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Observation on analgesic effects of ropivacaine sciatic nerve block guided by ultrasound combined with a nerve stimulator after fracture of the calcaneus

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Abstract: **Background**: Calcaneal fracture (FOC) is a common foot trauma. Severe postoperative pain can easily trigger the body's stress response, increase the risk of thrombosis, and seriously affect the recovery of patients. Sciatic nerve block (SNB) guided by traditional nerve stimulator (NS) has some problems such as inaccurate positioning and unstable block effect. Ultrasound-guided technology can visualize the nerve structure and puncture process in real time to improve the accuracy of block. **Objective**: In this study, we observed the analgesic effect of ropivacaine SNB on FOC under the guidance of ultrasound combined with a NS. **Methods**: We retrospectively analyzed 200 FOC patients, including 113 patients who received ropivacaine SNB guided by ultrasound combined with an NS (ultrasound group) and 87 patients who received ropivacaine SNB under the guidance of an NS (conventional group). **Results**: The ultrasound group showed a shorter onset time of anesthesia and a greater number of grade I (the block was successful and the patient had no obvious pain and muscle relaxation) anesthetic effect in patients ($P<0.05$). At 30 minutes after analgesia and 60 minutes after analgesia, the vital signs of the ultrasound group were more stable. In addition, the stress response indexes Epinephrine (E) and Cortisol (Cor) in the Ultrasound group were lower than those in the conventional group ($P<0.05$) and coagulation function indexes were higher than those in the conventional group ($P<0.05$). Finally, the incidence of adverse reactions in the ultrasound group was lower than that in the conventional group (10.34% *vs.* 2.65%, $P<0.05$). **Conclusion**: Ultrasound-guided ropivacaine SNB combined with NS has a good analgesic effect in analgesia after FOC surgery.

Keywords: Fracture of the calcaneus; Nerve block anesthesia; NS; Ropivacaine; Ultrasound

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INTRODUCTION

Fracture of the calcaneus (FOC), one of the most common foot fractures, is primarily caused by factors such as external trauma, resulting in bone destruction at the heel and disruption of its integrity or continuity (Chirvi *et al.*, 2022). Statistics indicate that FOC accounts for approximately 30.3% of all foot fractures and 2.9% of all body fractures, with a gradual rise in prevalence in recent years (Hoshi *et al.*, 2023). Due to the influence of comprehensive factors such as thin skin at the heel, scarce soft tissue and nerve branch injuries, postoperative pain in FOC is extremely evident (Batin *et al.*, 2023). This intense pain not only significantly impacts the postoperative comfort of patients but may also trigger obvious postoperative stress responses, increasing the occurrence of postoperative risk events (complications, poor wound healing, infection, etc.) (Li & Lui, 2023). Hence, improving the postoperative pain condition of FOC is an important issue that urgently requires a solution in clinical practice.

The Sciatic nerve block (SNB) is an effective analgesic method with the advantages of precise analgesia and reduced side effects of opioids. However, accurate puncture is difficult and even if the nerve stimulator (NS) is used for guidance, there is still a risk of vascular and nerve injury (Kull *et al.*, 2024). Currently, ultrasound is widely applied in the fields of surgical anesthesia and postoperative analgesia. Through visualized manipulation, ultrasound can more clearly monitor the direction of needle insertion, the position of blood vessels and nerves and the direction of drug diffusion, further improving the success rate of nerve block while reducing complications (Ke *et al.*, 2023). However, the drawback of this block approach is that it requires a high level of professional expertise from the operator, requiring experienced anesthesiologists to achieve accurate puncture (Reining *et al.*, 2022), which also leads to the difficulty in popularizing ultrasound-guided nerve blocks in primary hospitals. Not only that, there is still a lack of clinical studies specifically evaluating the application of ultrasound combined with NS to guide the sciatic nerve block (SNB) with ropivacaine in patients with FOC, especially the studies systematically evaluating its effect on postoperative stress response and coagulation function. The present study aimed to fill this knowledge gap.

We hypothesized that ultrasound combined with NS guidance would provide better analgesia, more stably reduce the stress response, improve the hypercoagulable state and reduce the incidence of adverse reactions. Therefore, this study will conduct a comprehensive

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analysis of the analgesic effect and safety of ropivacaine SNB guided by ultrasound combined with a NS in FOC, so as to confirm the influence of this anesthesia scheme on the prognosis and rehabilitation of FOC patients and provide a reference for clinical practice.

