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Clinical Efficacy Study of Transtarsal Approach Combined with Heparin Sodium and Furosemide in Patients with Calcaneal Fracture

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Abstract: *Objective*: To investigate the therapeutic effect of trans-tarsal sinus approach surgery combined with dalteparin sodium and furosemide in the treatment of heel bone fracture. *Methods*: A hundred patients with heel bone fracture who were hospitalized from August 2023 to January 2025 were selected and randomly divided into two groups of 50 cases each. The control group was operated by purely trans-tarsal sinus approach, and the observation group added dalteparin sodium and furosemide on this basis. Postoperative limb swelling, pain, coagulation and inflammation indexes, fracture healing time, foot function and complications were compared between the two groups. *Results*: In the observation group, postoperative limb swelling subsided faster, pain score was lower, coagulation and inflammation indexes improved more significantly, fracture healing time was shorter, foot function recovery was better, and complication rate was lower, $P < 0.05$. *Conclusion*: The treatment of heel fracture by trans-tarsal sinus approach combined with sodium heparin and furosemide can significantly accelerate the patient's recovery and reduce the occurrence of complications, which has high clinical application value.

Keywords: Heel fracture; Tarsal sinus approach surgery; Dalteparin sodium; Furosemide

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1. Introduction

Fractures of the heel bone are very common among the types of tarsal fractures, and most of them are triggered by high-energy traumas such as falls from heights and traffic accidents [1, 2]. This type of fracture not only destroys the anatomical structure of the heel bone, but also has a serious impact on the function of the foot, which in turn reduces the quality of life of the patient [3]. For example, when falling from a high place, the gravity of the body is concentrated on the heel bone, and the strong impact causes the heel bone to fracture, and the patient not only suffers from severe pain, but also may face problems such as difficulty in walking and deformity of the foot in the subsequent life [4, 5].

Although the traditional 'L' incision can better reveal the fracture end, which is conducive to fracture repositioning and fixation, there are complications such as incision infection and skin necrosis, which seriously affects the patient's recovery and brings a huge economic burden to the patient [6, 7].

In recent years, the trans-tarsal sinus approach has received much attention as a minimally invasive and rapid recovery procedure [8, 9]. This approach selects the natural suture of the tarsal sinus, which reduces damage to the surrounding soft tissues, decreases blood flow, and facilitates postoperative wound healing and fracture healing [10, 11]. Meanwhile, limb swelling and hypercoagulable state of blood after a heel fracture are prone to complications such as deep vein thrombosis, which is a serious threat to patients' health [12]. Dalteparin sodium, as a low molecular heparin, has an anticoagulant effect and can effectively prevent deep vein thrombosis [13, 14]; furosemide, as a diuretic, can reduce limb swelling and improve local blood circulation [15]. Based on this, this study aims to thoroughly investigate the clinical efficacy of the combination of dalteparin sodium and furosemide in the treatment of heel fracture via the tarsal sinus approach, with the expectation of providing a more optimal solution for the clinical treatment, and further improving the therapeutic efficacy and quality of life of patients with heel fracture.

2. Materials and methods

2.1. Case selection

One hundred patients with heel bone fracture who attended the Department of Orthopaedics of the hospital from August 2023 to January 2025 are selected.

2.1.1. Inclusion criteria

(1) All cases were diagnosed by X-ray or CT.

(2) New fractures within 2 weeks after injury were identified.

(3) Age over 18 years old.

(4) Patients were clear, able to actively cooperate with treatment and follow-up, and signed the informed consent form.

2.1.2. Exclusion criteria

(1) Combined with serious heart, liver, kidney and other organs damage.

(2) Allergic reaction to drugs such as heparin sodium and furosemide.

(3) Open fracture.

(4) Those who withdrew from the study in the middle.

The patients are randomly divided into two groups of 50 cases each. Comparison of the two groups of patients in terms of general information, $P > 0.05$, is comparable. The specific data are shown in **Table 1**.

