

Bosworth Fracture-dislocation of the Ankle: A Case Report and Literature Review

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Abstract

Introduction: Bosworth fracture-dislocation is an unusual variant of ankle joint fracture and dislocation, which has a high clinically missed diagnosis rate due to poor visibility on X-ray. At the same time, successful closed manipulations in an ankle joint fracture and dislocation are difficult because of the fibula attachment at the posterolateral ridge of the tibia or at the fractured end of the posterior tibia.

Patient concerns: A 56-year-old man visited the hospital for further evaluation of a swollen, deformed right ankle resulting from a tumble 4 hours ago. There were no obvious complications such as skin damage or blood vessel and nerve damage at the time of treatment.

Diagnosis: The patient was diagnosed with Bosworth fracture-dislocation according to clinical history and X-ray examination and computed tomography (CT), which indicated posterolateral talus dislocation; the distal end of the proximal fibular fragment was inserted behind the tibia.

Interventions and outcomes: The patient initially failed to receive twice manipulative reductions. After the first attempt, roentgenograms and CT scan still showed a dislocated ankle and the proximal end of the fibula fracture was still inserted at the fractured end of the posterior tibia although the sound of the joint mounted into the acetabulum was heard. Then the inferior tibiofibula joint was fully exposed and locked with an inferior tibiofibula screw. Review roentgenograms and CT suggested that the ankle was manipulated successfully, and the broken end achieved perfect alignment, leading to a satisfactory function restoration.

Lessons: Early diagnosis and reduction of Bosworth fracture-dislocation is recommended, which can significantly decrease complications. The characteristic clinical manifestations of Bosworth fracture-dislocation are worthy of attention, including extreme external rotation of the ankle and difficulty in reduction. Simultaneously, the axilla sign on mortise roentgenograms, posterior dislocation of the talus on the lateral roentgenogram and fibular position relative to the talus on the external oblique roentgenogram are intrinsically valuable. During the surgery, the floating position can better expose the broken fracture end and allow standard lateral roentgenograms. For the reduction of Bosworth fracture-dislocation, it is important to avoid repeated attempts at closed reduction. Intraoperative reduction of the fibula is the key.

Introduction

Ankle fracture is one of the most common fractures of the lower limbs. which is generally caused by indirect violence, and it leads to fractures and dislocations of the ankle joint. Depending on the size, direction and location of the violence suffered during an ankle injury, ankle fractures can be divided into several types. Bosworth fracture-dislocation, first proposed by David Bosworth in 1947, is a rare fracture-dislocation of the ankle where the proximal fibular fragment lodges behind the tibia with a dislocation at the ankle joint¹. Clinically, Bosworth fracture-dislocation is concealed on an ordinary lateral X-ray, caused by misapprehension of ecumenic fracture and ankle dislocation, and senior Orthopedists sometimes

have challenges identifying them. Early detection of the emptiness of tibial and fibular incisions and repositioning of the fibula can ensure a definite diagnosis by computed tomography (CT) combined with iterative reconstruction. However, CT is not a routine examination procedure and often cannot be performed in the early stages. Consequently, early diagnosis and treatment of Bosworth fracture-dislocation is significant to carry out the normal and lateral position, oblique position and tenon position of the ankle joint and to master the specific imaging characteristics of Bosworth fracture-dislocation.

Yougun et al.² retrospectively analyzed 3,140 cases of ankle fractures, including 1,589 cases of supination and external rotation fracture and 51 cases of Bosworth fracture-dislocation. The incidence of Bosworth fracture-dislocation in ankle fractures is about 1.62%, and that of posterior external rotation in ankle fractures is 3.21%. Karel et al. found 47 articles on 97 cases through a literature review on Bosworth fracture-dislocation from 1947 to 2018.³ This indicates that Bosworth fracture-dislocation is clinically rare and its incidence is extremely low.

