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ORIGINAL ARTICLE

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# Ultrasound-guided femoral nerve block versus fascia iliaca compartment block for femoral fractures in emergency department: A randomized controlled trial

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## Abstract

**Aim:** Femoral fractures are one of the most debilitating injuries presenting to the emergency departments (EDs). The pain caused by these fractures is typically managed with opioids and adjunctive regional analgesia. These approaches are often associated with adverse side effects. Thus, appropriate alternative methods should be thoroughly investigated. To evaluate ultrasound-guided femoral nerve block (FNB) with ultrasound-guided fascia iliaca compartment block (FICB) in femoral fractures, to determine which provides better analgesia and less opioid requirement.

**Methods:** This study was a randomized clinical trial performed on adult patients presenting to the ED within 3 h of isolated femoral fracture with initial numerical pain rating scale (NRS-0) score of more than 5. The patients were randomized to receive FNB or FICB. The outcomes were block success rates, pain at 20 (NRS-20) and 60 (NRS-60) min after the end of the procedures, as well as the number and total dose of fentanyl administration during ED stay.

**Results:** Eighty-seven patients were recruited (40 FNB and 47 FICB). Success rates were 82.5% in FNB and 83.0% in FICB group, with no significant difference between the groups. NRS-20, NRS-60, the number of patients who received supplemental fentanyl, and the total dose of administered fentanyl were significantly lower following FNB. However, the length of the procedure was significantly lower in the FICB group.

**Conclusion:** Both FNB and FICB are effective in pain reduction for fractures of femur, but FNB provides more pain relief and less need for supplemental fentanyl.

**KEYWORDS**
emergency department, fascia iliaca compartment block, femoral nerve block, femur fracture

## INTRODUCTION

Femoral fractures, including hip fractures which characterized by a break between the femoral head and 5 cm below the lesser trochanter, stand out as among the most prevalent and debilitating injuries worldwide.[1–3] Management of pain is often considered a critical measure in patients presenting with these fractures, as inadequate pain management is often reported as a common complaint in patients admitted to EDs.[4,5] In emergency settings, pain management may be delayed or performed incompletely, leading to the possibility that the most efficacious pain management approach might not be undertaken.[6] The routine practice for the pain management of hip fractures

in the emergency departments (EDs) is known to be systemic analgesia using opioids and/or nonsteroidal anti-inflammatory drugs.[1] Although opioids have been considered traditionally as one of the most popular analgesic modalities for pain management in the EDs, they are associated with considerable adverse effects, including sedation, nausea, vomiting, respiratory depression, hypoxemia, delirium, increased requirement for monitoring, and prolonged length of hospital stay.[7,8]

Peripheral nerve blocks (PNBs), such as femoral nerve block (FNB) and fascia iliaca compartment block (FICB), have been demonstrated as safe, effective, and relatively convenient method for acute pain management in the EDs.[9,10] These regional anesthesia methods, usually performed under the guidance of ultrasound, have been studied as single procedures or in combination, and are compatible with the facilities available in ED settings. Both FNB and FICB have been shown to be superior to intravenous (IV) fentanyl for pain management of hip fractures, while lacking the associated adverse effects of opioids.[2,11] However, most studies have been performed in the operating room setting and the efficacy of these procedures in EDs is less understood. Although FNB has been shown to be more efficient in pain management than many other analgesic modalities, a growing body of evidence and interest on FICB is also emerging, since it is reported to be technically more feasible and less invasive.[12,13] Studies suggest that FICB can substitute FNB, as both methods give a comparable degree of analgesia.[14,15]

There is, however, few conclusive research directly comparing ultrasound-guided FNB with FICB for femur fractures, particularly in the ED setting. Therefore, the primary objective of this study was to evaluate and compare a single ultrasound-guided FICB and a single ultrasound-guided FNB, administered within the ED, assessing key factors of pain scores, success rates of the procedures, and the total amount of supplemental opioid (IV fentanyl) administered during the patients' stay in the ED.

# METHODS

## Study design and settings

This was a single center parallel randomized clinical trial (RCT) conducted in Bahonar Hospital, an academic level 2 trauma center, in Kerman, Southeast Iran. Bahonar Hospital is the main referral trauma center in southeast of the country, with an annual ED admission rate of 100,000. Admitted patients are routinely triaged using a 5-level emergency severity index (ESI) system by a registered nurse, followed by an immediate visit by an emergency medicine (EM) specialist. Consultations are requested at the discretion of the EM service. Disposition of the patients to the wards or intensive care units may take 2–3 to 12 h post ED admission. This study was performed between January 1, 2022 and May 1, 2022.

