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Original Research Article

Landmark Guided Versus Ultrasound Guided Fascia Iliaca Compartment Block for Femoral Fractures: A Prospective Randomised Controlled Trial

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Abstract: Fascia iliaca compartment block (FICB) can be performed using anatomical landmarks or ultrasound guidance for analgesia after femoral fractures. This prospective, parallel-group, randomised controlled trial at Irrua Specialist Teaching Hospital, Nigeria, enrolled adults with femoral neck or shaft fractures and pain between 15 November 2021 and 14 January 2023. Participants were randomised 1:1 to landmark-guided or ultrasound-guided FICB, with 30 mL of plain 0.25% bupivacaine administered in each group. Co-primary outcomes were needle-tip precision and block effectiveness at 1 h; secondary outcomes included Numerical Rating Scale (NRS) pain scores, procedural time, time to block onset, time to first rescue analgesia, complications and satisfaction. Ninety participants were randomised and 89 were analysed. Needle-tip placement was confirmed in 44/44 participants (100.00%) with ultrasound and 29/45 (64.44%) with landmarks; the reported Fisher's exact test statistic was 19.073 (P = 0.050). Effective block at 1 h occurred in 41/44 (93.18%) and 41/45 (91.11%), respectively. Median NRS scores were lower with ultrasound at 30 min (2 vs. 3; P = 0.009) and 1 h (1 vs. 2; P = 0.001). Landmark-guided FICB was faster to perform (901 vs. 2,414 s; P = 0.050), while time to first rescue analgesia did not differ (P = 0.608). No clinically apparent complications were observed. Ultrasound guidance improved needle-tip localisation and was associated with lower early pain scores, whereas landmark-guided FICB remained a feasible and efficient alternative. The aggregate data do not establish universal differences in overall analgesic effectiveness or safety.

Keywords: Fascia Iliaca Compartment Block, Femoral Fracture, Ultrasound Guidance, Landmark Technique, Regional Analgesia, Acute Pain, Randomised Controlled Trial.

INTRODUCTION

Femoral fractures are common orthopaedic injuries that may require hospitalisation and are associated with considerable morbidity and mortality (Dunseath *et al*., 2026). Acute pain after femoral or proximal femoral trauma can be severe and may be inadequately treated during initial assessment, positioning, transportation and preparation for surgery (Ballantyne *et al*., 2011; Labronici *et al*., 2019). Inadequate analgesia can impede clinical assessment and mobilisation, whereas reliance on systemic analgesics may expose patients to avoidable adverse effects. Effective, safe and readily available analgesia is therefore an important component of the early and perioperative management of patients with femoral fractures.

Trauma involving the hip and femur may affect the surrounding soft tissues and the peripheral nerves supplying the region, including the femoral, obturator and lateral femoral cutaneous nerves (Labronici *et al*., 2019). Fascia iliaca compartment block is a regional analgesic technique in which local anaesthetic is deposited beneath the fascia iliaca, with the potential to provide analgesia in the territories of these nerves. FICB has been used for pain relief in patients with hip and femoral fractures and may reduce the need for systemic opioid and non-opioid analgesics (Labronici *et al*., 2019; Henry *et al*., 2019).

FICB may be performed using a landmark-based or ultrasound-guided technique. The landmark approach is inexpensive, straightforward and suitable for settings in which ultrasound equipment is unavailable. However, it is performed without direct visualisation of

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the relevant anatomy or needle tip, and the precision of needle placement and local-anaesthetic deposition may therefore be uncertain. Ultrasound guidance permits real-time identification of the relevant anatomical structures and needle advancement and may improve the certainty of needle tip localisation. Its use nevertheless depends on functioning equipment and appropriately trained personnel. In resource-constrained settings, these requirements may limit routine application and may require patients to be moved away from the emergency or operating area, potentially causing additional discomfort or disruption of the injured limb.

Although FICB is used for analgesia in femoral fractures, the technical precision, early analgesic response, procedural time and safety of landmark-based and ultrasound-guided techniques have not been adequately compared in our setting. This study was therefore designed to compare the two approaches in adults with femoral neck or femoral shaft fractures at Irrua Specialist Teaching Hospital. The study specifically assessed whether ultrasound guidance improved confirmation of needle-tip placement and early analgesic response while also evaluating the speed, feasibility and safety of both approaches.

The primary outcomes were needle-tip precision and analgesic effectiveness, with analgesic effectiveness defined by the presence or absence of pain at 1 h after FICB according to the study protocol. Secondary outcomes were procedural time, time to achieve the block, NRS pain scores at prespecified time points, time to first administration of rescue analgesia, patient satisfaction and complications or adverse effects during the 24-h observation period.

EXPERIMENTAL SECTION/MATERIAL AND METHODS

Study Design and Setting

This was a prospective, parallel-group, comparative randomised controlled trial with a 1:1 allocation ratio. The study was conducted at Irrua Specialist Teaching Hospital, a rural tertiary healthcare institution in Edo State, Nigeria, which provides specialised care to patients from Edo, Delta, Kogi, Ondo and neighbouring states. The hospital is situated along a major highway and receives patients with traumatic injuries, including femoral fractures following road traffic accidents.