Table 1. Comparison of general information of patients in two groups

Projects		Observation group (n=50)	Control subjects (n=50)	t/X^2	P
Sex/n	Men	32	30	0.170	0.680
	Woman	18	20		
Age/years		41.97 ± 8.26	41.87 ± 8.54	0.060	0.953
BMI(kg/m^2)		23.41 ± 3.57	24.12 ± 3.28	1.036	0.303

Table 1 (Continued)

Projects		Observation group (n=50)	Control subjects (n=50)	t/X^2	*P*
Type of fracture/n	intra-articular	38	34	0.794	0.373
	extra-articular	12	16		
Time from injury to surgery/d		5.18 ± 1.47	5.26 ± 1.38	0.281	0.780

2.2. Treatment method

In the control group, only the trans-tarsal sinus approach is performed. Postoperatively, the patient takes the lateral position, routine disinfection, spreading the towel, under the guidance of tourniquet, make a 4–5 cm oblique incision in the tarsal sinus, sequentially incise the skin and subcutaneous tissues, and pay attention to the protection of peroneal nerve and the lengthwise tendon of peroneal bone. The tarsal sinus is bluntly separated to expose the fracture end and remove all embedded haematoma and necrotic tissue. The fracture is repositioned under C-arm radiographs, and the anatomical structures of the heel bone, such as the Bohrer angle, the Gissan angle, and the width and height of the heel bone are reconstructed. After fixation, the wound is flushed with saline, a drain is placed, and the wound is closed layer by layer. Postoperatively, antibacterial drugs are generally applied to prevent infection, and the drainage tube is removed in 24–48 h, depending on the drainage situation.

The observation group is treated with dalteparin sodium and furosemide on the basis of the above surgery. The surgical method is the same as that of the control group, and dalteparin sodium is injected subcutaneously with 5000 IU/d at 6–12 hours after surgery for 7–10 days, during which the coagulation function is closely monitored. Furosemide is injected intravenously on the same day after surgery, with an initial dose of 20mg/d, and the dose is adjusted according to the swelling of limbs and urine output, generally used for 3–5 days. Meanwhile, electrolyte level is detected regularly, and electrolyte disorders are corrected in time.

2.3. Observation indicators

(1) Limb swelling and pain: Measure the circumference of the patient's ankle (10cm above the tips of the inner and outer ankles) on 1, 3 and 7 days after the operation to assess the degree of limb swelling; the degree of pain is assessed by visual analogue scoring (VAS).

(2) Changes in coagulation function and inflammatory indexes: Fasting venous blood is collected before surgery, 1 day after surgery, and 7 days after surgery, and PT, APTT, and FIB are detected by automatic coagulation analyzer; CRP and IL-6 are detected by ELISA.

(3) Fracture healing and recovery of foot function: routine postoperative X-ray review is performed to record the time of fracture healing (from the preoperative period to the time when the fracture line was blurred and there was a continuous bone scab passing through). The foot function of the patients is evaluated by applying the ankle posterior foot scoring system of the American Academy of Foot and Ankle Surgery (AOFAS).

(4) Occurrence of complications: The occurrence of complications such as incision infection, deep vein thrombosis, skin necrosis, traumatic arthritis and so on are counted in the two groups after surgery.

2.4. Statistical methods

The data obtained are statistically analyzed with SPSS22.0 software. The count data are recorded as the number of

cases and percentage, and analyzed by the method of X^2 test. The measurement data are recorded as the mean and standard deviation, and analyzed by the method of t-test, and the difference existed at the statistical level when $P < 0.05$.

3. The results of the study

3.1. Swelling and pain of limbs

On 1 day after surgery, the circumference of the foot and ankle and the VAS score of the two groups were compared, $P > 0.05$. On 3 and 7 days after surgery, the circumference of the foot and ankle of the observation group was smaller than that of the control group, and the VAS score was lower than that of the control group, $P < 0.05$, and the detailed data are shown in **Table 2**.