## Study population

Patients aged over 16 years who were admitted with an isolated femoral fracture (including head to the distal femur) due to a blunt trauma within 3 h of the admission, and had an initial numeric rating scale (NRS) pain score of more than 5 (out of 10) were included in this study. NRS scores were collected by a trained health-care professional using patients' subjective assessment of pain, which involved asking patients to rate their pain on a numeric scale ranging from 0 (*no pain*) to 10 (*worst pain imaginable*) during the initial assessment upon admission. The presence of femoral fracture was methodically determined through diagnostic X-ray imaging, which enabled the identification of distinct structural distortions in the femur.

Exclusion criteria were the existence of painful distracting injuries (defined as a subjective pain caused by an injury in an anatomical region other than the femoral region which could potentially confound with the assessment of pain in the femoral region), impaired consciousness (defined as a Glasgow coma scale lower than 15 which may have resulted from hemodynamic shock, brain injury, post-fracture delirium, etc.), receiving any analgesic treatment before inclusion, comorbidities that could affect sensation or prevent the block (including diabetes, peripheral neuropathies, and very severe coagulopathies), history of hypersensitivity to lidocaine, and patient's refusal to participate.

## Method of the RCT

The RCT employed a single-blinded, parallel-group design, and registered in the Iranian Registry of Clinical Trials (IRCT) with the reference code of IRCT20131226015941N8. We assessed 150 patients for eligibility based on our inclusion criteria, then randomized all included patients ($n = 87$). We conducted randomization using Random Allocation Software (version 2.0, Microsoft Corporation, WA, USA), an automated, internet-based method. However, because we utilized simple randomization, we expected one group to have more than 40 members. We allocated the patients based on simple randomization, creating a random sequence using the random numbers table. Allocation concealment was done according to the traditional method of using envelopes, which were kept safe by the head nurse of the ED. Additionally, a single-blinded design was applied, wherein patients remained unaware of their assigned study group throughout the duration of the trial. Patients were consequently randomized into two groups: group one received ultrasound-guided FNB ($n = 40$), while group two received ultrasound-guided FICB ($n = 47$).

## Study variables and outcomes

Patients' data including the age, gender, comorbidities, history of opioid addiction, body mass index (BMI), initial

vital signs, mechanism of injury, and concurrent injuries were obtained through patients' history and physical examination. Additionally, patients were assessed in terms of the injury severity index (ISS) and NRS score before the beginning of the procedures (NRS-0). The time from ED admission to the beginning of nerve block, as well as the total length of the procedure and the total lidocaine volume used were also recorded. The ISS functions as a means to assess injuries in trauma patients. Calculated by summing the squared values of the three most severe injuries, the ISS ranges from 3 (*least severe*) to 75 (*most severe*). Classifications include an ISS of 1–8 as minor, 9–15 as moderate, 16–24 as severe, and 25 or higher as very severe.[16]

Outcomes were defined as follows: NRS scores at 20 (NRS-20) and 60 (NRS-60) min after the end of the procedures, block success rate (defined as reduction by at least 2 points from NRS-0 to NRS-60 and an NRS-60 of 7 or less),[17] and total dose of fentanyl administration as a supplemental analgesic after 60 min from the procedure to the ED disposition.

## Procedures

Both procedures were performed by an attending EM specialist who had passed a training course of ultrasound-guided nerve blocks and had at least 1-year experience in both of the methods. Preparation was done using chlorhexidine 2% and isopropyl alcohol 70% (BodyPrep, Iran). Lidocaine 2% (Caspian Tamin, Iran) was used for both blocks. To ensure proper administration and dilution, lidocaine 2% was mixed with an equal volume of normal saline. Epinephrine was avoided since a considerable number of the patients were predicted to be in the geriatric population.

Under cardiac monitoring and pulse oximetry in the resuscitation room and using the high frequency ultrasound transducer (Mindray DC-7 Ultrasound Machines, China), the femoral nerve with its overlying fascia (fascia iliaca) at the inguinal crease and the fascia iliaca in the lower part of the abdomen (approximately mid-way between anterior superior iliac spine and the inguinal crease) were recognized in FNB and FICB blocks, respectively. The anesthetic agent was injected using a 20 mL syringe and a 22-gauge blunt tip spinal needle (in plain with the transducer) connected together by an extension tube. The amount of injection was 20–25 mL depending on the adequate fluid expansion in the correct region at the discretion of the performer for FNB and 30–40 mL for FICB.