Ethical Approval and Participant Protection

Ethical approval was obtained from the Research and Ethics Committee of Irrua Specialist Teaching Hospital (National Health Research Ethics Committee registration number NHREC/29/03/2017; protocol number ISTH/HREC/20202901/054; approval date 9 November 2020). The study was conducted in accordance with the ethical standards of the responsible institutional committee and the Declaration of Helsinki, as revised in 2013. Written informed consent was obtained from all eligible adult participants before enrolment.

Participants' names, initials and hospital numbers were not included in the study records or report. Electronic data were password protected, with access restricted to the investigator and the assistant involved in data analysis. Hard copy questionnaires were stored in a locked shelf.

The study was not registered in any of the registries specified in the journal guidelines. This absence of prospective registration is acknowledged as a limitation. Institutional ethical approval was obtained before recruitment.

Eligibility Criteria

Patients aged 18 years or older, of either sex, with femoral neck or femoral shaft fractures and pain at presentation in the Accident and Emergency Room, after a recent fracture in the ward or before an operative procedure were assessed for eligibility. Patients with American Society of Anesthesiologists (ASA) physical status I–III were eligible.

Patients were excluded if they declined participation; had known hypersensitivity to or another contraindication to local anaesthetic; an international normalised ratio (INR) of 1.5 or greater; a history of femoral bypass surgery or a vascular graft close to the proposed block site; inflammation or infection at the needle-puncture site; or ASA physical status IV or V.

At presentation, the study protocol was explained to eligible patients in a language they understood. Sociodemographic and clinical information, including age, sex, weight and height, was recorded using a structured data-collection form. Relevant medical and surgical histories were obtained, and musculoskeletal, cardiovascular, respiratory and nervous-system examinations were performed. For patients with recent fractures requiring acute care, two peripheral intravenous accesses were established when clinically indicated using 16-G and 18-G cannulae. Full blood count, serum electrolytes, urea and creatinine, coagulation profile and urinalysis were performed routinely. Chest radiography and electrocardiography were obtained when clinically indicated.

Randomisation, Allocation and Blinding

Ninety participants were randomised in a 1:1 ratio to receive FICB using either the landmark technique or the ultrasound-guided technique. Simple randomisation was performed using an opaque, sequentially administered envelope containing 90 slips, with 45 slips marked "A" and 45 slips marked "B." "A" indicated allocation to the landmark group and "B" indicated allocation to the ultrasound-guided group.

After each draw, the selected slip was replaced in the envelope.

The allocation sequence was generated by research assistants, who also enrolled participants and assigned them to the respective interventions. The senior registrar who performed the randomisation was not involved in outcome assessment or data analysis. The principal investigator performed the clinical review and administered all FICBs. A separate trained research assistant, who was blinded to group allocation, performed outcome assessments. Data analysis was conducted by a data analyst who remained blinded to group allocation. The operator could not be blinded to the allocated technique.

Periprocedural Monitoring and Common Intervention Protocol

Patients were positioned supine. Baseline systolic and diastolic blood pressure, mean arterial pressure, pulse rate, respiratory rate, peripheral oxygen saturation, electrocardiography and temperature were recorded using a multiparameter monitor (MINDRAY patient monitor, model iMEC10; Mindray, Shenzhen, China). Resuscitation drugs and equipment, including adrenaline, atropine and 20% lipid emulsion, were immediately available.

All procedures were performed under aseptic conditions after hand hygiene and use of sterile gloves. Equipment included a sterile pack, Savlon antiseptic solution followed by methylated spirit for skin preparation, syringes and needles, and 2–4 mL of 1% lignocaine for local skin infiltration. Each participant received 30 mL of plain 0.25% bupivacaine for FICB. No sedation or additional analgesic was administered before or during the block.

Landmark-Guided FICB

The anterior superior iliac spine and ipsilateral pubic tubercle were identified. An imaginary line between these landmarks was divided into thirds, and the injection point was marked 1 cm below the junction of the lateral one-third and medial two-thirds. The skin was prepared with Savlon antiseptic solution followed by methylated spirit, and 2–4 mL of 1% lignocaine was infiltrated at the marked point.

A 10-mL hypodermic syringe with a 22-G, 51-mm (2-inch), bevel-tip needle was introduced perpendicular to the skin after blunting the needle tip. The needle was advanced until two distinct “pops” were felt as it traversed the fascia lata and fascia iliaca. Immediately after the second “pop,” ultrasound was used to assess the needle-tip location. A needle tip visualised within the fascia iliaca compartment was classified as precise landmark-guided placement. A tip visualised within the fascia lata or iliopsoas muscle was classified as imprecise placement.

After confirmation of the needle-tip position, negative aspiration was performed, and 30 mL of plain 0.25% bupivacaine was injected slowly, with aspiration after every 5 mL. The needle was withdrawn, gentle pressure was applied to the injection site for 1–2 min, and the site was covered with sterile gauze and adhesive plaster.

