MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2019; 25: 3463-3468
DOI: 10.12659/MSM.915693

Received: 2019.02.14
Accepted: 2019.04.18
Published: 2019.05.10

Therapeutic Efficacy Analysis of Talar Fracture Internal Fixation with Lateral Malleolar Osteotomy

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCD 1,2 Gang Liu*
CDEF 1 Jun Ge*
BC 2 Xiaohan Zheng
EF 1 Cenhao Wu
EF 1 Qi Yan
AG 1 Huilin Yang
ABG 1 Jun Zou

1 Department of Orthopaedic Surgery, The First Affiliated Hospital of Soochow University, Suzhou, Jiangsu, P.R. China
2 Department of Emergency, The Affiliated Hospital of Guizhou Medical University, Guiyang, Guiyang, P.R. China

* Gang Liu and Jun Ge contributed equally to this article

Corresponding Authors: Jun Zou, e-mail: jzou@suda.edu.cn, Huilin Yang, e-mail: hlyang@suda.edu.cn
Source of support: This work was supported by National Natural Science Foundation of China (81472132, 81572183, 81672220, and 91849114), Priority Academic Program Development of Jiangsu Higher Education Institutions (PAPD)

Background: There are many surgical treatment approaches for talar fractures. However, due to the unique anatomical and blood supply characteristics of the talus, the traditional approaches tend to lead to blood supply damage. In order to best preserve the blood supply of the talus, we proposed a surgical approach of internal fixation of the talar fracture with lateral malleolar osteotomy and analyzed its efficacy.

Material/Methods: Twenty-six patients with talar fractures underwent open reduction surgery between January 2010 and December 2016. Following the lateral malleolar osteotomy, the talus was fully exposed. After anatomical reduction, the talus was fixed with 2 screws, and the lateral malleolus was fixed with distending wires. The treatment effects were assessed in the follow-up.

Results: All patients were followed for 7 to 22 months, for an average of 14.34 months. According to the Maryland Foot Score, 19 cases were excellent (90–100 points), 4 cases were good (85–90 points), and 3 cases were moderate (50–74 points).

Conclusions: Internal fixation of talar fractures with lateral malleolar osteotomy is a viable surgical approach to reduce injury to blood supply and maximize surgical exposure.

MeSH Keywords: Abortion, Therapeutic • Ankle Fractures • Jaw Fixation Techniques • Osteotomy, Le Fort • Talus

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/915693

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Background

The talus is generally divided into 3 parts: the head, neck, and body. Greater than 60% of the surface of the talus is covered in articular cartilage. The talus is adjacent to joints on 3 sides. Although the talus has no muscle attachments, it articulates superiorly with the tibia (talocrural joint), inferiorly with the calcaneus (subtalar joint), and anteriorly with the navicular bone, forming the active center of the ankle joint. The blood supply to the talus originates from the peroneal, anterior tibial, and posterior tibial arteries, forming a triangular vasculature. Major vessels include the artery to the sinus tarsi from the peroneal and anterior tibial arteries, deltoid branch from the posterior tibial artery, artery of the tarsal canal from the posterior tibial artery, and artery of the tarsal canal [1].

Talar fractures comprise approximately 2% of all lower limb injuries and are usually associated with high-energy injuries. The main purpose of treatment is to restore normal subtalar complex movement and maintain talar function. However, blood supply damages are severe in talar fractures. Because of the abundance of articular cartilage on the talar surface, open reduction and fixation are difficult. As such, talar fractures are often associated with increased risks of complications such as avascular necrosis, traumatic arthritis, and fracture non-reunion. Therefore, after talar fractures, it is important to have the best possible anatomical reduction and strong fixation, and more importantly, to protect the blood supply to the talus [2].

There are many surgical treatment approaches for talar fractures. Traditionally, there are 3 surgical approaches: the anteromedial, anterolateral, and posterolateral approaches [3]. However, due to the unique anatomical and blood supply characteristics of the talus, the traditional approaches tend to lead to blood supply damage. In order to best preserve the blood supply of the talus, we proposed a surgical approach of internal fixation of the talar fracture with lateral malleolar osteotomy and analyzed its efficacy in 26 patients with talar fractures who underwent surgery between January 2010 and December 2016.