After the procedure, NRS scores were assessed and recorded by a junior resident of EM who was blind to the procedure. Fentanyl (Caspian Tamin, Iran) was administered according to a regular hourly pain score chart. Fentanyl (usually at a starting dose of 1–1.5 μg/kg for analgesia) is the opioid agent used in our hospital as a routine protocol in trauma patients. In general, the EM physicians administer fentanyl if the NRS score is more than 7 or at the request of patients if no contraindication exists.

## Sample size

This study was designed to find an analgesic profile for FICB which is comparable with FNB, meaning that the NRS after the two procedures were not expected to be significantly different from each other. According to a previous study, the minimum clinically significant difference (MCSD) in pain scores was equivalent to a mean (SD) of 13 (17) mm on a 100 mm visual analog scale.[18] Considering a 95% confidence level, a study power of 80%, and a conservative consideration of the equivalent VAS scores as 11 mm, the sample size was calculated as 38 for each group. We determined a minimum size of 40 patients for each group. Randomization was carried out using an automated, internet-based system called Random Allocation Software (version 2.0, Microsoft Corporation, WA, USA). However, since we had used simple randomization, it was expected that one group would have probably more than 40 members.

## Statistical analysis

Statistical package for the social sciences (SPSS) version 16.0 (SPSS Inc., Chicago, IL, USA) was used for data analysis. Qualitative (categorical) variables, were expressed using frequency and percentage. For description of the quantitative variables with normal and non-normal distribution, mean (SD) and median (interquartile range [IQR]) were used, respectively. Comparisons between the two groups were performed using the Student's *t*-test for normally distributed dependent variables, and a Mann–Whitney *U* test for non-normal variables. Chi-squared test (or Fisher exact test) was used to compare categorical variables between the two groups. A $p < 0.05$ was considered statistically significant in all tests.

# RESULTS

## Basic characteristics

A total of 87 patients were finally included in this study: 40 in the FNB group and 47 in the FICB group (Figure 1). The median (IQR) age of the patients was 38 (39), with a minimum and maximum age of 16 and 88, respectively. Twenty-four patients (28.7%) were females, 20 (22.9%) had a history of hypertension, ischemic heart disease or cancer, and 22 (25.2%) reported opium or methadone addiction. The majority of the mechanism of injury was motor vehicle collisions in 63 (72.4%) followed by falling. Fracture of the femoral neck was diagnosed in 57 (65.5%), the remaining fracture sites were shaft of the femur (Table 1).