Ultrasound-Guided FICB

A high-frequency 6–12-MHz linear-array transducer connected to a Mindray diagnostic ultrasound scanner (DC-6 model; Mindray, Shenzhen, China) was placed transversely over the anterior thigh, just below the inguinal ligament. The femoral artery was first identified sonographically, followed by identification of the iliacus muscle lateral to the artery and the overlying fascia iliaca. When the femoral artery appeared to divide, the transducer was moved cranially until an appropriate sonographic view was obtained.

The needle was introduced in-plane with the ultrasound beam and advanced under continuous ultrasound visualisation until the tip was positioned beneath the fascia iliaca. No hydrodissection was performed. After negative aspiration, 30 mL of plain 0.25% bupivacaine was injected slowly. The needle tip and spread of local anaesthetic within the fascia iliaca compartment were observed during injection. Ultrasound-guided needle placement was classified as successful when the needle tip was visualised beneath the fascia iliaca. The extent of local-anaesthetic spread was observed to assess distribution but was not used as an endpoint for block success. The needle was withdrawn and the site was dressed as described for the landmark technique.

Outcome Measures

Pain intensity was assessed using the NRS, where 0 represented no pain and 10 represented the worst possible pain. The NRS was explained to each participant before the block. Pain scores were recorded before FICB and at prespecified post-block time points through the 24-h observation period. The protocol specified assessment at 15 min, 30 min, 1 h, 2 h and 4 h after the block, followed by assessment at 4-h intervals for 24 h. The aggregate NRS results available in the study information are reported in this manuscript.

At 1 h after FICB, the presence or absence of pain was assessed to determine initial block success. A block was considered unsuccessful if the participant continued to experience pain at 1 h after the procedure. The co-primary outcomes were needle-tip precision and analgesic effectiveness. Needle-tip precision was defined as the proportion of participants in whom the needle tip was appropriately located within the fascia iliaca compartment following the landmark technique or beneath the fascia iliaca during ultrasound-guided placement. Analgesic effectiveness was assessed using the 1-h block-success criterion.

Analgesic outcomes were assessed according to randomised treatment group and were not restricted to participants whose needle tips were confirmed to be precisely located. This approach allowed assessment of whether the allocated needle-placement technique was associated with differences in clinical analgesia.

For participants with a successful block, NRS scores were used to monitor postoperative pain. Rescue analgesia was administered when clinically indicated based on the participant's pain and clinical assessment rather than a predetermined NRS threshold. Rescue analgesia consisted of intravenous paracetamol 600 mg, administered at a minimum interval of 8 h between doses, with a maximum permitted dose of 1,800 mg within 24 h. The primary analgesic-duration outcome was the interval from performance of FICB to the first administration of rescue analgesia within the 24-h observation period. Once rescue analgesia was administered, follow-up for the time-to-first-rescue outcome was terminated and the time was recorded.

The pain-free period was defined as the duration from completion of FICB until the participant first reported an NRS score of 4 or greater, representing the onset of clinically significant pain requiring consideration of rescue analgesia. Patient satisfaction with pain relief was assessed using a 5-point Likert scale: 1, very poor; 2, poor; 3, good; 4, very good; and 5, excellent.

Adverse events, including local-anaesthetic systemic toxicity, vascular puncture, haematoma, nerve injury, infection, nausea, vomiting, dizziness and sedation, were monitored and recorded throughout the 24-h postoperative period. All participants remained admitted to the hospital during this period. The principal investigator, research assistants and ward nurses conducted regular monitoring and documented vital signs and any procedure-related or drug-related complications.

Sample-Size Calculation

The sample size was calculated using the two-proportion formula: $n = [(Z\alpha/2 + Z\beta)^2 \{P1(1 - P1) + P2(1 - P2)\}] / (P1 - P2)^2$. Here, n is the required number of participants per group, P1 is the anticipated analgesic effectiveness with landmark-guided FICB, P2 is the anticipated analgesic effectiveness with ultrasound-guided FICB, $Z\alpha/2$ is 1.96 for a two-sided 95% confidence level and $Z\beta$ is 0.84 for 80% power. Based on Dolan *et al*., (2008), anticipated analgesic effectiveness with the landmark technique was 47% (P1 = 0.47). Assuming a 60% relative increase with ultrasound guidance, P2 was calculated as $0.47 + (0.60 \times 0.47) = 0.752$. Substitution of these values produced a minimum sample size of 43 participants per group, or 86 participants in total. The statistical formula used in the supplied protocol was referenced as Hards *et al*., (2018).

A target sample size of 92 participants was planned to account for potential attrition. Ninety participants were ultimately recruited and randomised. No interim analysis or formal stopping rules were planned.

Statistical Analysis

Data were entered into a Microsoft Excel spreadsheet, checked for completeness and consistency, and imported into IBM Statistical Product and Service Solutions (SPSS) Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA), for analysis. Continuous variables were assessed for distribution and summarised as mean (standard deviation [SD]) when approximately normally distributed or median (interquartile range [IQR]) when skewed. Categorical variables were summarised as frequencies and percentages.