In addition, another characteristic of Bosworth fracture-dislocation is the high rate of manual reduction failure. Since the proximal fibula fracture is locked in the posterolateral ridge of the tibia or the catagmatic end of the posterior malleolus,⁴ conventional reduction techniques are too difficult to succeed in.

A patient with Bosworth fracture-dislocation was admitted in 2019. The patient had undergone multiple unsuccessful preoperative restorations before the surgery. The prone position was adopted during the surgery, and the posterolateral approach to the ankle joint was used. Postoperative review of CT films showed that the fibula was still inserted into the fractured end of the posterior ankle, which requires a timely secondary revision surgery. The patient's function was restored with no occurrence of complications such as parenchymal infection and fascial compartment syndrome, even though patient had several rehabilitation and surgical trauma resulting in a poor condition of the soft tissue. In order to ensure early diagnosis, reduce the missed diagnosis rate, and improve the efficacy of clinical treatment, a summary of the experiences and lessons from the diagnosis and treatment of this patient are reported as follows.

Case Presentation

A 56-year-old male patient with difficulty in walking reported to the emergency department for further treatment and presented with pain and a right swollen ankle joint due to a fall. At the time of treatment, the patient's right ankle was significantly swollen and deformed, accompanied with tenderness of the internal and external malleolus, a palpable sense of bone rubbing and normal pulsation of the dorsalis pedis artery. Routine anterior lateral X-ray examination of the ankle was performed immediately, and it indicated subluxation of the right ankle fracture (Fig. 1a). After manual reduction and splint fixation, the emergency physician rechecked the X-ray, which showed that the dislocation had not been corrected (Fig. 1b). One more manual reduction was attempted with a replaced polymer plaster fixation since the patient had been admitted to the hospital. However, the roentgenogram still showed dislocation at the

joint (Fig. 1c). CT and three-dimensional reconstruction demonstrated the images of distal fibula fracture, posterior malleolus fracture, proximal fibula fracture inserted in the fractured end of the posterior malleolus fracture, and posterior lateral dislocation of the talus, which could definitely be diagnosed as Bosworth fracture dislocation (Fig. 1d). Although manipulative reduction can force the tibia into the ankle joint, it will move out of place promptly after the grip is taken off, just like the key sign of acromioclavicular joint dislocation. Immediate treatment such as calcaneal traction and mannitol dehydration should be given, considering the repeated unsuccessful reduction and the pronounced swollen limb.

One week after the patient was hospitalized, the swelling was significantly alleviated. An open reduction and internal fixation of ankle fracture and dislocation were performed, ruling out all surgical contraindications. During surgery, the prone position was adopted, and the posterolateral incision of the ankle joint was approached behind the fibular longus and brevis muscle to expose the broken end of fracture, in order to clean the intravascular bleeding and fix the broken end with the locking plate at the posterior fibula. By approaching the interstice between the fibular longus and brevis and the flexor hallucis longus muscles, the posterior fracture fragment of the tibia was exposed and fixed with a T-lock plate. The reduction was achieved under direct vision, and no obvious abnormality was found in the movable ankle joint. Postoperative review of the X-ray indicated that the fractured end was well aligned, and the positive radiograph showed that the ankle point was normal, but the space between the anterior tibia and talus on the lateral radiograph was larger (Figure 2a). The mechanism is taken into consideration where the anterior joint capsule, ligament and other soft tissues are to be torn and loose. The limb was fixed at 90 degrees dorsiflexion while the plaster cast was replaced. The X-ray examination showed that the interstice was still too large (Figure 2b). Immediate CT and three-dimensional reconstruction were performed, and the fibula was not observed in the tibial and fibular notch in the transverse view. The proximal end of the fibula was still inserted in the fractured end of the posterior malleolus, and the dislocation of the tibiotalar joint remained (Figure 2c). Thus, the first surgery failed.