MATERIALS AND METHODS

Information and methodology

Research subjects

The significance level (α) was set at 0.05 (two-sided) and the test power (1-β) was 0.80. Based on the pilot study, the expected difference effect size (d/OR) of the primary outcome (onset of analgesic) was 40%. The minimum sample size was calculated to be 184. Due to possible dropout (10%), 200 patients with FOC from January 2022 to December 2023 were selected for retrospective analysis. According to patient wishes, 113 patients received ropivacaine SNB under the guidance of ultrasound combined with an NS and were regarded as the ultrasound group; another 87 patients received ropivacaine SNB guided by an NS and were regarded as the conventional group.

Inclusion criteria

Patients with FOC confirmed by X-rays, with clear indications for surgery, normal coagulation function, no drug allergy and complete medical records, were included.

Exclusion criteria

Patients with cognitive impairment, liver and kidney insufficiency, pregnancy, lactation, or anticoagulant medication in the past month were excluded.

Surgical methods

After the patients were admitted to the hospital, the minimally invasive plate internal fixation surgery was completed by the same group of surgeons in our hospital. After the operation, the patient was instructed to elevate the injured limb and given routine antithrombotic and infection prevention treatments.

Anesthesia methods

Conventional group: Lying on the side, a straight line connecting the above two muscles was drawn 8-10 cm above the skin fold of the back of the knee, with its midpoint as the needle entry point. After routine sterilization, a nerve stimulation needle (21G×70mm, TYPE CCR, Hachimitsu, Japan) connected to a peripheral NS (SY-708A, Jiangsu Suyun Medical Equipment Co., Ltd.) was inserted vertically and slowly into the needle at this point. The initial stimulation current was 1.0 mA, until the current induced dorsiflexion or plantarflexion of the plantar or toe and then the current was reduced to 0.3-0.6 mA. If obvious muscle contraction could still be induced, it meant that the point of injection had been reached and after no blood was drawn back, 20 mL of 0.375% ropivacaine (AstraZeneca AB, H20140764) was injected into the nerve periphery (Xu *et al.*, 2022).

Ultrasound group: The patient was placed in the lateral position with the affected limb on top and the knee slightly flexed, the apex of the popliteal fossa rhombus was used as the puncture point and the sciatic nerve and its branches were identified by ultrasound (S-Nerve, FUJIFILM Sonosite) scanning (Fig. 1). Puncture was performed under real-time ultrasound monitoring, with the assistance of a NS for localization and the operation was the same as that of the conventional group and the direction of the puncture needle was adjusted according to the ultrasound image in time to ensure that the ropivacaine encircled the target nerve plexus. Under real-time ultrasound monitoring (ultrasound group) or after induced target muscle contraction (conventional group), 0.375% ropivacaine 20ml was injected without blood. Successful block was confirmed by observing the spread of local anesthetic around the target nerve (visible in the ultrasound group) and/or the disappearance of target muscle contraction during (ultrasound group) or after injection.

After the nerve block was completed in both groups and the analgesic effect was assessed, the patients were sequentially sedated with midazolam (Jiangsu Enhua, Approval No. H20143222) 0.02-0.05 mg/kg, fentanyl (Yichang Renfu, Approval No. H42022076) 3-5 μg/kg, propofol (Fresenius Kabi AB, Approval No. HJ20170305) 2-4 mg/kg, cis-atracurium (Hangzhou Aoya, Approval No. H20213438) 0.15-0.20 mg/kg. Train-of-four (TOF) (Veryark, Guangxi Willie Ark) and bispectral index (BIS) (186-0106, Shanghai Kehui) were monitored. Tracheal intubation was performed when the TOF count=0 and the BIS value was between 40-60 and mechanical ventilation was performed after intubation. Propofol 4-10mg/kg/h and cis-atracurium 1-2ug/kg/min were pumped in at a constant rate during the operation and the dose was adjusted in time according to the intraoperative situation to maintain the TOF count=1-2 and BIS 40-60. Cis-atracurium was discontinued before surgical suturing, propofol was discontinued at the end of surgery, the patient's position was adjusted to supine and the endotracheal tube was removed after the patient reached the extubation indications (TOF count=0.9, BIS value of 80-100, recovery of consciousness, ability to breathe on his/her own, stable respiration and recovery of muscle strength). Subsequently, they were sent to the anesthesia recovery room for mask oxygenation and after 30 min of observation, they were sent back to the ward when the modified Aldrete score was ≥9.

