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*Original Article*

# Application of ultrasound-guided FICB block in femoral shaft fracture fixation offers improved pain control while effectively sustaining the stability of vital signs

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**Abstract:** Objective: To investigate the effects of ultrasound-guided fascia iliaca compartment block (FICB) in patients receiving femoral shaft fracture fixation. Methods: The prospective study enrolled 118 patients with femoral fractures. They were randomly divided into 59 patients who underwent ultrasound-guided FICB and combined spinal and epidural analgesia (FICB group), and 59 patients who received combined spinal and epidural analgesia (CSEA group). Degree of pain (visual analog scale [VAS]), mean arterial pressure (MAP), and heart rate (HR) before surgery (T1) and at 30 min (T2) and 1 h (T3) after analgesia were compared between the two groups. Following the surgery, status scores were recorded. Results: At T1, there were no statistically significant differences in VAS scores and MAP ($P$>0.050). However, at T2, VAS scores and MAP were significantly lower in the FICB group than those in the CSEA group ($P$<0.050). At T3, patients in the FICB group had lower VAS scores than those in the CSEA group ($P$<0.050). Moreover, in the FICB group, intragroup comparison of HR at the three time points showed no statistically significant differences ($P$>0.050). However, in the CSEA group, HR significantly decreased from T1 to T2 ($P$<0.050), and then significantly increased from T2 to T3 ($P$<0.050). In the FICB group, Ramsay sedation scores were lower than those in the CSEA group ($P$<0.001). Conclusion: Application of ultrasound-guided FICB block in femoral shaft fracture fixation offers improved pain control while effectively sustaining the stability of vital signs; thus, its use should be promoted in clinical practice.

**Keywords:** Femoral shaft fracture, fixation, ultrasound guidance, FICB

## Introduction

Hip fracture usually refers to a femoral shaft fracture, mainly caused by external force crush injuries, such as car crashes or other heavy items, or falling injuries. These injuries typically manifest as comminuted, spiral, or transverse fracture and acute pain, and have associated soft tissue injuries [1, 2]. Femoral shaft fractures are common, secondary only to ankle and lower leg fractures in incidence rate [3]. It was reported that by 2016, new cases of femoral shaft fracture have already exceeded 1.2 million [4]. The majority of femoral shaft fractures occur during car accidents, accounting for approximately 62.87% of all patients [5]. Furthermore, the increase in the number of cars contributes to a higher frequency of car accidents and the increased incidence of femoral shaft fracture [6]. Evidence has shown that the incidence rate of femoral shaft fracture has increased by 12-fold compared with 10 years ago, and continues to rise [7].

Among the types of femoral shaft fracture, femoral intertrochanteric fracture is the most common one, accounting for 76.15% of all types [8]. When the fracture occurs, patients do not only have to tolerate tremendous pain, but may also experience soft tissue injury, swelling, and inflammation caused by the fracture-induced release of inflammatory cytokines [9]. Pain associated with femoral shaft fracture increases with changes in position, severely affecting patient quality of life [10]. Thus, currently, surgery is the first-line treatment for femoral shaft fracture [11], which reduces the fracture, as well as alleviates pain and prevents further soft tissue injuries.

Currently, there are many anesthetic options available to surgeons; among their functions, anesthetics not only efficiently provide analgesia to patients during surgery and alleviate the risk after surgery, but also hasten patient recovery, thereby acting as one of the key elements in determining patient prognosis [12]. Among the various block methods, fascia iliaca compartment block (FICB) has been confirmed to be effective in the treatment of lower leg fracture [13, 14]. FICB can efficiently block the femoral nerves, lateral femoral cutaneous nerve, and obturator nerves. However, the technique using fascial click had a low success [15]. Developments in technology have enabled the application of video-assisted ultrasound-guided FICB block, greatly increasing the success rate of FICB to 92.33% [16]. Nevertheless, there are few studies reporting the application of ultrasound-guided FICB in the treatment of femoral shaft fracture.

Since 2017, ultrasound-guided FICB has been widely used in the surgical treatment of femoral shaft fracture, with satisfactory results. In the present study, we compared the analgesic efficacy and vital signs of patients between FICB and oral administration of tramadol to demonstrate the efficacy of ultrasound-guided FICB in the treatment of femoral shaft fracture. The results of the present study provide reference for clinical treatment of femoral shaft fracture going forward.