Material and Methods

General information

Between January 2010 and December 2016, we retrospectively analyzed 26 patients with talar fractures in the Department of Emergency Trauma Surgery in our hospital. Only closed lateral process fractures or comminuted lateral fractures of talus were included in the study (Figure 1). Cases with open fracture, infection, coagulation disorders, contraindication to surgical treatment, pathological fracture, or primary peritalar fusion were excluded. There were 18 males and 8 females with an average age of 37.81 years (range, 19–57 years). Among these patients, there were 14 cases of motor vehicle injuries, 10 cases of falls from heights, and 2 cases of heavy-object smash injuries. Among these cases, 7 cases were talar body fractures, 9 cases were Hawkins type II talus neck fractures, 6 cases were Hawkins type III talus neck fractures, and 4 cases were Hawkins type IV talus neck fractures. The patients were all healthy before the operation, without any chronic diseases or comorbidities. None of the patients had a history of smoking, or drug or alcohol abuse.

Methods

Informed consents were obtained from the patients and their relatives. All patients underwent emergent manual reduction after admission to eliminate joint dislocation. At least 1 week after the injury, delayed operations were offered to patients until the ankle swelling was completely relieved. The study was also approved by the ethics committee of The First Affiliated Hospital of Soochow University (approval number ECSUFH-2009-035). All patients underwent a lateral arc-incision approach. The incision was initiated from 2 cm above the lateral ankle, closely along the outer edge of the Achilles tendon, around the outer sac, and extending to the talus to reveal the external ridge. Preserving the anterior and posterior tibiofibular ligaments, as well as the talofibular ligament, the calcaneofibular ligament and deep fascia were divided and pulled to the 2 sides to expose the talus head, neck, and body. At the lateral ankle joint, lateral malleolar osteotomy was performed with an inverted V shape, and the talus body was revealed with distal retractions. After the ankle joint was inverted so that the talus was subluxated, the fracture was reduced under full visualization and temporarily fixed with 2 Kirschner wires. The ankle joint was flexed, relaxing the Achilles tendon and retracting it to the medial side, to reveal the posterior aspect of the talus. The needle entry point was selected in the bare area of the talus, or in other words, the area that was not covered behind the talus when maximally flexing the ankle joint. The talus was then fixed with 2 Kirschner wires from the back. The needles needed to be parallel to the sole and at an angle of 20–30° with the outer edge of the foot. After the accurate position was confirmed with imaging, the two 3.5-mm needles were fixed. Afterwards, the positioning needles were retracted, the talus was reduced, and the lateral malleolus was restored and internally fixed with distending wires. Finally, the incision was flushed, and the bleeding was ceased. After all layers were sutured back, a U-shaped plaster was casted for external fixation and used for 3 weeks. Postoperatively, all the patients were asked to ensure nonweight bearing approach for 3 months or until the fracture healed completely radiographically. Despite complications, the patients then took to using a weight-bearing approach without any special rehabilitation

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Figure 1. (**A, B**). Pre-operative x-ray of a patient's ankle. (**C, D**) Pre-operative CT scan of a patient's ankle.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 1. Maryland Score of the patients.

Maryland Score	Excellent (90–100)	Good (75–89)	Moderate (50–74)	Bad (<50)
Patients No.	19	4	3	0

Figure 2. (**A, B**) X-ray of a patient's ankle on the 3rd days after the operation. (**C, D**) X-ray of a patient's ankle 1 year after the operation.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

therapy or supportive tools. The level of reduction was determined by computed tomography scan.

Results

All 26 patients in this study underwent lateral malleolar osteotomy, as well as reduction and internal fixation under full visualization. The patients were followed for 7 to 22 months, for an average of 14.34 months. According to the Maryland Foot Score, at the last follow-up, 19 cases were excellent (90–100 points), wherein the reduction was good, and the anatomical reduction standard was fulfilled; 4 cases were good (85–90 points), wherein the reduction was poor with traumatic arthritis due to the severe smashing of the talar neck medial fracture; and 3 cases were moderate (50–74 points), wherein talar necrosis occurred and healed after ankle joint fusion (Table 1). In all patients, the lateral malleolar osteotomy site had healed, and no bone nonunion occurred. (Figure 2)

Discussion

After a talar fracture, there are many surgical treatment methods possible. There are 3 kinds of traditional surgical approaches: the anterior medial, anterolateral, and posterolateral approaches [3]. For talar fractures, a double incision is usually performed, including medial and lateral incisions [4]. The medial incision originates from the tip of the medial malleolus and extends to the scaphoid between the anterior and posterior tibial tendons, and the lateral incision starts from the lateral malleolus tip and extends to the middle of the wedge or base of the fourth metatarsal. The 2 incisions separately expose the medial and lateral sides of the talus head and neck. However, even with the double-incision approach, the talus body is not fully exposed in the case of forced foot flexion; intraoperative traction to extend the foot may further impair the blood supply to the talus, and the talus may not maintain stability after reduction with this type of traction.