Categorical variables were compared using Pearson's chi-square test or Fisher's exact test, as appropriate. Normally distributed continuous variables were compared using the independent-samples Student's t test, and non-normally distributed continuous variables were compared using the Mann–Whitney U test. NRS pain scores at individual prespecified time points were compared between groups using the Mann–Whitney U test. The repeated NRS measurements were not analysed collectively using a single longitudinal model; analyses were performed at individual prespecified time points, with adjustment for multiple comparisons in the serial NRS analyses.

All tests were two-sided. Exact P values were reported where available. A P value < 0.05 was considered statistically significant. Effect estimates and confidence intervals are reported when they were available in the study information or could be calculated directly from complete aggregate counts. No missing values were imputed.

RESULTS AND DISCUSSION

Participant Flow and Analysis Population

The participant flow is shown in the CONSORT diagram (Figure 1). Of 110 patients assessed for eligibility, 90 consented to participate and were randomised in a 1:1 ratio. Forty-five participants were allocated to the ultrasound-guided group and 45 to the landmark group. Twenty patients assessed for eligibility did not proceed to randomisation.

All 45 participants in the landmark group received the assigned intervention. One participant in the ultrasound-guided group withdrew after allocation for undisclosed personal reasons and was not included in the final analysis. No other post randomisation exclusions occurred, and no protocol violations were reported. The final analysed population therefore comprised 44 participants in the ultrasound-guided group and 45 in the landmark group, for a total of 89 participants.

Participants with available outcome data were analysed according to their originally assigned intervention groups.

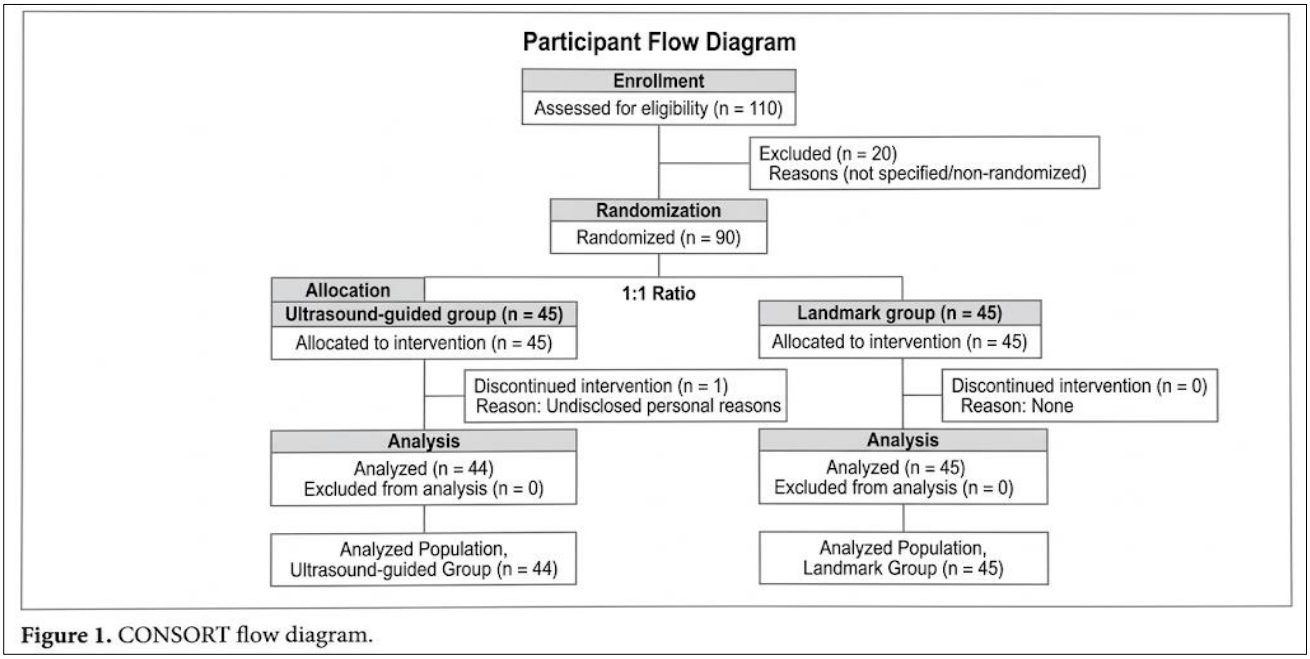
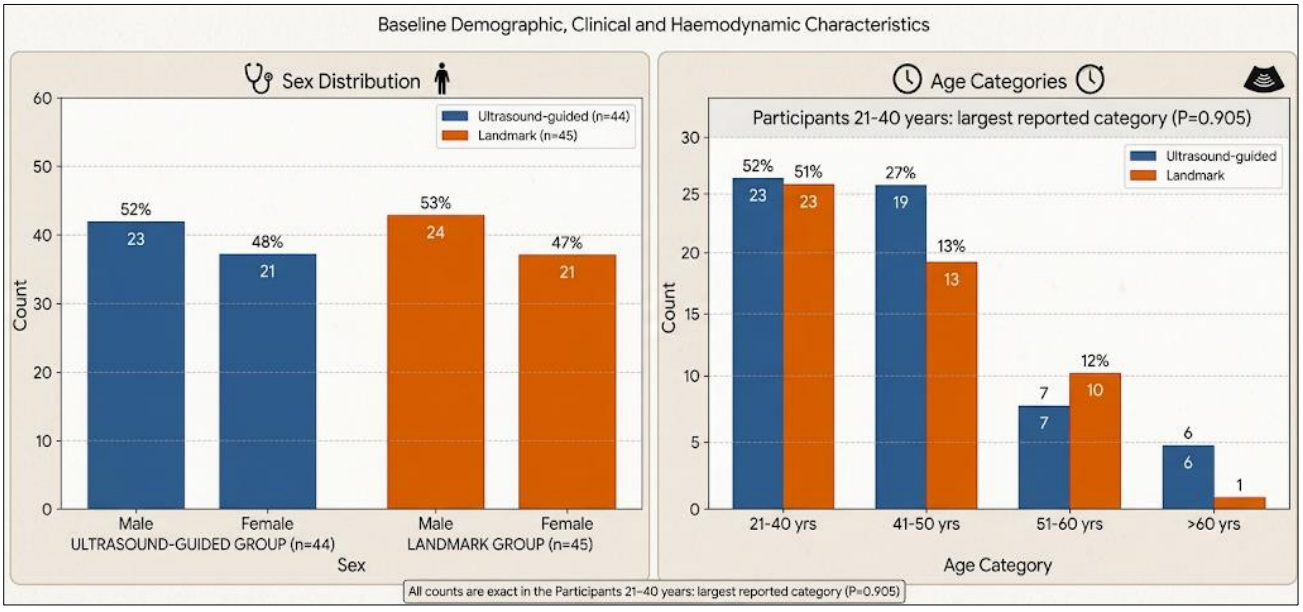