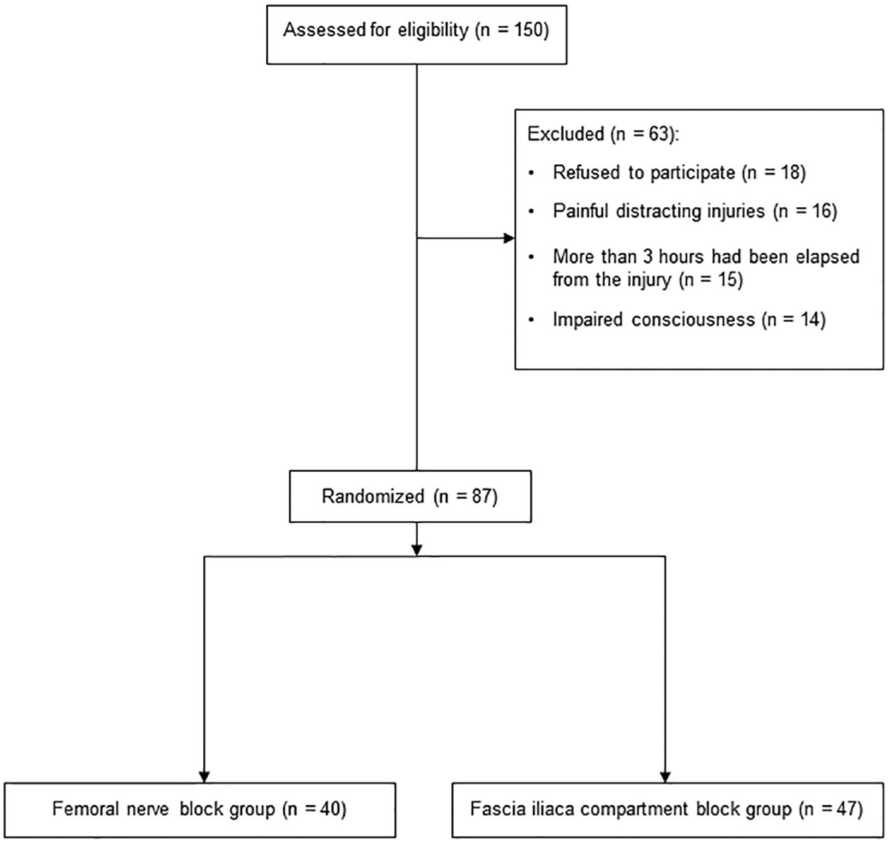


**FIGURE 1** Enrollment procedure flow diagram, comprising of inclusion and exclusion criteria.

**TABLE 1** Basic characteristics of the patients in each group.

| | FNB | FICB | *p*-value |
|---|---|---|---|
| Gender, *n* (%) | | | |
| Female | 12 (30.0) | 12 (25.5) | 0.064 |
| Male | 28 (70.0) | 35 (74.5) | |
| Age, median (IQR) | 30 (38) | 46 (45) | 0.150 |
| History of HTN, IHD, or cancer, *n* (%) | 11 (27.5) | 9 (19.1) | 0.820 |
| Opium addiction, *n* (%) | 12 (30.0) | 10 (21.3) | 0.930 |
| Site of injury, *n* (%) | | | |
| Neck of the femur | 24 (60.0) | 33 (70.2) | 0.890 |
| Shaft of the femur | 16 (40.0) | 14 (29.8) | |
| Mechanism of injury, *n* (%) | | | |
| Motor vehicle collision | 35 (87.5) | 28 (59.6) | 0.510 |
| Falling | 5 (12.5) | 19 (40.4) | |

Abbreviations: FICB, fascia iliaca compartment block; FNB, femoral nerve block; HTN, hypertension; IHD, ischemic heart disease; IQR, interquartile range; n, number; *p*, *p*-value.

During the course of ED management, 57 (65.5%) patients received IV fentanyl according to a regular hourly pain score chart, and eight (9.1%) people received blood products at the discretion of the EM physician in charge. The median (IQR) length of ED stay was 5 (7) h, with a minimum and maximum of 3 and 13.5 h, respectively. The median time from completion of the procedures to the disposition of patients from the ED was 4 (6) h; during this period of time, a median (IQR) total dose of 100 (250) μg of IV fentanyl have been administered (Table 2).

## Comparison between the two groups

There was no difference between males and females regarding NRS-0, lidocaine dose and any of the outcomes including

**TABLE 2** Clinical characteristics and comorbidities of study participants.

| | FNB | FICB | *p*-value |
|---|---|---|---|
| ISS, median (IQR) | 16 (9) | 16 (8) | 0.88 |
| SBP, median (IQR) | 110 (20) | 100 (12.5) | 0.12 |
| PR, mean (SD) | 104.2 (24.0) | 106.6 (16.1) | 0.59 |
| RR, median (IQR) | 20 (2) | 18 (2) | 0.66 |
| BMI, median (IQR) | 25 (8) | 23.5 (10) | 0.17 |
| Minutes from ED arrival to initiate the procedures, median (IQR) | 15 (10) | 15 (5) | **0.04** |
| Time to disposition (h), median (IQR) | 4 (6) | 4 (6) | 0.95 |
| Transfusion, *n* (%) | 4 (10.0) | 4 (8.5) | 0.84 |

Abbreviations: BMI, body mass index; ED, emergency department; estimated by the investigator; FICB, fascia iliaca compartment block; FNB, femoral nerve block; IQR, interquartile range; iSS, Injury severity score; *n*, number; *p*, *p*-value; PR, pulse rate at presentation; RR, respiratory rate at presentation; SBP, systolic blood pressure at presentation (mmHg); SD, standard deviation. Bold values indicates statistically significant $p < 0.05$.

