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Original Article

Arthroscopic-assisted reduction plus internal fixation and traditional open reduction plus internal fixation for talus fractures: a comparative study

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Abstract: Objective: To explore the efficacy of arthroscopic-assisted reduction and internal fixation (ARIF) and traditional open reduction and internal fixation in the treatment of talus fractures. Methods: This study retrospectively analyzed the clinical data of 92 patients with talus fractures admitted to our hospital. The patients were divided into a control group (treated with traditional open reduction and internal fixation) and a research group (with ARIF) with 46 cases in each. The operation indices, the score of the American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Scoring System (AOFAS-AH), callus growth score, pain score, treatment effect, complications and quality of life score were compared between the two groups. Results: The research group showed shorter time of fracture healing, hospitalization and less intraoperative blood loss than the control group (all P<0.001). The ankle-hindfoot score in the research group was higher than those in the control group 3 and 6 months after surgery (both P<0.001). The excellent and good rate of treatment in the research group (93.48%) was higher than that in the control group (78.26%; P<0.05). Compared with the control group, the VAS score was lower and the callus growth score was higher in the research group at 1st, 3rd and 6th month after surgery (all P<0.01). The incidence of complications in the research group (2.17%) was lower than that in the control group (13.04%; P<0.05). Six months after surgery, the SF-36 score increased compared with that before surgery, with higher parameters in the research group than in the control group (P<0.001). Conclusion: ARIF is more effective than traditional open reduction and internal fixation in treating talus fractures, with less complications and higher safety.

Keywords: Arthroscopy, reduction and internal fixation of talus fractures, traditional open reduction and internal fixation, talus fractures

Introduction

Talus fractures are mostly traumatic types caused by high energy, such as falling from a high place and traffic accidents. Patients are often accompanied by peripheral soft tissue injuries of varying degrees and multiple systemic trauma, which have a great impact on their daily work and life [1, 2]. In addition, the talus has a special structure and poor blood circulation, and is located in the ankle point with abundant ligament structures surrounding it, all of which leads to the difficulty of surgical exposure, reduction and fixation [3, 4]. Recently, with the increasing number of high-altitude work and traffic accidents, the incidence of talus fracture continues to increase, which has become a serious threat to people's health and life. So, safe and effective intervention for patients with talus fractures is a good treatment option. Surgery is an important measure for the current clinical treatment of talus fractures. Traditional open reduction and internal fixation are applied earlier and mature, but they

are so traumatic that may further damage the blood supply and cause ischemic necrosis of the talus, which is not conducive to functional rehabilitation [5]. As a result, there are limitations in its clinical application, and it is gradually difficult to meet the actual clinical needs. With the popularization of minimally invasive concept and the improvement of medical technology, arthroscopic-assisted reduction and internal fixation (ARIF) of talus fractures have been popularized and applied, which can reduce trauma, ensure exposure range and is simple to operate [6]. However, the current clinical research on ARIF mainly focuses on complications and functional rehabilitation, but rarely on callus growth. Based on this, clinical data of 92 patients with talus fractures were analyzed to evaluate the application effect of ARIF and traditional open reduction and internal fixation, as well as their influence on callus growth and quality of life of patients. This study found that arthroscope-assisted reduction and internal fixation is effective in the treatment of talus fracture. The focus of the study is on the patients with talus fracture. The SF-36 scale found that the treatment has a good effect on the quality of life of the patients, which are the novelties of this study. Compared with previous studies, the range of subjects is smaller, which provides a basis for determining the treatment range of arthroscopy-assisted reduction and internal fixation.

Materials and methods

General information

This study retrospectively analyzed the clinical data of 92 patients with talus fractures admitted to our hospital from October 2018 to June 2020. The patients were divided into a control group (treated with traditional open reduction and internal fixation) and a research group (with ARIF) with 46 cases in each. This study has been approved by the Ethics Committee of our hospital, and all patients signed an informed consent form.

Selection criteria

Inclusion criteria: (1) Patients who met the diagnostic criteria of talus fracture in *Surgery*, and confirmed by CT and X-ray [7]. (2) Patients with an age of 18-60 years old; (3) Patients with unilateral fracture; (4) Patients with good compliance and could cooperate with the investigation and study. (5) Patients who did not receive any other related treatment before being included in the study.