## Material and methods

### *General material*

The study prospectively analyzed 118 patients with femoral shaft fracture. The patients comprised 84 men and 35 women, with a mean age of 52.23±11.57 years (range: 37 to 69 years). This study was approved by the Ethics Committee of the Ningbo Sixth Hospital, and all subjects provided written informed consent.

### *Inclusion and exclusion criteria*

Inclusion criteria were patients with a diagnosis of a femoral shaft fracture on imaging; fixation for restoration in this hospital; complete clinical data; age between 20 and 70 years; and ability to cooperate with proposed medical care.

Exclusion criteria were patients with cardiovascular or cerebrovascular diseases; severe organ failure; combined injury; fractures in multiple sites; a history of long-term administration of analgesics; intolerance to the surgery; allergy to the local amides anesthetics and opioids; peripheral nerve lesions; mental disorders; difficulty in communication; and patients who were transferred to other hospitals.

### *Methods*

After intravenous anesthesia induction with propofol, fentanyl and cisatracurium, and laryngeal mask airway insertion, monitoring of non-invasive blood pressure (NIBP), heart rate (HR), pulse oximetry (SpO2) and electrocardiogram (ECG) were performed with continuous oxygenation. The patients were maintained in the supine position, with extension of the lower limbs, and after sterilization, a portable ultrasound imager (Guangdong Jiaoyang Medical Instruments Co., Ltd., CTS-5500 Digital Portable Ultrasound Imager, CTS) was used at a frequency between 8 and 12 MHz to identify the puncture site at 1.0 cm to the cross point of the tuberculum pubicum ligation and one-third of the anterior superior spine. The ultrasonic probe was placed levelly on the inguinal region, perpendicular to the long axis of leg, and the image showed that the high-level echoes of fascia iliaca and broad ligament covered the low-level echoes of iliopsoas. Then, a 19G puncture needle was inserted at a 45° angle to the skin and puncture needle movement was observed on the ultrasound imager. After two breakthroughs, 5 mL normal saline was injected; successful positioning was indicated by the spreading of liquid along the interspace of fascia iliaca on the ultrasound image. Once pumpback showed no blood, 30 mL 0.4% ropivacaine hydrochloride was slowly injected; then, an aseptic dressing was placed on the puncture site to press on the lower part beneath the puncture site to prevent the spread of anesthetic into the nerve endings of the plexus lumbalis.

In the CSEA group, the patients were maintained in a lateral position, with the affected side up, and block was performed through an epidural puncture in the interspace between L3 and L4. Following the outflow of cerebrospinal fluid, 1.8 mL 0.4% bupivacaine in 2 mL water was injected, followed by insertion of the epidural catheter. Ten minutes prior to surgery, all

**Table 1.** Demographic information and clinical data [n (%)]

| | FICB group (n=59) | CSEA group (n=59) | $X^2$ or t | P |
|---|---|---|---|---|
| Age | 54.16±9.67 | 53.47±10.54 | 0.371 | 0.712 |
| Body weight (KG) | 67.86±13.67 | 69.14±12.81 | 0.525 | 0.601 |
| BMI (KG/m$^2$) | 22.63±3.24 | 23.46±3.82 | 1.273 | 0.206 |
| Operation time (hour) | 2.14±0.42 | 2.20±0.53 | 0.682 | 0.497 |
| Intraoperative blood transfusion | 325.65±28.95 | 318.69±31.42 | 1.251 | 0.213 |
| Intraoperative blood loss | 418.62±40.57 | 412.69±38.44 | 0.815 | 0.417 |
| Gender | | | 0.051 | 0.822 |
| Male | 47 (79.66) | 46 (77.97) | | |
| Female | 12 (20.34) | 13 (22.03) | | |
| Living Environment | | | 0.902 | 0.342 |
| Town | 55 (93.22) | 52 (88.14) | | |
| Rural | 4 (6.78) | 7 (11.86) | | |
| ASA grading | | | 0.521 | 0.470 |
| I | 50 (84.75) | 47 (79.66) | | |
| II | 9 (15.25) | 12 (20.34) | | |
| Fracture site | | | 0.308 | 0.579 |
| Left leg | 34 (57.63) | 31 (52.54) | | |
| Right leg | 25 (42.37) | 28 (47.46) | | |

patients in each group were administered continuously with 0.5 to 1.0/kg dexmedetomidine for sedation.