**TABLE 3** Procedural outcomes and complications of FNB versus FICB.

| | FNB | FICB | *p*-value |
|---|---|---|---|
| Length of the procedure (min), median (IQR) | 9 (4) | 7 (4) | **0.040** |
| Lidocaine 2% volume (mL), median (IQR) | 20 (3) | 22 (4) | 0.100 |
| Patients that received fentanyl (IV), *n* (%) | 22 (55.0) | 35 (74.5) | **0.002** |
| NRS 0, median (IQR) | 10 (2) | 10 (2) | 0.570 |
| NRS 20, median (IQR) | 6 (2) | 6 (2) | **0.008** |
| NRS 60, median (IQR) | 6 (2) | 7 (2) | **0.008** |
| NRS 0–20, median (IQR) | 3 (3) | 2 (2) | **0.010** |
| NRS 0–60, median (IQR) | 3 (2) | 2 (1) | **0.014** |
| Total dose of fentanyl (μg), mean (SD) | 92.8 (118.9) | 175.0 (136.2) | **0.007** |
| Success rate of blockage, *n* (%) | 33 (82.5) | 39 (83.0) | 0.790 |
| Complications, *n* (%) | | | |
| Hematoma | 2 (5) | 0 | 0.620 |
| Mild respiratory depression | 0 | 1 (2.1) | |

Abbreviations: FICB, fascia iliaca compartment block; FNB, femoral nerve block; IQR, interquartile range; IV, intravenous; *n*, number; NRS, numeric rating scale; NRS 0–20 and NRS 0–60, changing pain score in the initial 20 and 60 min after the procedure, respectively; *p*: *p*-value; SD, standard deviation. Bold values indicates statistically significant $p < 0.05$.

NRS-20, NRS-60, pain score alteration in the first 20 and 60 min (NRS 0–20 and NRS 0–60, respectively), number of patients who required IV fentanyl and the total administered dose of IV fentanyl. Fracture site distribution (namely fracture of the neck and shaft) was also similar between the two groups ($p = 0.89$).

Before the start of the procedures, there was no statistically significant difference between the two groups in pain scores (NRS-0). According to the minutes taken by the procedures, FICB was faster. Following the procedures, the FNB group showed statistically significant lower values of NRS-60. Reduction in NRS 0–60 was more than 3 points in both of the groups which was clinically acceptable; however, in the FNB group, it was significantly higher. In the FNB group, 33 (82.5%) blocks were successful, whereas 39 (83.0%) patients in the FICB group received a successful block ($p = 0.79$). Regarding the number of patients who required adjunctive fentanyl, 35 (74.5%) of the FCIB group patients received the drug in the ED stay, whereas in the FNB group, 22 (55.0%) required administration of fentanyl ($p = 0.002$). Patients in the FICB group received a significantly larger total dose of IV fentanyl ($p = 0.007$). Except for two small-sized hematomas in the FNB group, no complications regarding the procedures were found in neither of the groups. However, there was one episode of mild respiratory depression in the FICB group regarding IV fentanyl administration; though not severe enough to be intervened by more than a brief period of bag mask ventilation (Table 3).

## DISCUSSION

This RCT was aimed to compare FICB and FNB as two of the most frequently used regional anesthesia for pain management in femoral fractures. Our results indicate that although both FNB and FICB are effective means of

acute pain management, FNB provides more pain relief and less need for supplemental fentanyl, whereas FICB is faster to perform. Our study demonstrated that both FNB and FICB are effective for acute pain management in femoral fracture with acceptable success rates (83.0% for FICB vs. 82.5% for FNB; $p = 0.79$). Notably, FICB was faster to perform considering the time taken by the performers to do the procedures. Regarding the adverse effects, both methods were safe, except for two small-sized hematomas in the FNB group and one episode of mild respiratory depression in the FICB group after IV fentanyl administration, which was resolved with a brief period of bag mask ventilation. In terms of pain relief, FNB was found to be more efficient, as evidenced by statistically significant lower NRS scores at 20 and 60 min after the procedures. Additionally, FNB required less supplemental fentanyl, leading to a higher proportion of patients not needing any fentanyl during their ED stay. Although we did not continue evaluation of pain scores after the first 60 min post-procedure, the number of patients who did not receive any fentanyl during the ED stay period was significantly higher in the FNB group. This finding, in addition to the finding of less total dose of administered fentanyl in the FNB group, can be a reason for FNB to be considered more efficient and durable in providing analgesia in fractures of femur. Taken together, the choice between two or more methods to achieve a clinical outcome should be based on various factors, such as available time, physician expertise, and patient characteristics. FNB may be preferred for elderly patients with hip fractures to reduce delirium risk and adverse reactions to opioids. On the other hand, FICB may be more suitable in time-constrained ED settings, with less expertise available, and for young adults without concomitant injuries. However, the ultimate decision depends on individual patient and physician considerations.