Analgesic effect evaluation

The onset time of anesthesia in both groups was recorded. Subsequently, the anesthetic effect of the patients was evaluated. The anesthetic effect was evaluated with reference to the Nerve Block Effectiveness Rating (Apfelbaum *et al.*, 2022) and the Visual Analogue Scale (VAS) (Gavan *et al.*, 2025). Grade I: The block was successful and the patient had no obvious pain and muscle relaxation, VAS 0. Grade II: The anesthesia range is

basically complete and the patient has slight pain and muscle relaxation, VAS 1-3. Grade III: The anesthesia range is small and the patient experiences obvious pain with stiff muscles, VAS 4-7. Grade IV: Anesthesia fails and an alternative anesthesia method is adopted, VAS 8-10.

Observation of vital signs

Hemodynamic parameters, including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and oxygen saturation of blood (SaO_2), were monitored before analgesia (T0), 30 minutes after analgesia (T1) and 60 minutes after analgesia (T2).

Detection of stress response and coagulation function

Elbow venous blood of patients in both groups was collected before and after analgesia (at 60 minutes) and divided into two portions. One portion was used to detect cortisol (Cor) and epinephrine (E) by enzyme-linked immunosorbent assay (ELISA). The other portion was used to detect thrombin time (TT), prothrombin time (PT) and activated partial thromboplastin time (APTT) by an automatic coagulation analyzer.

Safety assessment

The adverse reactions during the analgesia process in both groups of patients, such as hypotension and respiratory depression, were counted.

Statistical analysis

Statistical analysis was conducted using SPSS 24.0 software. For categorical data, it is expressed as a percentage (%) and the chi-square test is used for inter-group comparison. For measurement data that conform to a normal distribution, it is expressed as mean ± standard deviation ($\bar{\chi}\pm s$); comparisons were made using independent and paired t tests. Non-normally distributed measures were presented as medians (interquartile ranges); compared by Mann-Whitney U and Willcoxon test. A difference is considered statistically significant when $P<0.05$.

RESULTS

Baseline data

To minimize the bias caused by baseline differences between groups, we collected and compared the baseline characteristics of the two groups (Table 1) and the results showed no statistically significant differences in the key variables such as age, sex and fracture site (left/right) ($P>0.05$), indicating that the baseline of the two groups was comparable.

Comparison of analgesic effects

There were no patients achieving Grade IV anesthetic effect in either group; the two groups were similar in the number of patients achieving Grade II and III anesthetic effect ($P>0.05$), but a greater number of patients achieving Grade I anesthetic effect was determined in the ultrasound group compared to the conventional group ($P<0.05$). In addition, the ultrasound group showed a shorter onset time of anesthesia than the conventional group ($P<0.05$) (Table 2).

Comparison of vital signs

DBP, SBP, HR and SaO_2 levels did not differ statistically between groups at T0 ($P>0.05$). At T1, there was no change in SaO_2 in the two groups ($P>0.05$), but DBP, SBP and HR were all increased compared with T0, with even lower DBP, SBP and HR levels in the ultrasound group ($P<0.05$). At T2, the SaO_2 of both groups remained unchanged ($P>0.05$); the DBP, SBP and HR of the ultrasound group were reduced compared to T1 ($P<0.05$) but were no difference from T0 ($P>0.05$); DBP, SBP and HR in the conventional group were also lower than those at T1, but still higher compared to T0 ($P<0.05$) (Table 3).

Comparison of stress response and coagulation function

We found no notable difference in E, Cor, TT, PT and APTT between groups before analgesia ($P>0.05$). After analgesia, TT, PT and APTT increased in both groups, with more significant increases in the ultrasound group compared with the conventional group ($P<0.05$), while E and Cor decreased and were even lower in the ultrasound group ($P<0.05$) (Table 4).