Exclusion criteria: (1) Patients with other fractures; (2) Patients with severe bone defects at the fracture site; (3) Patients with abdominal organ injuries and/or serious spinal injuries; (4) Patients with a large number of broken bones at the fracture end; (5) Patients with severe soft tissue swelling and the presence of soft tissue vesicles or blisters at the fracture end, which is difficult to perform arthroscopy; (6) Patients with speech communication disorder, hearing disorder, cognitive dysfunction or nervous system diseases.

Methods

Control group: The control group underwent traditional open reduction and internal fixation. The patient lay on his back on the operating table and was given conventional disinfection and draping. Local wound debridement was performed after he was anesthetized completely under epidural anesthesia. The fourth metatarsal base and the trans-tarsal sinus were selected as the surgical incision sites. When cutting and separating nerves, ligaments and muscle tissues, attention was paid not to damage the dorsal median cutaneous nerve of the foot, and gradually expose the fracture end to the visual field. Then, a 3.0 mm Kirschner wire (Shenzhen Keruixin Precision Pipe Industry Co., Ltd.) was used for reduction and fixation, and the drill sleeve protector (Shenzhen New Concept Medical Technology Co., Ltd., China) was placed through the incision at the middle point between the lateral malleolus and the Achilles tendon. Under the track of C-arm X-ray machine (Shanghai Taiyi Medical Apparatus Equipment Co., Ltd., China), two cannulated screws (Shenzhen New Concept Medical Technology Co., Ltd., China) were driven from the calcaneus. The incision was closed after successful reduction.

Research group: The research group was treated with ARIF of talus fractures. First of all, three-dimensional reconstruction, CT plain scan and frontal and lateral X-ray films were performed to determine the condition of talus fractures. For patients with talus neck fracture, the swing position was taken, the affected

trunk was raised about 30°, and the small broken bones and blood clots were removed by arthroscopy (Shenzhen New Concept Medical Technology Co., Ltd., China). The fracture end of talus neck could be seen in patients with Hawkins-Canale type I-II. Because of no serious displacement, the ankle joint was slightly extended back, the midfoot was pushed back to complete the reduction, and Kirschner wires were placed from anterior to posterior for fixation. In the semi-prone position, the posterior internal and external channels were established horizontally on both sides of the Achilles tendon, and the arthroscope was inserted through the posterior external channel. Thereafter, an exchange rod (Hebei Maigu Medical Equipment Co., Ltd., China) was inserted through the posterior internal channel to peel off the soft tissue at the top of arthroscopy, and a plane knife (Hebei Maigu Medical Equipment Co., Ltd., China) was inserted inside to clear the soft tissue behind the joint capsule to expose the tendon of the flexor pollicis longus and the posterior external tubercle of the talus. Finally, 2 Kirschner wires were placed parallel to the second metatarsal bone. For type III patients, the body of talus was protruded from the ankle point when the arthroscopy was placed, and was reset to the ankle point to remove the fiber bundles that affect the reduction. Then, from the lateral side of the Achilles tendon to the anterior part of the body of talus, a Kirschner wire was placed from the anterior external channel to pry the fractured head, and the ankle joint was extended back to complete the reduction of the body of talus. In such way, it was converted to type I-II, and the rest operations were the same as before. For talar body fracture: for Sneppen II patients, arthroscopy was placed into the patient in swing position through anterolateral and anterolateral approaches to remove blood clots and broken bones. The fracture was reduced and fixed by Kirschner wires. The feet were flexed by metatarsals, the neck fracture was pulled and reduced, and fixed by Kirschner wires. Next, in the lateral prone position, the posterior approach was established, Kirschner wires were placed from the rear to the front, and cannulated screws were placed vertically toward the body and talus. As for fixation, annulated screws were applied for the body part and titanium cannulated screws were used for the longitudinal axis of the talus. For patients with type IV-V, lateral double channel or posterior double channel was used for reduction and fixation based on fracture characteristics. All patients were prepared by Gypsum (Hebei Maigu Medical Equipment Co., Ltd., China) and routinely given ceftazidime (Shanghai New Asiatic Pharmaceutical Co., Ltd., China) for anti-infection.

Outcome measures

Statistics were made on the general data of both groups, including age, gender, cause of injury, affected side and type of fracture.