PNBs, such as FNB and FICB, have become increasingly recognized as safe and effective alternatives to systemic opioids and invasive procedures for managing acute and chronic pain.[1] These techniques have been investigated in various trauma settings, including chest trauma, rib fractures, and extremity injuries.[19] For lower extremity injuries, FNB and FICB are among the most commonly used PNBs.[20,21] FNB blocks the anterior thigh to the knee, while FICB targets the proximal end of the femoral nerve, obturator nerve, and lateral cutaneous nerve of the thigh, providing sensory blockage for the hip joint and adjacent areas.[20,22,23] FNB and FICB have both been employed independently or as part of multi-modal approaches for analgesia in femoral fractures. Additionally, FNB is a preferred choice for providing analgesia in surgical procedures involving the anterior thigh and addressing patellar fractures, while FICB finds frequent application in the context of knee fracture management.[20,21,23] Studies have highlighted several advantages of ultrasound-guided FNB and FICB in trauma cases. These procedures are simple, safe, and effective, reducing pain scores, opioid consumption, and opioid-related adverse events significantly.[19] Further, both PNBs are generally single-attempt procedures with minimal complications, improving analgesia, patient satisfaction, and overall outcomes.[8] Nevertheless, although mostly benign, the potential complications such as allergic reactions, peripheral nerve injury, hematoma, infection, local anesthesia toxicity, and disrupted sensation after the nerve blocks should be considered.[19,24]

The literature on comparing FNB and FICB outcomes in femoral and hip fractures for both adults and children is inconsistent. While some studies have reported equal analgesia between the two methods,[25–27] other reported a superior analgesic profile, higher patient satisfaction, and less opioid consumption following FNB.[15,28] Moreover, some studies suggest different effectiveness profiles based on the time frame and the location of pain relief. Some distinctive findings in the literature include that FNB is a better analgesic option for the first 6 h after operation (faster effects) on the medial side of the thigh, while FICB is better for the later 6 h and on the lateral side.[14,29] However, there is a consensus in the literature that FICB is simpler to learn, easier to perform, and faster to complete.[30] As of now, both FNB and FICB have been mainly studied for pre, peri, and postoperative analgesia, but still, the comparative information regarding these two blocks for hip, femur, and knee surgery is insufficient, while this data in the ED setting are even more scarce.[19,25,26]

This article rigorously compares ultrasound-guided FNB and FICB as analgesic methods for femoral fractures. It finds both methods effective but highlights FNB's superiority in pain relief and reduced need for opioids, contributing valuable insights for EM. The study's consideration of practical factors makes it a valuable resource for health-care providers. Our study faced some limitations that should be acknowledged. First, ethical considerations restricted pain score evaluation to 60 min, although the number of fentanyl recipients and the total fentanyl administered were included as outcomes to compensate. Lastly, limitations in human resources hindered the precise evaluation of pain scores at predefined time frames for administering fentanyl. Emphasizing future trends, research should explore broader applications across expertise levels and refine pain assessment methods to enhance patient care. This study opens the door to investigating the effectiveness of these techniques in diverse patient populations and settings, offering potential insights into optimized pain management protocols. Moreover, future studies may delve into advancements in regional anesthesia techniques and automation for remote expert guidance, ultimately evolving the landscape of acute pain management in the context of femoral fractures.

## CONCLUSIONS

This RCT provides valuable insights into the comparative efficacy of ultrasound-guided FNB and FICB for pain

management in femur fractures in the ED setting. Both FNB and FICB are effective in pain reduction for fractures of femur and offer significant advantages over systemic opioids. FNB provided better pain relief and reduced supplemental fentanyl requirement, while FICB demonstrated faster performance. Both methods could be recommended as considerations for analgesic modalities in the fast-paced ED environment. Ultimately, the choice between the two methods should be made based on specific patient and clinical considerations.

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## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interests for this article.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ETHICS STATEMENT

Approval of the research protocol: This study has been approved by the institutional review board of Kerman University of Medical Sciences (Ethics no. IR.KMU.REC.1398.050).
Informed consent: We obtained informed consent from the patient.
Registry and registration no. of the study/trial: This study has been registered in the Iranian Registry of Clinical Trials (IRCT) with the reference code of IRCT20131226015941N8.
Animal studies: N/A.

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