Figure 1. CONSORT flow diagram.

Baseline Characteristics

The demographic and baseline clinical characteristics are presented in Figure 2. Sex distribution was similar between groups. The ultrasound-guided group included 23/44 males (52.27%) and 21/44 females (47.73%), whereas the landmark group included 24/45 males (53.33%) and 21/45 females (46.67%). Participants aged 21–40 years constituted the largest reported age category in both groups, comprising 23/44 participants (52.27%) in the ultrasound-guided group and 23/45 participants (51.11%) in the landmark group (P = 0.905). The reported mean ages were 43.63 (SD 3.01) years and 43.57 (SD 3.18) years, respectively (P = 0.989). ASA physical-status distribution was reported as comparable between groups (P = 0.371)



Baseline haemodynamic characteristics were reported as follows. Mean systolic blood pressure was 136.00 (SD 15.14) mmHg in the ultrasound-guided group and 136.75 (SD 15.47) mmHg in the landmark group. Mean diastolic blood pressure was 84.59 (SD 11.58) versus 83.47 (SD 10.37) mmHg; mean pulse rate was 98.50 (SD 14.59) versus 96.82 (SD 17.75) beats/min; mean respiratory rate was 21.09 (SD 2.15)

versus 20.40 (SD 2.48) breaths/min; and mean peripheral oxygen saturation was 98.63% (SD 1.84) versus 98.17% (SD 1.84%), respectively. Comparative P values for these individual haemodynamic variables were not available in the study information. Peripheral oxygen saturation remained above 94% in both groups.

Needle-Tip Precision and Block Effectiveness

Needle-tip precision is presented in Tables 1 and 2. Ultrasound guidance identified the fascia iliaca compartment and permitted visualisation of the needle tip beneath the fascia iliaca in all 44 analysed participants (100.00%). With the landmark technique, the needle tip was confirmed within the fascia iliaca compartment in 29/45 participants (64.44%). In the remaining landmark-group participants, the needle tip was visualised in the fascia lata in 8/45 (17.78%) and in the iliopsoas muscle in 8/45 (17.78%). The reported Fisher's exact test statistic for the distribution of needle-tip location was 19.073, with P = 0.050.

Analgesic effectiveness was analysed according to the assigned treatment groups. An effective block at 1 h was achieved in 41/44 participants (93.18%) in the ultrasound-guided group and 41/45 (91.11%) in the landmark group. The corresponding numbers of participants without an effective block at 1 h were 3/44 (6.82%) and 4/45 (8.89%), respectively. The absolute difference in observed success proportions was 2.07 percentage points in favour of ultrasound guidance. No between-group P value for this binary outcome was available in the study information.

Among landmark-group participants with confirmed needle-tip placement within the fascia iliaca compartment, 25/29 (86.21%) achieved an effective block. The eight participants whose tips were visualised in the fascia lata and the eight whose tips were visualised in the iliopsoas muscle were also reported to achieve successful blocks, although onset in these participants occurred after 35 min or more. This subgroup observation is reported descriptively and does not replace the primary comparison according to randomised treatment group.