In addition, the traditional approaches have their limitations. In the anterior medial approach, damages to the main blood supply to the talus are likely due to the anterior medial location of the triangle artery – the important branch that is the main blood supply to the talus. Therefore, osteotomy can be performed on the medial malleolus. First, the talus can be better displayed. Second, the damage to the triangle artery can be avoided. This approach has achieved a good effect. However, comminuted fractures often occur on the medial side, making it difficult to identify landmarks for anatomical reduction [5]. The anterior lateral approach is also likely to damage the sinus tarsi vessels.

The posterolateral approach inserts the screw from the posterior to anterior direction. The risk is lower compared to the former 2 approaches. However, the talus exposure is poor, leaving the talus neck and subtalar joint incompletely displayed. The risks of this approach mainly include screw penetration through the subtalar joint, which would compromise the talus joint and damage the radial artery and saphenous nerve [3]. Arterial and nerve damage is primarily related to the physician's understanding of the anatomical location, while the penetration of the subtalar joint is primarily due to poor talar exposure. We found that the lateral side of the lateral malleolus has only superficial veins and no other important arteries or nerves. Inspired by medial malleolar osteotomy, we wondered whether the talus could be further fully exposed through lateral malleolar osteotomy based on the posterolateral approach. Therefore, this group of patients underwent the lateral approach with lateral malleolar osteotomy to reveal the surgical field, a new approach for which the efficacy has not yet been reported.

Twenty-six patients were followed for 7–22 months, for an average of 14.34 months. Among them, 19 patients achieved the standard of anatomical reduction, corresponding to a cure rate of 73.08%. Considering the vulnerable blood supply and the resultant complications, surgeons in the 1970s would treat displaced talus fractures with an emergency operation [6]. However, since 2004, several studies, including the Vallier et al. study, have suggested that there was no association between osteonecrosis and delayed surgery, as long as the talus dislocation was given an emergent reduction, and the incidence of osteonecrosis was only associated with the degree of scapular neck complication and open fracture [7]. According to Grear et al., delaying fixation might be superior theoretically, largely due to more time for soft tissue recovery and surgical planning enhancement [6]. We offered delay operation for our study patients. In our current study, although there were 4 patients with traumatic arthritis (15.38%) and 3 patients with talus necrosis (11.53%), the incidence was much lower than that with traditional approaches, which may be because we performed early manual reduction and delayed operation for the patients. In addition, Maryland Ankle Score indicated that the reconstruction of ankle function by this approach was satisfactory.

Actually, some of the complications might be inevitable, because the blood supply may be disrupted from injury itself, not necessarily the surgical technique. Several studies have demonstrated a positive relationship between the incidence of osteonecrosis after talar fractures and the severity of the fracture, instead of surgery timing [6,7]. About 80% of Hawkins grade III or IV fractures can lead to osteonecrosis. However, surgeons should choose an optimal surgical approach to protect the blood supply as much as possible or avoid the further destroy.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Since the lateral malleolus tip is about 1 cm lower than the medial malleolus tip, the talus can be blocked from being easily detached when the ankle joint is inverted. The advantage of our incision approach is that it removes the barrier of the lateral malleolus, and better exposes the talar varus. This way, it is easier to identify anatomical landmarks, to reduce, and to fix. More importantly, this approach does not damage the lateral tarsal artery and maximizes the blood supply to the talus. In addition, because the fibula bears less weight than the tibia, we believe that osteotomy of the lateral malleolus is beneficial to early functional exercise for the patient. On the other hand, the drawback is that the lateral malleolus is dissected, which may cause nonhealing of the lateral malleolus fracture, which some patients may find unacceptable. At the same time, since the medial side of the talus is not fully exposed, the broken medial bones may not be easily reduced or fixed.