Main outcome measures: General information of patients, including the time of operation, the amount of blood loss during operation, the time of fracture healing and hospitalization. The ankle function (the American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Scoring System (AOFAS-AH)) of the two groups before surgery, 3 months and 6 months after surgery were compared. The scoring system includes alignment (15 points), function (45 points) and pain (40 points); The higher the score, the better the ankle function. In view of the score of Ankle-hindfoot Scoring System, the treatment effect was evaluated, with 90-100 points as excellent, 75-89 as good, 50-74 as fair, and less than 50 as poor. Excellent and good rate = (excellent + good + fair) cases/total cases *100% [8].

Secondary outcome measures: Pain degree and postoperative callus growth scores of the two groups before and 1 month, 3 months and 6 months after surgery were compared. The pain degree was evaluated according to Visual Analogue Scale (VAS) scale with 10 points in total. The higher the score, the stronger the pain. The growth of callus was evaluated by Li's standard and X-ray examination: 0 point: The edge of the broken end was sharp and neat, without callus; 1 point: The edge of the callus was blurred, the amount of callus was less, and the edge of the broken end tended to be blurred; 2 points: The edge of the callus was irregular, the amount of callus was slightly more, and the edge of the broken end was obviously blurred; 3 points: The edge of the callus was clear, the amount of callus was more but not filled, and the edge of the broken end almost disappeared; 4 points: The edge of the callus was connected with the cortex, the defect of the callus was filled, and the edge of

Table 1. Comparison of general data between the two groups (n%; $\bar{x}$±sd)

Index	Research Group (n = 46)	Control Group (n = 46)	t/χ^2	P
Gender (male/female)	32/14	35/11	0.494	0.482
Age (years)	38.9±7.9	40.0±8.2	0.655	0.514
Causes of injury (cases)				
Traffic accident	11 (23.91)	14 (30.43)	0.494	0.482
Heavy injury	14 (30.43)	13 (28.26)	0.052	0.819
Fall from height	19 (41.30)	15 (32.61)	0.747	0.388
Other	2 (4.35)	4 (8.70)	0.713	0.398
Affected side (cases)			0.747	0.388
Left	15 (32.61)	19 (41.30)		
Right	31 (67.39)	27 (58.70)		
Fracture types (cases)			0.415	0.519
Talar neck fracture	27 (58.70)	30 (65.22)		
Fracture of talus body	19 (41.30)	16 (34.78)		
BMI (kg/m^2)	23.48±2.76	24.17±2.66	1.221	0.225
Time from fracture to operation (h)	2.51±1.09	2.38±1.23	0.536	0.593

Note: BMI, Body mass index.

Table 2. Comparison of operation conditions between the two groups ($\bar{x}$±sd)

Group	Research Group	Control Group	t	P
Number of cases	46	46		
Operation time (min)	94.64±16.28	89.95±20.33	1.221	0.225
Intraoperative blood loss (mL)	56.18±10.78	89.20±13.64	12.882	<0.001
Length of stay (d)	3.69±0.95	8.10±2.63	10.696	<0.001
Fracture healing time (months)	3.21±1.01	4.23±0.98	4.916	<0.001

the broken end disappeared [9]. The incidence of complications = the number of complications/the total number of cases *100%, was compared between the two groups. The quality of life of patients before and after surgery was evaluated according to the Short-Form 36 Item Health Survey (SF-36) scale, which covers the domains of social functioning, vitality, general health and role-emotional with 100 points in total. The higher the score, the better the quality of life.

Statistical methods

The data were analyzed by SPSS 22.0, and the measurement data were expressed as ($\bar{x}$±sd). The indices at different time points within the group were compared by repeated measure ANOVA followed with least significant difference test. Independent sample t test was performed for comparison between the two groups, and paired t test was performed for intra-group comparison before and after intervention. The counting data were recorded as n (%) and analyzed by the χ^2 test. The difference was statistically significant when P<0.05.

Results

General information

There was no marked difference in gender, age, cause of injury, affected side, type of fracture, BMI and time from fracture to operation between the study group and the control group (all P>0.05; **Table 1**).

Operation conditions

There was no significant difference in operation time between the research group and the control group (P>0.05). Whereas, the time of fracture healing and hospitalization was shorter, and intraoperative blood loss was less in the research group than in the control group (all P<0.001; **Table 2**).