Comparison of safety

The total incidence rate of adverse reactions was lower in the ultrasound group than in the conventional group (10.34% *vs.* 2.65%, $P<0.05$) (Table 5).

DISCUSSION

Enhancing patient comfort after FOC surgery is a key component in improving outcomes (Sousa *et al.*, 2023). First of all, we compared the analgesic effect of anesthesia. The number of patients with grade I anesthesia was more in the ultrasound group and the time for anesthesia to take effect was significantly shortened, suggesting that both the anesthetic effect and efficiency of the ultrasound group were superior to those of the conventional group.

According to the report by Tu NH *et al*., nerve block anesthesia guided by ultrasound combined with an NS has better anesthesia effects (Tu *et al.*, 2024), which is consistent with the results of this article. In the observation of vital signs, lower HR, DBP and SBP at T1 and T2 were determined in the ultrasound group compared to the conventional group, suggesting higher stability of vital signs in the ultrasound group during anesthesia. This is because, under general anesthesia, the body's vital signs can fluctuate greatly as the intensity of the stimulus changes (Baskin *et al.*, 2023). Ultrasound-guided SNB anesthesia allows for a clear observation of the location of nerve fibers and surrounding tissues and the assistance of an NS enables puncture and positioning under direct vision.

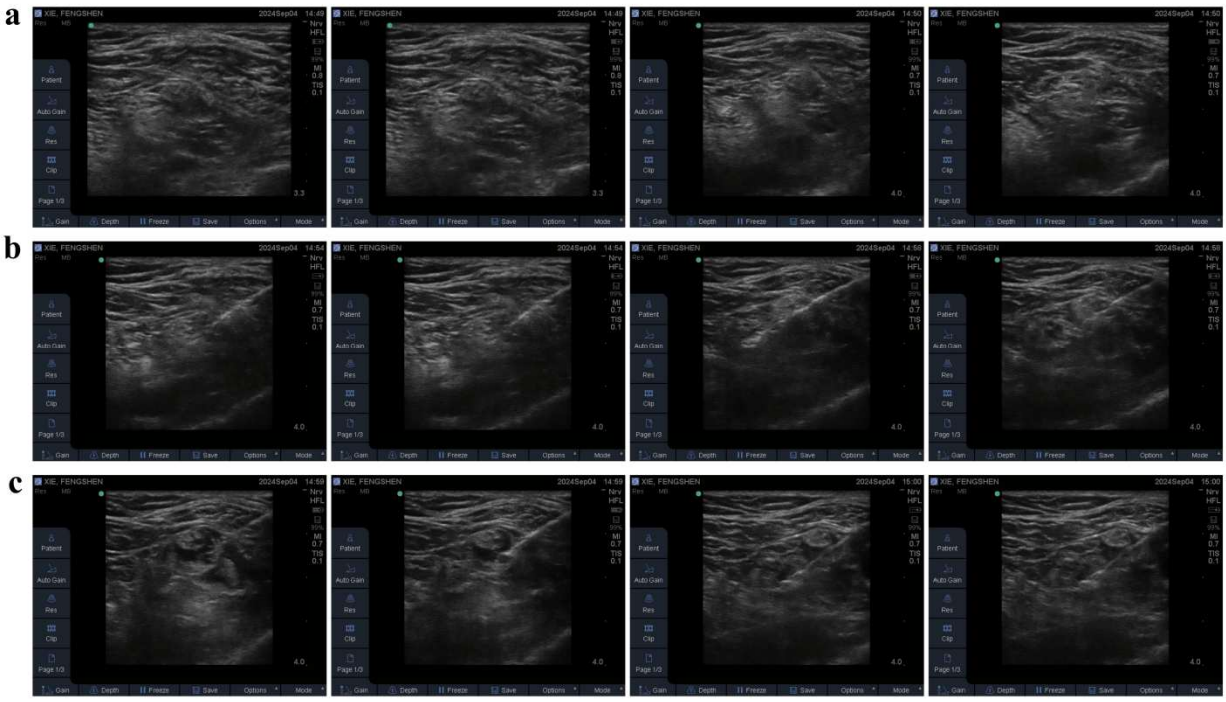

Fig. 1: Ultrasound monitoring image during puncture. (a) before puncture, (b) during puncture, and (c) after puncture.