Table 1: Primary Treatment Group Outcomes and Anatomical Findings

Category	Characteristic / Variable	Ultrasound-Guided (n = 44)	Landmark (n = 45)	Comparative Statistic / P Value
Needle-Tip Location	Fascia Iliaca Compartment	44 (100.00%)	29 (64.44%)	Fisher's Exact Statistic = 19.073, P = 0.050
	Fascia Lata	0 (0.00%)	8 (17.78%)	—
	Iliopsoas Muscle	0 (0.00%)	8 (17.78%)	—
1-Hour Analgesic Effectiveness	Effective Block	41 (93.18%)	41 (91.11%)	Absolute Difference = 2.07% (P value unavailable)
	Ineffective Block	3 (6.82%)	4 (8.89%)	—

Table 2: Subgroup Analysis: Landmark Group Anatomical Tip Location vs. Block Success

Landmark Needle-Tip Location	Participants (n = 45)	Successful Block Count (%)	Onset Characteristics
Fascia Iliaca Compartment	29	25 (86.21%)	Standard onset
Fascia Lata	8	8 (100.00%)	Delayed onset (≥ 35 min)
Iliopsoas Muscle	8	8 (100.00%)	Delayed onset (≥ 35 min)

Procedural Time and Pain Scores

Procedural times and pain scores are presented in Table 3. The mean time required to perform FICB was 2,414 s (SD 1,120 s) with ultrasound guidance and 901 s (SD 349 s) with the landmark technique (P = 0.050). The mean time to achieve the block was 1,593 s (SD 364 s) and 1,651 s (SD 785 s), respectively (P = 0.749).

At 30 min after FICB, the median NRS score was 2 (IQR 1.0–3.5) in the ultrasound-guided group and 3 (IQR 2.0–6.0) in the landmark group (P = 0.009). At 1 h, the corresponding median NRS scores were 1 (IQR 1.0–2.0) and 2 (IQR 2.0–5.0), respectively (P = 0.001). No statistically significant between-group differences were reported at the later assessment points for which results were available. The exact later medians, IQRs and P values are not reproduced because they were not included in the aggregate study information.

Table 3: Primary Treatment Group Outcomes and Anatomical Findings

Results reported as Mean (SD) or Median (IQR) as specified. P-values are between groups.

Outcome Category	Outcome Metric	Ultrasound-guided Group (n=44)	Landmark Group (n=45)	*P*-value
Procedural Characteristics (Mean ± SD)	Time required to perform FICB (s)	2,414 (1,120)	901 (349)	0.050*
	Time to achieve the block (s)	1,593 (364)	1,651 (785)	0.749
Post-Block Pain Intensity (Median [IQR])	At 30 min, NRS score	2 [1.0–3.5]	3 [2.0–6.0]	0.009**
	At 1 h, NRS score	1 [1.0–2.0]	2 [2.0–5.0]	0.001***
Later Assessment Points (Binary outcome)	Between-group differences in NRS scores	No differences	No differences	N/A ^

**FICB* = fascia iliaca compartment block; *NRS* = Numeric Rating Scale (0-10); *IQR* = interquartile range; *US* = ultrasound.
^Exact values for later assessment points were unavailable in aggregate study information.
**Significance codes: **P*<0.05, ***P*<0.01, ****P*<0.001.

Time to First Rescue Analgesia

The mean time to first administration of rescue analgesia was 15,616 s (SD 8,412 s), approximately 260 min, in the ultrasound-guided group and 14,744 s (SD 7,599 s), approximately 246 min, in the landmark group. The between-group difference was not statistically significant (test statistic = −0.514; P = 0.608). Because rescue analgesia was administered according to clinical judgement rather than a predetermined NRS threshold, this outcome represents time to first administered rescue analgesia rather than a fully standardised duration of analgesia.

Complications and Patient Satisfaction

No clinically apparent complications were reported in either group during the 24-h postoperative observation period. No local-anaesthetic systemic toxicity, vascular puncture, haematoma, nerve injury, infection, nausea, vomiting, dizziness or sedation was reported (Ketelaars *et al*., 2018; Els *et al*., 2014). This finding is reassuring, but zero observed events in 89 analysed participants cannot establish equivalent safety or exclude uncommon complications.

Patient satisfaction was assessed using the prespecified 5-point Likert scale. Satisfaction data were analysed for 42 participants in each group. The overall satisfaction comparison did not identify a statistically significant difference between the ultrasound-guided and landmark groups (two-sided Fisher–Freeman–Halton exact test, P = 0.897). Satisfaction was therefore broadly comparable between the techniques in the available analysis.

Interpretation in Relation to Previous Work

This prospective randomised controlled trial compared the technical precision, analgesic effectiveness, procedural time, safety and patient satisfaction associated with landmark-guided and ultrasound-guided FICB in adults with hip or femoral fractures. Ultrasound guidance permitted identification of the fascia iliaca compartment and confirmation of needle-tip position in all 44 analysed participants (100.00%), whereas the needle tip was confirmed within the fascia iliaca compartment in 29 of 45 participants (64.44%) who received the landmark technique. These findings support greater certainty of anatomical localisation with ultrasound guidance.

