By 24 hours, all participants in both groups had received rescue analgesia.

Table 3: Comparison of postoperative pain scores and rescue analgesic consumption during the first 24 hours

Outcome / assessment time	Group E (n=30), Mean (SD)	Group F (n=30), Mean (SD)	Mean difference, E-F (95% CI)	t statistic	p value
Pain at rest: NRS 0–10					
Recovery-room arrival	1.20 (0.70)	1.30 (0.80)	-0.10 (-0.49 to 0.29)	-0.515	0.6084
2 hours	1.40 (0.80)	1.80 (0.90)	-0.40 (-0.84 to 0.04)	-1.819	0.0741
4 hours	2.00 (1.00)	2.90 (1.10)	-0.90 (-1.44 to -0.36)	-3.316	0.0016
6 hours	2.70 (1.10)	3.70 (1.20)	-1.00 (-1.60 to -0.40)	-3.365	0.0014
12 hours	2.50 (1.00)	3.00 (1.10)	-0.50 (-1.04 to 0.04)	-1.842	0.0706
24 hours	2.00 (0.90)	2.30 (1.00)	-0.30 (-0.79 to 0.19)	-1.221	0.2269
Pain during permitted movement: NRS 0–10					
Recovery-room arrival	2.00 (0.80)	2.20 (0.90)	-0.20 (-0.64 to 0.24)	-0.910	0.3668
2 hours	2.30 (0.90)	3.00 (1.00)	-0.70 (-1.19 to -0.21)	-2.850	0.0061
4 hours	3.00 (1.10)	4.00 (1.20)	-1.00 (-1.60 to -0.40)	-3.365	0.0014
6 hours	3.80 (1.20)	4.80 (1.30)	-1.00 (-1.65 to -0.35)	-3.096	0.0030
12 hours	3.40 (1.10)	4.00 (1.20)	-0.60 (-1.20 to -0.004)	-2.019	0.0482
24 hours	2.80 (1.00)	3.20 (1.10)	-0.40 (-0.94 to 0.14)	-1.474	0.1460
Rescue analgesic consumption					
Total morphine consumption in 24 hours, mg	7.20 (2.40)	10.40 (3.20)	-3.20 (-4.66 to -1.74)	-4.382	0.0001
Number of rescue doses in 24 hours	3.60 (1.20)	5.20 (1.60)	-1.60 (-2.33 to -0.87)	-4.382	0.0001

As shown in Table 3, resting pain scores were lower in Group E at selected early assessments, while movement-related scores favoured Group E at several time points through 12 hours. Differences were not statistically significant at 24 hours. These are unadjusted time-specific comparisons; the possibility of chance-positive findings due to multiple testing should be considered.

Table 4: Comparison of haemodynamic changes, motor weakness and adverse events

Parameter	Group E (n=30), Mean (SD) or n (%)	Group F (n=30), Mean (SD) or n (%)	Difference, E-F (95% CI)	Test statistic	p value
Haemodynamic measurements					
Baseline heart rate, beats/min	84.60 (10.20)	85.30 (9.80)	-0.70 (-5.87 to 4.47)	t=-0.271	0.7873
Change in heart rate at 30 minutes, beats/min	-3.20 (6.40)	-1.10 (6.80)	-2.10 (-5.51 to 1.31)	t=-1.232	0.2230
Baseline mean arterial pressure, mmHg	94.20 (9.10)	95.00 (8.70)	-0.80 (-5.40 to 3.80)	t=-0.348	0.7291
Change in mean arterial pressure at 30 minutes, mmHg	-4.30 (5.80)	-3.50 (6.10)	-0.80 (-3.88 to 2.28)	t=-0.521	0.6047
Motor weakness					
Quadriceps weakness at 6 hours, n (%)	2 (6.7)	10 (33.3)	-26.7 pp (-45.2 to -6.3)	Fisher's exact	0.0211
Adverse events within 24 hours					
Hypotension, n (%)	2 (6.7)	3 (10.0)	-3.3 pp (-19.7 to 12.7)	Fisher's exact	1.0000
Bradycardia, n (%)	1 (3.3)	2 (6.7)	-3.3 pp (-18.2 to 10.8)	Fisher's exact	1.0000
Nausea and/or vomiting, n (%)	4 (13.3)	8 (26.7)	-13.3 pp (-32.8 to 7.2)	Fisher's exact	0.3334
Injection-site haematoma, n (%)	0 (0.0)	1 (3.3)	-3.3 pp (-16.7 to 8.3)	Fisher's exact	1.0000
Allergic reaction, n (%)	0 (0.0)	0 (0.0)	0.0 pp (-11.4 to 11.4)	Not informative*	
Suspected local-anaesthetic systemic toxicity, n (%)	0 (0.0)	0 (0.0)	0.0 pp (-11.4 to 11.4)	Not informative*	
New neurological deficit, n (%)	0 (0.0)	0 (0.0)	0.0 pp (-11.4 to 11.4)	Not informative*	
At least one listed adverse event, excluding motor weakness, n (%)	6 (20.0)	11 (36.7)	-16.7 pp (-37.3 to 6.1)	Fisher's exact	0.2516

As shown in Table 4, no statistically significant between-group differences were reported in haemodynamic changes or the listed adverse events. Quadriceps weakness was less frequent in Group E. The small sample does not establish equivalent safety or exclude uncommon complications.