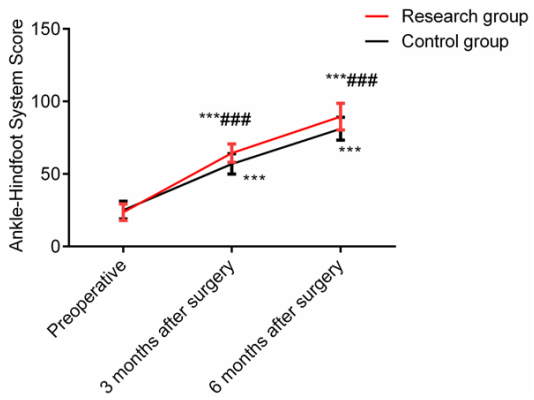

Figure 1. Comparison of ankle hindfoot scoring system between the two groups. Compared with before operation, ***P<0.001; compared with control group, ###P<0.001.

Ankle-hindfoot scoring system

There was no obvious difference between the two groups in ankle-hindfoot scoring system before surgery (P>0.05); However, 3 months and 6 months after surgery, the scores of ankle-hindfoot scoring system increased (P< 0.001), with more significant increase in the research group than in the control group (P<0.001) (**Figure 1**).

Efficacy

The excellent and good rate of treatment in the research group (93.48%) was higher than that in the control group (78.26%; P<0.05; **Table 3**).

VAS and callus growth scores

Neither VAS scores nor callus growth scores showed significant difference between the two groups before surgery (P>0.05). In both groups, the VAS scores at 1st, 3rd and 6th month after surgery were lower than those before surgery, and callus growth scores at 3 and 6 months after surgery were higher than those at 1st month after surgery (all P<0.001); Compared with the control group, the VAS scores were lower and callus growth scores were higher in the research group at 1st, 3rd and 6th months after surgery (all P<0.01; **Figure 2**).

Incidence of complications

The incidence of complications in the research group (2.17%) was lower than that in the control group (13.04%; P<0.05; **Table 4**).

SF-36 score

The SF-36 score manifested no remarkable difference between the two groups before surgery (P>0.05), but increased at 6th month after surgery, with a higher score in the research group than in the control group (P<0.001; **Table 5**).

Discussion

Talus fracture is a fracture type caused by high energy. Due to the special structure of talus, it is easy to develop osteonecrosis, joint stiffness and traumatic arthritis following fractures [9-11]. In clinical practice, open reduction and internal fixation are often used to treat talus fractures, but the operation is so much traumatic so that it is easy to damage the residual nourishing vessels during reduction and fixation [12, 13]. With the continuous development and improvement of minimally invasive surgery, arthroscopic assisted surgery has been popularized and applied, which can reduce surgical trauma, provide a clear surgical field for the operator and ensure the effectiveness and safety of treatment [14, 15]. Kong et al. has shown that compared with patients in the control group who received traditional open reduction and internal fixation (66.67%), the total effective rate of patients in the observation group who underwent arthroscopic-assisted countersunk nail internal fixation for talus fractures reached 91.67%, with higher scores of ankle-hindfoot scoring system and shorter time of fracture healing and hospitalization [16]. Guo et al. confirmed that ARIF for patients with talus fractures could improve ankle function, with a high safety profile [17]. Li et al. also found that arthroscope-assisted reduction and internal fixation in the treatment of talus body fracture could improve body function with less complications, less secondary trauma to ankle joint and quicker recovery after operation, which is beneficial to ensure the integrity of ankle joint structure [18]. However, the research of Guo et al. on ARIF is a single-group study, while ours was a comparative study on the application value of ARIF and traditional open reduction and internal fixation in talus fractures. In this study, shorter fracture healing time and hospitalization time, higher ankle-hindfoot score system scores and excellent and good rate of treatment, as well as lower VAS scores and incidence of complications were

Table 3. Comparison of treatment effect between the two groups (n (%))

Program	Research Group (n = 46)	Control Group (n = 46)	χ^2	P
Excellent	25 (54.35)	14 (30.43)		
Good	18 (39.13)	22 (47.83)		
Fair	3 (6.52)	9 (19.57)		
Poor	0 (0.00)	1 (2.17)		
Excellent and good rate	43 (93.48)	36 (78.26)	4.390	0.036