In order to achieve a good surgical effect, we summarize the following important technical considerations for the new surgical approach: 1) timely reduction of the joint dislocation should be performed before surgery [7]; 2) the surgical incision should be performed as close as possible to the Achilles tendon to facilitate the full exposure of the posterior aspect of the talus and a better selection of needle insertion points; 3) the osteotomy plane cannot be higher than the intercondylar joint surface, the purpose of which is to protect the inferior tibiofobular ligament; 4) Eberl et al. used an inverted V-shaped osteotomy during surgery to avoid inflicting damages to the inferior tibiofobular ligament and to stabilize the lateral malleolus fixation [8]; and 5) needle positioning demands attention to the anatomical shape of the talus. Because the talus is small anteriorly and large posteriorly, its longitudinal axis is parallel to the sole and at an angle of 20–30° with the medial edge of the foot [9]. Therefore, the direction of the surgical needle should be parallel to the aforementioned 2 directions; otherwise, the screw tends to exit sideways from the medial/lateral or superior/inferior edges of the talus neck. When this happens, the talus head cannot be fixed, defeating the purpose of the fixation. When inserting the needle, the ankle joint should be bent as much as possible, so that the talus is shifted forward as much as possible. This way, the exposed posterior edge of the talus will not collide with the ankle joint; otherwise, the collision will cause pain and damage the cartilage surface, eventually leading to traumatic arthritis. After the talus is fixed, the truncated lateral malleolus is fixed with a distending wire and protected with a routine U-shaped plaster for 3 weeks.

Despite the satisfying results of our findings, there were still some limitations to this study. First, only 26 patients were enrolled in this study. In addition, follow-up time was less than 2 years. The small number of patients and the short-term follow-up might have caused errors to the accuracy and reliability of our study results. Finally, we only did a therapeutic efficacy analysis for internal fixation with lateral malleolar osteotomy on patients with lateral talar fracture. We failed to set up a control group, or a baseline group treated with typical open reduction internal fixation through anteromedial/anterolateral incisions. Whether the lateral surgical approach with malleolar osteotomy is better than the traditional approach, and whether the approach could be a routine option requires more research to further investigate.

Conclusions

Based on this study, we believe that patients with Hawkins type II, III, and IV talar neck fractures can undergo internal fixation with lateral malleolar osteotomy. It's a viable option that can minimize vascular injury and maximize visualization of the talus, but further long-term studies are warranted.

References:

1. Chen H, Liu W, Deng L, Song W: The prognostic value of the Hawkins sign and diagnostic value of MRI after talar neck fractures. Foot Ankle Int, 2014; 35(12): 1255–61
2. Tennant JN, Chamnanni R, Pizzimenti MA et al: Risks to the blood supply of the talus with four methods of total ankle arthroplasty: A cadaveric injection study. J Bone Joint Surg Am, 2014; 96(5): 395–402
3. Shakked R, Tejwani NC: Surgical treatment of talus fractures. Orthop Clin N Am, 2013; 44(4): 521–28
4. Wajsfisz A, Makridis KG, Naji O et al: An anterior ankle arthroscopic technique for retrograde osteochondral autograft transplantation of posteromedial and central talar dome cartilage defects. Knee Surg Sports Traumatol Arthrosc, 2014; 22(6): 1298–303
5. Kwaadu KY: Management of talar fractures. Clin Podiatr Med Surg, 2018; 35(2): 161–73
6. Maher MH, Chauhan A, Altman GT, Westrick ER: The acute management and associated complications of major injuries of the talus. J Bone Joint Surg Rev, 2017; 5(7): 1–11
7. Vallier HA, Reichard SG, Boyd AJ, Moore TA: A new look at the Hawkins classification for talar neck fractures: Which features of injury and treatment are predictive of osteonecrosis? J Bone Joint Surg Am, 2014; 96(3): 192–97
8. Godoy-Santos AL, Albuquerque DM, Diniz-Fernandes T, Rammelt S: Fracture of the talar neck associated with a compression fracture of the calcaneocuboid joint in a 5-year-old child: A case report. Arch Orthop Trauma Surg, 2013; 133(9): 1267–71
9. Pearce DH, Mongiardi CN, Fornasier VL, Daniels TR: Avascular necrosis of the talus: A pictorial essay. Radiographics, 2015; 25(2): 399–410

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]