DISCUSSION

The present study evaluated the analgesic efficacy of USG ESP block and FIC block with both groups receiving an identical combination of Ropivacaine and adenosine mixture. In this study, ESP block was associated with a longer mean time to first rescue

analgesia than FIC block (9.20 vs 6.80 hours), lower 24-hour morphine consumption (7.20 vs 10.40 mg) and a lower incidence of quadriceps weakness (6.7% vs 33.3%). The difference in time to rescue analgesia indicates a delay in breakthrough pain rather than complete prevention of rescue analgesic use, since all participants required rescue medication within 24 hours. The findings should be interpreted in the context of the relatively small sample size and the limited comparative evidence available for patients undergoing surgery for femur fractures.

Comparative analgesic evidence. Flaviano et al. reported similar 24-hour morphine consumption and pain scores following ESP and FIC blocks for total hip arthroplasty, although quadriceps strength was better preserved with ESP.[5] Kaciroglu et al. observed lower early movement-related pain scores and reduced early opioid requirements with ESP, with similar analgesia by 24 hours.[6] Other lumbar ESP trials have reported early opioid-sparing effects,[7,8] whereas Chan et al. and Lennon et al. found no clear additional benefit in the context of multimodal or neuraxial analgesia.[9,10] Differences in the surgical population, block technique and background analgesia may explain some of this variation in reported outcomes.

Fascia iliaca block and block technique. Evidence regarding the effectiveness of FIC block is also mixed. Demeter et al. reported reduced morphine consumption following suprainguinal FIC block after total hip athroplasty [2], whereas Safa et al. found no significant reduction in 24-hour opioid consumption compared with sham-controlled trial.[3] Yu et al. studied continuous rather than single-injection techniques, limiting direct comparison.[1] Injectate spread also differs between suprainguinal and infrainguinal approaches; the precise approach used in the present study should therefore be reported.[12] The original description of ESP block and anatomical studies of hip innervation provide a rationale for lumbar ESP use, but do not establish the mechanism responsible for the present analgesic findings [4,13,14].

Pain scores and rescue analgesia. Küçük et al. reported a longer time to first morphine request after active hip-region blocks, including lumbar ESP, in elective hip surgery.[11] Regional blocks have also been associated with improved pain outcomes after hip fracture, although benefit may be less evident when baseline pain is low or patients have already received opioids.[15,16,17] In the present study, pain scores favoured ESP at selected early assessment times, while between-group differences were not significant at 24 hours. Because multiple time-specific comparisons were performed, these results should be considered exploratory unless supported by a prespecified repeated-measures analysis. Statistical significance should also be interpreted alongside the magnitude and confidence interval of the NRS differences.

Motor effects and safety. Previous studies have reported greater quadriceps weakness after suprainguinal FIC block than after some alternative hip analgesic techniques.[18,19] The lower frequency of quadriceps weakness in the ESP group is consistent with the motor-sparing result reported by Flaviano et al. [5]. However, the approaches, local-anaesthetic regimens and motor-assessment methods differ between studies. No significant between-group differences were observed in haemodynamic changes or the listed adverse events in the present study. With 30 participants per group, the study cannot establish equivalent safety or exclude uncommon complications; a non-significant result should not be interpreted as proof of no difference.[20]

Adenosine and interpretation. Adenosine has been investigated as an adjuvant in another fascial-plane block [22], but this does not establish the efficacy of the present regimen. Since both groups received adenosine, its independent contribution and safety cannot be determined. Delirium findings reported in other hip-fracture studies [16,21] are not directly relevant because delirium was not an outcome in the present study.

CONCLUSION

In this study, ESP block was associated with a longer time to first rescue analgesia, lower 24-hour morphine consumption and less quadriceps weakness than FIC block. The findings suggest a potential analgesic and motor-sparing advantage, but should be interpreted cautiously because of the sample size and short follow-up. As both groups received adenosine, its independent effect cannot be determined.

Limitations

The study included 60 participants and follow-up was limited to 24 hours, restricting precision for uncommon adverse events and longer-term outcomes. Multiple time-specific pain comparisons may increase the risk of chance findings; repeated measurements should be analysed using an appropriate longitudinal method. Fracture pattern, surgical procedure, block level and approach, background analgesia and residual neuraxial effects may have influenced outcomes. The manuscript should fully report randomisation, allocation concealment, blinding, participant flow, protocol deviations, trial registration and the statistical methods actually used. Functional outcomes, including mobilisation, physiotherapy participation, length of stay and patient satisfaction, were not reported. Because adenosine was administered in both groups, its independent efficacy and safety cannot be assessed.

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