Table 1: The clinical baseline data of the two groups were compared

		Conventional (n=87)	Ultrasound (n=113)	c^2 (or t)	P
Sex	Male	61 (70.11)	74 (65.49)	0.48	0.488
	Female	26 (29.89)	39 (34.51)		
Age		55.01±8.23	54.92±6.00	0.091	0.928
Causes of fractures	Falls	66 (75.86)	79 (69.91)	0.877	0.645
	Traffic incident	15 (17.24)	24 (21.24)		
	Other	6 (6.90)	10 (8.85)		
Fracture site	Left	42 (48.28)	60 (53.10)	0.457	0.499
	Right	45 (51.72)	53 (456.90)		
Time from fracture to surgery (d)		5.55±1.06	5.35±1.19	1.221	0.224
Operating time (min)		71.41±10.69	70.76±9.05	0.467	0.641
Incision length (cm)		4.00±0.89	4.09±0.78	0.763	0.0446
Sanders Classification	I	54 (62.07)	75 (66.37)	0.397	0.528
	II	33 (37.93)	38 (33.63)		

Table 2: The anesthetic effect of the two groups was compared

Groups	Level of anesthesia				Onset of analgesic (min)
	I	II	III	IV	
Conventional (n=87)	38 (43.68)	48 (55.17)	1 (1.15)	0 (0.00)	13.92±2.85
Ultrasound (n=113)	66 (58.41)	47 (41.59)	0 (0.00)	0 (0.00)	7.04±2.45
χ^2 (or t)	4.272	3.635	1.305	-	18.330
P	0.039	0.057	0.253	-	<0.001
95%CI	-	-	-	-	-7.620 to -6.140

In this way, the positioning process is simplified, the puncture process is guided in real-time and the effect is improved; on the other hand, the damage to blood vessels, nerves and surrounding tissue structures can be reduced, the nerve structure can be intuitively displayed and the anesthesia diffusion situation can be grasped, so that the anesthesia takes effect faster and the effect is more lasting, thus improving the analgesic effect of anesthesia (Malahias *et al.*, 2022).

Table 3: The vital signs of the two groups was compared

	Groups	T0	T1	T2	F	P
DBP (mmHg)	Conventional (n=87)	85.47±6.70	93.07±7.15*	90.45±5.97*#	29.550	<0.001
	Ultrasound (n=113)	85.77±6.50	87.71±6.18*	85.36±5.77#	4.681	0.010
	t	0.318	5.679	6.090		
	P	0.751	<0.001	<0.001		
SBP (mmHg)	Conventional (n=87)	105.94±8.06	113.79±7.02*	106.64±6.54*#	26.490	<0.001
	Ultrasound (n=113)	104.65±11.01	108.23±8.41*	103.73±7.97#	7.127	0.001
	t	0.918	4.978	2.763		
	P	0.360	<0.001	0.006		
HR (times/min)	Conventional (n=87)	80.55±7.90	92.20±8.19*	84.95±7.29*#	49.400	
	Ultrasound (n=113)	80.18±5.63	88.53±6.30*	80.63±6.55#	65.450	
	t	0.392	3.576	4.408		
	P	0.696	<0.001	<0.001		
SaO_2 (%)	Conventional (n=87)	92.22±0.81	92.24±0.85	92.34±0.97	0.606	0.502
	Ultrasound (n=113)	92.23±1.00	92.35±0.95	92.45±1.14	1.324	0.268
	t	0.107	0.887	0.668		
	P	0.915	0.376	0.505		

Note: *vs.* T1 *P<0.05, *vs.* T2 #P<0.05.

Table 4: The stress response and coagulation function of the two groups was compared