The overall analgesic effectiveness results should be interpreted according to the randomised treatment groups rather than according to needle-tip location. An effective block at 1 h was reported in 41 of 44 participants (93.18%) in the ultrasound-guided group and 41 of 45 participants (91.11%) in the landmark group. The observed difference in success proportions was 2.07 percentage points. Because the comparative P value and confidence interval for this binary outcome were not available in the study information, the data do not establish a statistically supported difference in overall early block effectiveness between the techniques. The descriptive subgroup result of 25/29 (86.21%) among landmark participants with confirmed precise placement should not be used as the primary treatment comparison.

The landmark-group findings distinguish technical precision from clinical analgesic response. Of the 29 participants in whom the landmark needle tip was confirmed within the fascia iliaca compartment, 25 (86.21%) achieved an effective block. The eight participants whose needle tips were visualised in the fascia lata and the eight whose tips were visualised in the iliopsoas muscle were also reported to achieve successful blocks, although onset occurred after 35 min or more. These data reconcile with the overall landmark-group result of 41 successful blocks among 45 participants: 25 successes among the 29 precisely placed injections and 16 successes among the 16 injections with an extra-compartment needle-tip location. Nevertheless, these findings should not be interpreted as demonstrating that extra-compartment injection is predictably effective or clinically equivalent to correct compartment placement. The numbers are small, the observation is secondary to the randomised comparison, and the timing and

mechanism of delayed responses cannot be established from the available aggregate data.

The principal analgesic advantage observed with ultrasound guidance was an earlier reduction in pain intensity. At 30 min after FICB, the median NRS score was 2 (IQR, 1.0–3.5) in the ultrasound-guided group and 3 (IQR, 2.0–6.0) in the landmark group (P = 0.009). At 1 h, the corresponding median NRS scores were 1 (IQR, 1.0–2.0) and 2 (IQR, 2.0–5.0), respectively (P = 0.001). No statistically significant between-group differences were reported at the later assessment points for which results were available. Accordingly, ultrasound guidance may have improved the speed of early pain relief, but the available results do not demonstrate a sustained analgesic advantage across the complete observation period.

The time to first administration of rescue analgesia was similar between the groups. The mean time was 15,616 s, approximately 260 min, in the ultrasound-guided group and 14,744 s, approximately 246 min, in the landmark group; the difference was not statistically significant (P = 0.608). This result indicates that the earlier reduction in NRS scores with ultrasound guidance did not translate into a demonstrably longer interval before the first administered rescue analgesic. The outcome should be interpreted as time to first rescue-analgesia administration rather than as a direct measure of the complete duration of sensory blockade.

The early pain difference may plausibly be related to more reliable needle-tip localisation and confirmation of local anaesthetic deposition with ultrasound guidance. However, the study design cannot determine whether this difference resulted exclusively from needle position. Baseline pain intensity, fracture pattern, anatomical variation, tissue depth, operator technique, the timing of assessments and the spread of local anaesthetic may also have contributed. Both groups received the same volume and concentration 30 mL of plain 0.25% bupivacaine and no sedation or additional analgesic was administered before or during the block.

Ultrasound-guided FICB required more time to perform than landmark-guided FICB. The reported mean performance times were 2,414 s and 901 s, respectively, with P = 0.050. This result should be described cautiously as a borderline between-group finding, but it remains clinically relevant in an emergency or trauma setting where early analgesia, patient comfort and efficient preparation for further care are important. The mean time to achieve the block was similar between groups—1,593 s with ultrasound guidance versus 1,651 s with the landmark technique (P = 0.749). Performance time and time to clinical block onset should therefore remain separate outcomes.

The present procedural-time finding is consistent with the report by Erturk *et al*., (2021), who observed a shorter performance time for landmark-guided FICB than for ultrasound-guided FICB in patients with hip fractures requiring positioning for spinal anaesthesia. In contrast, Wang *et al*., (2015) reported a shorter performance time with an ultrasound-guided approach in a different clinical context. Differences in operator experience, patient body habitus, ultrasound equipment, needle characteristics and the definition of performance time may account for these differing observations.

The landmark technique remains clinically relevant, particularly in settings where ultrasound equipment or trained personnel are unavailable. It is inexpensive, relatively straightforward and can be performed close to the emergency or operating area without moving the patient to an ultrasound-equipped location. Previous reports have described landmark-guided FICB as useful for analgesia in hip, femoral and knee procedures, thigh burns and prehospital femoral fractures (McRae *et al*., 2015). Other reports and editorials have emphasised its practicality in resource-constrained settings (Iserson, 2020; Plecko *et al*., 2019). St Louis *et al*., (2018) reported immediate analgesia lasting up to approximately 200 min after landmark-guided FICB for fracture of the neck of the femur using limited equipment. Groot *et al.,* (2015) also reported effective pain relief after landmark-guided FICB at 120 min and 8 h in patients with hip fracture. These observations are compatible with the present finding that landmark-guided FICB produced a high overall block-success rate, despite its lower rate of confirmed needle-tip precision.