Table 2. Comparison of limb swelling and pain between the two groups ($\bar{x} \pm s$)

Norm	Time	Observation group (n=50)	Control subjects (n=50)	*t*	*P*
ankle circumference(cm)	1 day after surgery	28.76 ± 1.54	28.47 ± 1.85	0.852	0.396
	3 days after surgery	26.17 ± 1.49*	27.69 ± 1.53*	5.033	0.000
	7 days after surgery	24.16 ± 1.75*#	15.94 ± 1.42*#	5.585	0.000
VAS(cent)	1 day after surgery	7.26 ± 1.03	7.15 ± 1.14	0.506	0.614
	3 days after surgery	5.46 ± 0.77*	6.34 ± 0.93*	5.154	0.000
	7 days after surgery	3.18 ± 0.64*#	4.29 ± 0.71*#	8.211	0.000

Note: *$P < 0.05$ compared with 1 day postoperatively, #$P < 0.05$ compared with 3 days postoperatively.

3.2. Changes in coagulation function and inflammation indexes

Preoperatively, the coagulation function and inflammation indexes of the two groups were compared with each other, $P > 0.05$. On postoperative day 1, PT and APTT were shortened, and the levels of FIB, CRP, and IL-6 were elevated in the two groups, with $P < 0.05$ in intragroup comparison, but $P > 0.05$ in intergroup comparison. On postoperative day 7, PT and APTT were lengthened in the observation group compared to the control group, and the levels of FIB, CRP, and IL-6 were reduced in the observation group compared to the control group, with $P < 0.05$ in intragroup comparison, and $P > 0.05$ in intergroup comparison. $P < 0.05$, the specific data are shown in **Table 3**.

Table 3. Comparison of changes in coagulation function and inflammatory indexes between the two groups (x±s)

Groups	Time	PT (s)	APTT (s)	FIB (g/L)	CRP (mg/L)	IL-6 (pg/mL)
Observation group(n=50)	preoperative	12.48 ± 1.24△	35.46 ± 317△	2.83 ± 0.57△	5.26 ± 1.24△	15.49 ± 3.17△
	1 day after surgery	10.76 ± 0.85*△	30.17 ± 2.64*△	3.51 ± 0.64*△	18.56 ± 3.54*△	35.87 ± 5.13*△
	7 day after surgery	13.27 ± 1.19*#△	38.49 ± 3.56*#△	3.06 ± 0.43*#△	9.47 ± 2.13*#△	20.41 ± 4.15*#△
Control subjects (n=50)	preoperative	12.37 ± 1.21	35.57 ± 3.24	2.74 ± 0.51	5.14 ± 1.31	15.87 ± 3.16
	1 day after surgery	10.54 ± 0.97*	30.14 ± 2.76*	3.67 ± 0.54*	19.15 ± 3.74*	35.67 ± 5.41*
	7 day after surgery	12.11 ± 1.07*#	33.12 ± 3.06*#	3.38 ± 0.56*#	13.46 ± 2.57*#	28.47 ± 5.61*#

Note: Compared with 1 day postoperatively, *$P < 0.05$; compared with 3 days postoperatively, #$P < 0.05$; compared with the control group, preoperatively and 1 day postoperatively, △$P > 0.05$, and 7 days postoperatively, △$P < 0.05$.

3.3. Fracture healing and foot function recovery

The fracture healing time of the observation group was shorter than that of the control group, $P < 0.05$. Six months after the operation, the excellent rate of AOFAS score of the observation group was higher than that of the control group, $P < 0.05$, and the data statistics are shown in **Table 4**.