	Groups	Before analgesia	After analgesia	t	P
E (ng/L)	Conventional (n=87)	56.89±5.84	49.96±6.63*	7.311	<0.001
	Ultrasound (n=113)	56.17±7.71	44.26±5.37*	13.480	<0.001
	t	0.722	6.719		
	P	0.472	<0.001		
Cor (pmol/L)	Conventional (n=87)	116.48±8.99	96.49±7.63*	15.820	<0.001
	Ultrasound (n=113)	115.26±11.03	87.52±6.05*	23.430	<0.001
	t	0.838	9.267		
	P	0.403	<0.001		
TT (s)	Conventional (n=87)	13.47±1.88	14.99±2.53*	4.505	<0.001
	Ultrasound (n=113)	13.12±1.96	16.12±2.84*	9.264	<0.001
	t	1.278	2.923		
	P	0.203	0.004		
PT (s)	Conventional (n=87)	10.33±2.04	11.25±1.86*	3.090	0.002
	Ultrasound (n=113)	10.27±1.41	12.50±1.86*	10.150	<0.001
	t	0.250	4.732		
	P	0.803	<0.001		
APTT (s)	Conventional (n=87)	21.31±3.06	24.13±2.92*	6.194	<0.001
	Ultrasound (n=113)	21.23±3.31	25.74±2.91*	10.880	<0.001
	t	0.177	3.885		
	P	0.860	<0.001		

Note: *vs.* before analgesia *P<0.05.

Table 5: The adverse reactions of the two groups were compared

Groups	Nausea and vomiting	Hypotension	Respiratory depression	Nerve damage	Urinary retention	Overall incidence
Conventional (n=87)	3 (3.45)	3 (3.45)	1 (1.15)	1 (1.15)	1 (1.15)	10.34
Ultrasound (n=113)	1 (0.88)	1 (0.88)	1 (0.88)	0 (0.00)	0 (0.00)	2.65
χ^2						5.154
P						0.023

Note: *Hypotension*: SBP less than 90 mmHg or a decrease of more than 20% from baseline. *Respiratory depression*: Respiratory rate less than 8 breaths/minute or SpO_2 less than 90%. *Nerve damage*: Postoperative paresthesia (numbness, tingling), dyskinesia (decreased muscle strength), or pain consistent with the area innervated by the block, lasting longer than the intended duration of block (e.g., >24 hours), and confirmed by neuroelectrophysiological examination or clinical evaluation. *Urinary retention*: After the operation, the bladder was filled but the patient could not urinate by himself, and catheterization was needed.

On the other hand, previous research has indicated that surgical patients will experience a certain degree of stress response during surgery and under anesthesia, which is closely related to the redox imbalance in patients (El-Hussuna *et al.,* 2025). In this study, the ultrasound group showed lower E and Cor levels than the conventional group, suggesting a milder stress response. This might be attributed to the combined use of ultrasound and NS, which can observe the depth and angle of needle insertion in real-time to enable more accurate and efficient positioning and allow for the observation of the surrounding nerve structures and the diffusion of anesthetic drugs, making it possible to adjust the needle tip position and dose in a timely manner and avoid overdosing, thereby reducing nerve damage and alleviating stress-induced injury. Meanwhile, FOC patients develop stress reactions during the operation due to anesthesia, pain and surgical trauma, which in turn activate the internal and external coagulation systems and promote the body to be in a hypercoagulable state. Clinical research has shown that fracture patients are often accompanied by vascular endothelial injury, which, combined with decreased activity, leads to a decrease in blood flow velocity, resulting in an increased risk of thrombosis when the blood is in a hypercoagulable state. Once the thrombus detaches, it may lead to pulmonary embolism, endangering the patient's life (de Jong *et al.*, 2024). Therefore, for fracture patients, clinicians should pay greater attention to the patient's coagulation status during the perioperative period to ensure postoperative rehabilitation (Breitling & Kretzschmar, 2022). The results showed that the levels of TT, PT and APTT in the ultrasound group were higher compared with the conventional group, suggesting that ropivacaine SNB guided by ultrasound combined with an NS can ameliorate hypercoagulability more effectively. This is attributed to the fact that ropivacaine SNB guided by ultrasound combined with an NS can successfully block the sympathetic nerve at the FOC site, effectively dilate the blood vessels at the fracture site and increase the blood flow velocity. The above results confirm that ropivacaine SNB guided by ultrasound, combined with an NS, can more effectively reduce stress responses and promote blood circulation. However, it is important to emphasize that these measurements were performed over a relatively short time window. This short-term change may reflect a potential modulatory effect of nerve block, especially successful sympathetic block, on local vascular tone, blood flow velocity and early coagulation/fibrinolytic system activity.