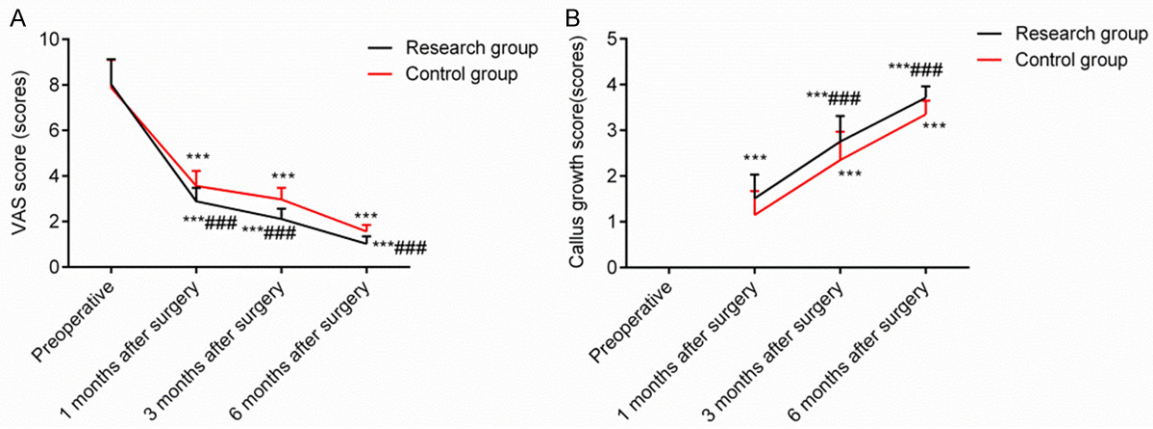

Figure 2. Comparison of VAS and callus growth scores between the two groups. A: VAS score; B: Callus growth score. Compared with before operation, ***P<0.001; compared with control group, ###P<0.001.

Table 4. Comparison of complications between the two groups (n (%))

Program	Research Group (n = 46)	Control Group (n = 46)	χ^2	P
Malunion	1 (2.17)	1 (2.17)		
Traumatic arthritis	0 (0.00)	1 (2.17)		
Nonunion of bone	0 (0.00)	1 (2.17)		
Infected	0 (0.00)	2 (4.35)		
Necrosis of talus	0 (0.00)	1 (2.17)		
Total incidence	1 (2.17)	6 (13.04)	3.866	0.049

Table 5. Comparison of SF-36 scores between the two groups ($\bar{x}$±sd, point)

Group	Research Group	Control Group	t	P
Numbers	46	46		
Before operation	51.32±9.67	53.35±10.22	0.979	0.330
6 months after operation	90.59±8.31	83.93±7.79	3.966	<0.001
t	20.889	16.140		
P	<0.001	<0.001		

determined in the research group as compared to the control group, which is consistent with the preceding studies. It indicates that ARIF is superior to traditional open reduction and internal fixation in the treatment of talus fractures, which can not only shorten postoperative rehabilitation time, reduce pain and promote joint function rehabilitation, but lower the risk of complications and ensure the safety of treatment. The main reasons are as follows through analysis: Arthroscopic assisted surgery can clarify the joint structure and perform related operations without making joint incision and lateral malleolus or medial malleolus osteoto-

my, and can clearly view the complete joint structure, which is beneficial to reduce the damage to normal tissues, thus maintaining the blood supply of talus and providing good conditions for the functional rehabilitation of the body [19]. Meanwhile, arthroscopic assisted surgery is less traumatic, and only a small incision is needed to implement the related treatment operations, which can effectively prevent the risk of complications such as infection from being increased by large-area skin incision, minimize the damage to the surrounding tissues, muscles, blood vessels and nerves of the fracture, retain the original tissues, and enhance the effect of postoperative rehabilitation [20, 21]. Callus growth is a vital factor affecting fracture healing and functional rehabilitation. This study found that the callus growth scores in the research group were better than that in the control group 1 month and 3 months after surgery, which further confirmed that ARIF has higher application value and is beneficial to early healing and functional rehabilitation of patients with talus fractures.

In addition, this study found that the SF-36 score in the research group was higher than that in the control group after surgery, suggesting that ARIF can improve the quality of life of patients with talus fractures more effectively. The main reason is that this surgery can reduce surgical trauma, and has a more significant effect on functional improvement, which is beneficial to early recovery of foot and ankle function of patients, facilitate their earlier return to normal work and life, and reduce the trouble caused by disease, thus allowing for a better quality of life.

However, there are still some limitations in this study. For example, due to the small sample size and short observation time, further studies are needed to confirm whether the research results have wide validity.

To sum up, ARIF is better than traditional open reduction and internal fixation in treating talus fractures, which can reduce surgical trauma, relieve pain, improve joint function and quality of life, with low complication rate and high safety profile.

Disclosure of conflict of interest

None.

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