Both techniques used an infrainguinal entry point. The obturator nerve may be incompletely affected by an infrainguinal FICB, although the femoral nerve is more consistently reached (Stein *et al*., 2012). Hebbard *et al*., (2011) reported that a suprainguinal entry point may produce more extensive spread, and Major and Narayanan (2023) described an anatomical rationale for more proximal approaches. However, the present study did not compare infrainguinal and suprainguinal FICB. Its findings therefore cannot be extrapolated to the relative performance of different injection levels. Similarly, the use of plain bupivacaine means that the study does not address whether adjuvants or alternative local-anaesthetic regimens would alter onset, spread or duration. Elkhodair *et al*., (2011) reported relatively rapid onset using a combination of lignocaine and a longer-acting local anaesthetic. The present study did not evaluate epinephrine, clonidine, dexamethasone or other adjuvants.

Although ultrasound guidance achieved needle-tip localisation beneath the fascia iliaca in all 44 participants, three participants in that group did not meet the study definition of an effective block at 1 h. This finding demonstrates that visual confirmation of needle position does not guarantee analgesic success in every

patient. Clinical response may additionally depend on the adequacy and distribution of local-anaesthetic spread, anatomical variation, fracture related pain and the timing and definition of block success. Ultrasound guidance should therefore be described as superior for needle localisation and associated with lower early pain scores in this study, rather than as unequivocally superior for every analgesic endpoint.

Baseline haemodynamic characteristics were comparable in the supplied report, and peripheral oxygen saturation remained above 94% in both groups. These findings provide no indication of an important baseline physiological imbalance in the reported measures. However, complete comparative P values for individual haemodynamic variables and serial post-block haemodynamic results were not available, so the data do not constitute a complete comparative haemodynamic safety analysis.

The analgesic findings are broadly compatible with previous reports of effective ultrasound-guided FICB for hip and femoral fracture pain. Lawrence *et al*., (2012) reported a substantial reduction in pain scores at 120 min after ultrasound-guided FICB in cognitively intact patients with hip fractures. Seunguk *et al*., (2016) reported effective FICB and reduced postoperative fentanyl consumption after ropivacaine with epinephrine, while Pepe *et al*., (2023) reported improved injection accuracy, procedural safety and analgesic efficacy after ultrasound-guided FICB in adults treated in an Emergency Department. These reports support the feasibility and analgesic potential of ultrasound-guided FICB but do not establish superiority over landmark-guided FICB in the population studied here. Differences in patient characteristics, fracture type, local anaesthetic, volume, concentration, adjuvants and procedural technique and outcome definitions limit direct comparison.

This study has several strengths. It used a prospective randomised parallel-group design, applied a 1:1 allocation ratio, used the same local-anaesthetic regimen in both groups and assessed outcomes with a research assistant and data analyst who were blinded to group allocation. It directly evaluated needle-tip location after landmark-guided FICB using ultrasound confirmation, thereby addressing a practical question relevant to a rural tertiary hospital. It also assessed early pain scores, time to first rescue analgesia, procedural time and time to achieve the block, haemodynamic variables, complications and patient satisfaction. The absence of sedation or additional analgesia before or during FICB reduced a potential source of immediate analgesic confounding.

Several limitations should be acknowledged. First, this was a single-centre study with 89 analysed participants, which limits the precision and generalisability of the estimates. Although the calculated minimum sample size was 86 participants, the attrition-adjusted target was 92, while 90 participants were ultimately randomised and one participant withdrew from the ultrasound-guided group. Second, the operator could not be blinded to the allocated technique, although the outcome assessor and data analyst were blinded. Third, ultrasound confirmation was used to classify needle-tip location after the landmark procedure, meaning that the precision endpoint incorporated a verification step that was not part of routine landmark-guided clinical practice. Fourth, some baseline category counts and later NRS summaries were not available in the aggregate study information. No values were imputed.

The clinical implication of this study is that ultrasound-guided FICB provides greater certainty of needle-tip localisation and was associated with lower NRS pain scores during the first hour after the block. Landmark-guided FICB was faster to perform and produced a high overall block-success proportion, making it a clinically relevant option when ultrasound equipment or expertise is unavailable. Ultrasound guidance should not, however, be presented as universally superior: the overall randomised-group block-success proportions were similar, the time to first rescue analgesia did not differ significantly, no complications were observed in either group, and patient satisfaction did not differ significantly between groups (P = 0.897). The most defensible conclusion is that ultrasound guidance improves technical precision and may improve early analgesia, whereas landmark guidance remains a feasible and efficient alternative in resource constrained trauma settings.

CONCLUSION

In this randomised trial, ultrasound-guided FICB provided more certain needle-tip localisation than the landmark technique and was associated with lower median NRS pain scores at 30 min and 1 h. Landmark-guided FICB was faster to perform and had a similar observed overall block-success proportion. The available data do not establish a difference in time to first rescue analgesia or comparative safety. Patient satisfaction was assessed in 42 participants in each group, with no statistically significant between-group difference. Ultrasound guidance may therefore improve technical precision and early analgesia, whereas landmark-guided FICB remains a feasible and efficient alternative in resource-constrained trauma settings.

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DECLARATIONS

Ethics Approval and Consent to Participate

The study received approval from the Research and Ethics Committee of Irrua Specialist Teaching

Hospital under protocol number ISTH/HREC/20202901/054, with NHREC registration number NHREC/29/03/2017. Written informed consent was obtained from all participants.

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