*Outcome measures*

Degree of pain before surgery (T1), and at 30 min (T2) and 1 h (T3) after analgesia was evaluated using the visual analogue scale (VAS) [16], with a total score of 10 points and a higher score representing more severe pain. Surgical risk indicators included mean arterial pressure (MAP) and HR. Preoperative and postoperative emotional effects were assessed using the Self-rating Anxiety Scale (SAS) and the Self-rating Depression Scale (SDS) [17].

*Statistical methods*

SPSS version 24.0 software (IBM, New York, USA) was used for data analysis and processing. Enumeration data were presented in form of rate (%), and intergroup comparison was performed using the chi-square test. Measurement data, such as VAS scores, MAP, and HR, were expressed in mean ± standard deviation, and compared using repeated measures analysis of variance with post hoc Bonferroni test. $P<0.050$ suggested that the difference had statistical significance.

## Results

*Baseline data*

The following data were compared between the two groups: age, weight, surgical time, blood loss, transfusion volume, sex, residence, American Society of Anesthesiologists score, and fracture site. No statistically significant differences were found between groups ($P>0.050$) (**Table 1**).

*FICB group had less pain*

At T1, there was no statistically significant difference in VAS scores between the two groups ($P>0.050$). At T2, mean VAS score in the FICB group was 1.93±0.51, significantly lower than the mean score of 2.82±0.60 in the CSEA group ($P<0.050$). At T3, the mean VAS score in FICB further decreased to 1.68±0.24 points, still significantly lower than the mean score of 2.77±0.49 in the CSEA group ($P<0.050$). At the different time points in the FICB group, VAS scores gradually decreased from T1 to T3 ($P<0.050$), while in the CSEA group, mean VAS scores at T2 and T3 were not significantly different ($P>0.050$), but were lower than that at T1 ($P<0.050$) (**Figure 1A**).

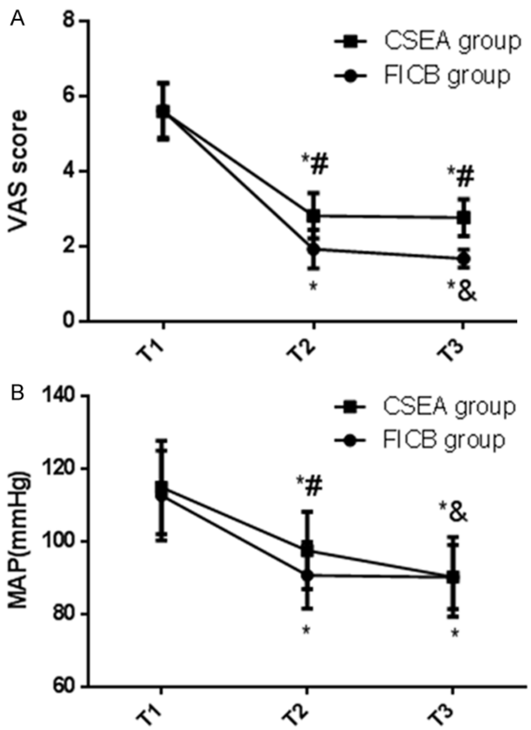


**Figure 1.** A. VAS scores for both patient groups. *represents a comparison of VAS scores of the same group at T1, $P<0.05$; &represents a comparison with the VAS score of the same group at T2, $P<0.05$; #represents a comparison with the VIC score of the FICB group at the same time, $P<0.05$. B. MAP for both patient groups. *represents a comparison with the same group at T1, $P<0.05$; &represents a comparison with the same group at T2, $P<0.05$; #represents a comparison with FICB group, $P<0.05$.