Finally, in the comparison of safety, we identified a lower incidence of adverse reactions in the ultrasound group, suggesting higher anesthesia safety of the protocol used in the ultrasound group. The reason is that ultrasound-guided nerve block can promote the diffusion of anesthetic drugs, block central nerve conduction and alleviate intraoperative stress responses, thereby maximizing the stability of hemodynamics and achieving higher anesthesia safety. At the same time, by using ultrasound guidance combined with an NS, not only can the needle tip position be observed in real-time during the positioning process to avoid damaging blood vessels and nerve fibers (Zhang *et al.*, 2023), but the needle tip position can also be dynamically adjusted during the injection of anesthetic drugs, achieving the effect of anesthetic drugs surrounding the target nerve and avoiding the impact of anesthesia drug injection deviation on the blocking effect (Chen *et al.*, 2022). All these advantages are beneficial for further improving the effectiveness and safety of postoperative analgesia for FOC in future clinical practice.

However, the feasibility of the application of ultrasound combined with NS guidance in postoperative analgesia after FOC still needs to be considered, especially in primary hospitals. The application of this technique requires an ultrasound device and a neurostimulator, which involves initial equipment acquisition and maintenance costs. The successful implementation of this technique requires special training in the use of ultrasound-guided nerve block and neurostimulator and there is a certain learning curve. Compared with NS alone, the operation of combined guidance may be a little time-consuming, especially in the early stage. Future studies should evaluate the cost-effectiveness ratio of this technique and develop standardized training curricula to shorten the learning curve.

Although the analgesic effect, vital sign stability, stress response and coagulation parameters in the ultrasound combined with NS guidance group were observed to be better than those in the conventional NS guidance group in this study, it needs to be recognized that the improvement in these results may be the result of multiple factors. Firstly, operator skill and experience play a key role in the success and efficacy of nerve blocks. The procedures were performed by experienced anesthesiologists, which provides some assurance of the quality of the technique, but it also limits the generalizability of the results to less experienced operators. Second, the patient's individual anatomical variations (e.g., depth of nerve location, tissue hierarchy) may also affect the efficacy of block and drug diffusion. Although there were no significant differences in baseline data such as age, gender and fracture type between the two groups, there may still be unmeasured confounding factors (such as comorbidities, intraoperative blood loss and operation time) that affect the results of stress and coagulation indexes. This is also an important limitation that is unavoidable in retrospective analyses. Therefore, it is necessary to expand the sample size and extend the study period to further improve the comprehensiveness of the results. At the same time, the dosage of anesthetic drugs is also the focus of attention. In the future, we still need to compare the application effects of anesthetics of different concentrations to provide more reliable references and

guidance for clinical practice. Finally, although testing of the primary endpoint was prespecified, other comparisons (e.g., secondary endpoints, comparisons across time points) are exploratory. We did not make statistical adjustments for multiple comparisons (e.g., Bonferroni correction). Therefore, statistical differences ($P<0.05$) found in secondary outcomes and subgroup analyses should be interpreted with caution, with an increased risk of type I error (false positives). It is also important to acknowledge that this study did not utilize validated multidimensional pain assessment tools beyond the VAS and the anesthetic effect grading. Future research should incorporate established instruments such as the McGill Pain Questionnaire or behavioral pain scales to provide a more comprehensive evaluation of the analgesic experience.

CONCLUSION

Ropivacaine SNB guided by ultrasound combined with a NS has good anesthetic and analgesic effects. It can inhibit the stress response after FOC surgery and help restore early hemodynamics, improve the stability of patients' vital signs and enhance analgesic safety to provide a more reliable guarantee for patients' rehabilitation. However, given the retrospective nature of this study and the aforementioned limitations, the conclusions need to be further validated in prospective, randomized controlled trials before they can be more widely recommended in clinical practice.

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Authors' contributions
Zhijun Sun designed the study, Xi Zhou wrote and revised the manuscript, Kena Yang collected and analyzed data, Shanshan Ye visualized the data and all the authors read and approved the final submitted manuscript.

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Data availability statement
The data used to support the findings of this study are available from the corresponding author upon request.

Ethical approval
This study has been approved by the ethics committee of Yuyao Hospital of Traditional Chinese Medicine (NO.2024-022). Because it was a retrospective study, the requirement for informed consent from patients was waived. The study was conducted in strict accordance with the principles of the Declaration of Helsinki and all patient data were anonymized.

Conflicts of interest
The authors report no conflict of interest.

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