Table 4. Comparison of fracture healing and foot function recovery between the two groups of patients

Groups	*n*	Fracture healing time (weeks)	Number of cases with good AOFAS scores (cases)	AOFAS score excellence (%)
Observation group	50	10.24 ± 1.57	44	88.00
Control subjects	50	12.46 ± 2.07	34	68.00
t/X^2		6.042	5.828	11.655
P		0.000	0.016	0.001

3.4. Incidence of complications

The incidence of postoperative complications in the observation group was lower than that in the control group, $P < 0.05$. The specific distribution is shown in **Table 5**.

Table 5. Comparison of the occurrence of complications between the two groups [cases (%)]

Groups	n	Cutaneous infection	Deep vein thrombosis	Skin necrosis	Traumatic arthritis	Total incidence
Observation group	50	1(2.00)	1(2.00)	1(2.00)	2(4.00)	5(10.00)
Control subjects	50	3(6.00)	5(10.00)	2(4.00)	4(8.00)	14(28.00)
t						5.263
P						0.022

4. Discussion

The results of this study clearly show that the observation group, after being treated with trans-tarsal sinus approach surgery combined with dalteparin sodium and furosemide, demonstrated significant advantages in a number of key indicators compared with the control group who underwent trans-tarsal sinus approach surgery alone. In terms of postoperative limb swelling reduction, the circumference of the foot and ankle in the observation group was significantly smaller than that in the control group at 3 and 7 days postoperatively, suggesting that the combined treatment could reduce swelling more rapidly and effectively. In terms of pain relief, the VAS scores of the observation group were significantly lower than those of the control group at 3 and 7 days postoperatively, and the patients' pain perception was significantly reduced. In terms of coagulation function improvement, PT and APTT in the observation group were prolonged compared with the control group at 7 days postoperatively, and FIB level was reduced, which lowered the risk of deep vein thrombosis. In terms of inhibition of inflammatory response, CRP and IL-6 were lower in the patients in the treatment group compared with the control group 7 days after surgery, and the inflammatory response was better controlled. Compared with the control group, the observation group was significantly shorter, the excellent rate of foot function recovery was significantly higher than that of the control group, and there were fewer postoperative complications, which fully demonstrated the efficacy and safety of the therapy.

Trans-tarsal sinus approach surgery uses the natural gap of the tarsal sinus to enter, which greatly reduces the damage to the surrounding soft tissues and blood flow, and lays a good foundation for postoperative incision healing and fracture healing [16, 17]. Dalteparin sodium can achieve anticoagulation effect by increasing the inhibition of coagulation factors Xa and IIa by AT-III, thus effectively preventing DVT and improving the coagulation ability of patients [18]. Furosemide may promote water and salt excretion by blocking Na+ reabsorption in renal tubular epithelial cells, reducing lower limb oedema, improving local blood circulation, and accelerating fracture healing [19, 20].

In addition, combined treatment may create favourable conditions for fracture healing by improving local microcirculation and inhibiting the inflammatory response. Inflammatory response plays an important role in the process of fracture healing, and excessive inflammatory response can hinder the fracture healing process. In this study, the postoperative inflammation index of the observation group was lower than that of the control group, which strongly implies that the combined method is an effective anti-inflammatory and accelerated fracture healing method.

However, this study has some limitations. The small sample size may not be able to comprehensively cover the effects of different individual differences on the treatment effect. The short follow-up period makes it difficult to conduct in-depth observation of long-term efficacy and long-term complications. In the future, it is necessary to expand the sample size and conduct a multicentre, long-term follow-up study, so as to comprehensively and accurately assess the efficacy and safety of the combined treatment regimen.

5. Conclusion

The ankle sinus approach in patients with heel fracture, combined with sodium heparin, furosemide and other medications, can significantly relieve patients' lower limb swelling, pain, coagulation and inflammatory reaction, accelerate fracture healing, improve the excellent rate of patients' foot function recovery, and reduce the number of complications, which is a safe and effective treatment method with important clinical value.

Disclosure statement

The authors declare no conflict of interest.

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