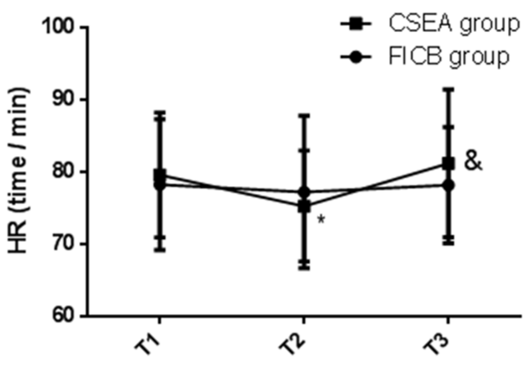


**Figure 2.** HR for both groups of patients. *represents HR compared with the same group T1, $P<0.05$; &represents HR compared with the same group T2, $P<0.05$.

*FICB group exhibited lower surgical risk*

With respect to MAP comparisons between the two groups, there was no significant difference at T1 ($P>0.050$). However, at T2, mean MAP in the FICB group was 90.68±9.12 mmHg, significantly lower than the mean MAP of 97.53±10.62 mmHg recorded in the CSEA group ($P<0.050$). At T3, mean MAPs in the FICB group and the CSEA group were 90.20±8.86 and 90.26±10.97 mmHg, respectively (difference not significant; $P>0.050$). In the FICB group, MAP at T2 was significantly decreased compared with MAP at T1 ($P<0.050$), but the difference between T2 and T3 showed no statistical significance ($P>0.050$); in the CSEA group, MAP was gradually decreased from T1 to T3 ($P<0.050$) (**Figure 1B**).

Differences in HR at T1, T2, and T3 between the two groups showed no statistical significance ($P>0.050$). In the FICB group, HR comparisons among different time points also showed no statistically significant difference ($P>0.050$). However, in the CSEA group, mean HR at T2 was 75.26±7.68 beats/min, significantly lower than the mean HR of 79.57±8.64 beats/min at T1 ($P<0.050$), while at T3, HR was increased to 81.19±10.24 beats/min, significantly higher than that at T2 ($P<0.050$). The difference between T1 and T3 showed no statistical significance ($P>0.050$) (**Figure 2**).

*FICB group showed lower SDS and SAS scores*

There were no significant differences in preoperative SDS and SAS scores between the two groups ($P>0.050$). After surgery, the SDS and SAS scores in FICB group were significantly lower than those in CSEA group ($P<0.001$), ($P=0.003$; **Figure 3A** and **3B**).

**Discussion**

Femoral shaft fracture fixation is currently a frequently performed surgery, during which intravertebral block is often used [18]. FICB can deliver adequate anesthetics through the interspace between the fascia iliaca and iliopsoas, thereby attaining sufficient anesthetic efficacy on the legs [19, 20]. However, in comparison with nerve block, FICB may work better in blocking the obturator nerve and lateral femoral cutaneous nerves [21]. Conventional FICB technique only can confirm the puncture site through the sensation of two breakthroughs [22]. FICB has gradually been perfected. Real-time monitoring during the injection of the anesthetics enables necessary adjustments of

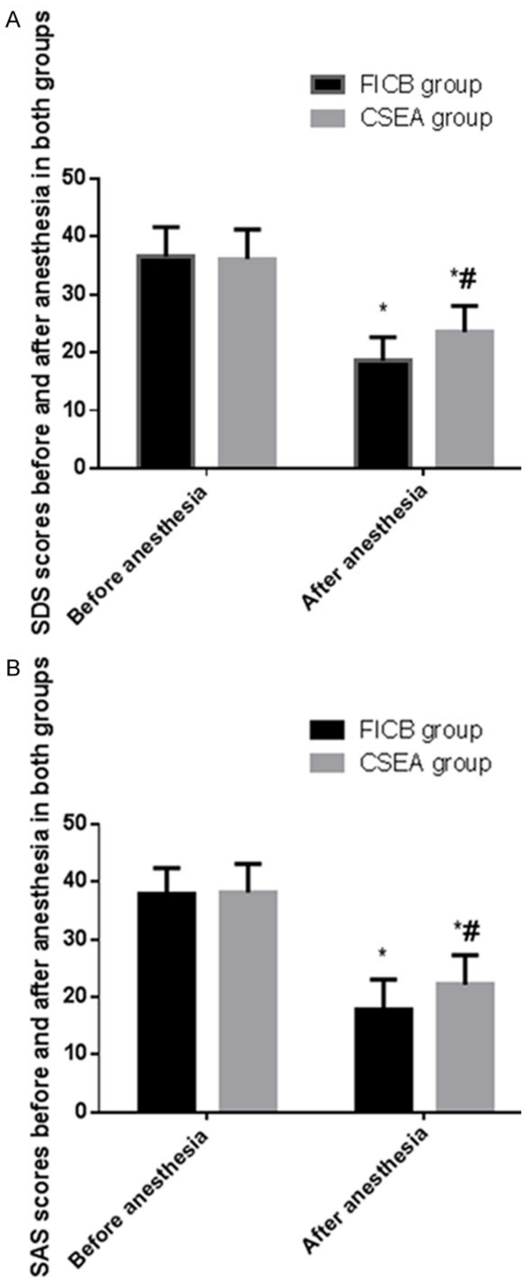


**Figure 3.** A. The SDS scores of the two groups before and after anesthesia. *represents a comparison with SDS scores before anesthesia, P<0.001; #represents a comparison with the SDS score of the FICB group after anesthesia, P<0.001. B. The SAS scores before and after anesthesia in both groups. *represents a comparison with SAS scores before and after anesthesia, P<0.001; #represents a comparison with the SAS score of the FICB group after anesthesia, P<0.001.

needle position at any time in case of spread of anesthetics inside the iliopsoas or to the fascia iliaca [23]. We compared the efficacy between ultrasound-guided FICB and a conventional block method in the treatment of femoral shaft fracture, so as to clarify the value of ultrasound-guided FICB.

Results of this study showed that at T1, differences in VAS scores, MAP, and HR between the two groups were not significantly different (*P*>0.050); at T2 and T3, the VAS scores in the FICB group were evidently lower than those in the CSEA group, suggesting a more pronounced analgesic effect of FICB. However, MAP and HR at T2 and T3 in the FICB group were all significantly lower than those in the CSEA group, indicating that patients in the FICB group showed superior vital signs. It has been reported that patients with femoral shaft fractures are particularly susceptible to paroxysmal muscle spasms [24], which result in more significant pain at this than at any other fracture site; in these patients, FICB can effectively mitigate muscular spasms and pain. In addition, FICB obviates the search for nerve reflex with change in position, further alleviating patient pain and anxiety. Furthermore, through the local spread of anesthetics, blocking the sciatic nerve can provide effective pain relief, and patients may have less postoperative adverse events associated with a massive application of block.

Pain is more severe after orthopedic surgery than any other clinical surgeries [25]. Fracture patients require a longer period of recovery, and cannot perform any rehabilitation training, thus limiting the range of motion of the thoracic diaphragm and limiting the movement associated with cough or deep breath. The resultant accumulation of bronchial secretions in the airway may induce pneumonia and other respiratory disease. Meanwhile, the acute postoperative pain further promotes a tremendous generation of inflammatory cytokines and triggers systemic inflammation and oxidative stress responses [26]. Intravertebral block may significantly increase the incidence of the above-noted adverse reactions, while FICB only blocks the sciatic and femoral nerves, thus avoiding the dysfunction of other nerves. This suppresses perioperative stress responses and ameliorates the oxygenation in the myocardium, and eventually decreases postoperative adverse reactions. Due to the effect of the anesthetics used in the CSEA group, recovery may be delayed, and nerve function may be affected. However, the dosage of anesthetics in FICB is significantly lower than that in CSEA, generating less effect on the hemodynamics of patients.

In the present study, we compared outcomes between ultrasound-guided FICB and conventional intravertebral block in fixation surgery for femoral shaft fracture. However, there were limitations such as small sample size and inability to perform statistical analysis for patients receiving other anesthetic methods. Hence, in future studies, continuous improvement will be made to further optimize the results of this experiment.

In conclusion, the application of ultrasound-guided FICB block in femoral shaft fracture fixation provides promising analgesic efficacy while effectively sustaining the stability of vital signs. Thus, the use of ultrasound-guided FICB should be promoted in clinical practice.

## Disclosure of conflict of interest

None.

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