Full communication with the patient and his relatives, who gave the permission to carry out revision surgery. We adopted the floating position and the primary incision to expose the inferior tibiofibular syndesmosis indicating the lacerated anterior tibiofibular ligament, the dislocated inferior tibiofibular joint and the impaction. With the fibula in position, the pry was inserted in front of the proximal end of the fibula fracture. Reduction by leverage was successful after releasing the posterior tibiofibular ligament. Nickel clad was fixed at the distal fibula to reduce the fibular fracture which resulted in a connection of the fibular notch of the tibia. Thus, the second surgery was successful. Postoperative review of the X-ray and CT with three-dimensional reconstruction showed that the fracture dislocation was corrected (Fig. 3). Three months after the operation, the function of the ankle joint recovered with satisfactory effect.

Discussion

1 Rare and high misdiagnosis ratio

Bosworth fracture-dislocation is rare in the clinic, with few and insidious imaging features which poses challenges to even senior doctors when making an immediate diagnosis. Cho et al.⁵ sampled 15 cases with Bosworth fracture-dislocation, while only 5 patients were diagnosed with Bosworth fracture-dislocation according to the initial imaging examination. The primary diagnosis rate was 33.3%. Yougun et al.² retrospectively analyzed 51 patients with Bosworth fracture-dislocation in 4 university hospitals. According to statistical analysis, 22 patients were not diagnosed with Bosworth fracture-dislocation before surgery; 10 of them were diagnosed with Bosworth fracture-dislocation during surgery. Twelve patients failed to receive a diagnosis, and the initial diagnostic rate was 43.1%. Consequently, the primary diagnosis rate of Bosworth fracture-dislocation is low, and the clinical misdiagnosis rate is high.

Improving the efficiency of clinical diagnosis is a top priority, and one needs to understand the injury mechanism of Bosworth fracture-dislocation. Schatzker et al.⁶ believed that the mechanism of injury is a posterior lateral dislocation of the talus, which leads to an injury of the lower tibiofibular ligament and results in a fibula fracture followed by further external rotation of the talus. Currently, most scholars agree that the mechanism of injury is external rotation, which corresponds with the Maisonneuve mechanism of injury. On this basis, Bosworth injury will occur after suffering from a strong continued external rotation.⁷ The characteristic indication can be divided into two points: 1. The ankle joint is in extreme external rotation; 2. Manipulative reduction is difficult.

X-ray imaging has many typical features for the diagnosis of Bosworth fracture-dislocation, including the Axilla sign on the mortise view, posterior dislocation of the talus on the lateral view, and the distance between fibula and talus on the external oblique view.⁸⁻¹⁰ The Axilla sign is mainly due to the continuous internal rotation of the tibia, and the axilla of the medial tibial plate can be seen on the X-ray. The mortise view of the ankle is a 15-25-degree internal rotation projection position. Clinically, due to the patient's pain, it is often impossible to obtain a standard projection position. Incarceration of the tibial tendon and fragments also appears an axilla syndrome. Khan et al.¹⁰ retrospectively analyzed 10 patients with Bosworth fracture-dislocation. X-ray imaging revealed an axilla sign. Therefore, the axilla sign cannot be used as a diagnostic criterion, but it has high sensitivity and specificity for predicting Bosworth fracture-dislocation.

On the lateral radiograph of Bosworth fracture-dislocation, the posterior dislocation of the talus can be clearly observed. For general ankle fractures and dislocations, manual reduction is usually effective. In Bosworth fracture-dislocation, it is difficult to reset the fracture and dislocation because of the incarceration, which leads to separation after restoration, and this is similar to the key sign of acromioclavicular joint dislocation.

External oblique X-rays show that the fibula is located in the middle of the talus. Kyu et al.⁸ divided the talus into two parts on the external oblique view. With the fibula as the boundary, the anterior part was α , and the posterior part was β . $\alpha/(\alpha + \beta)$ was used to judge the Bosworth fracture and dislocation. As a result of the location of the fibula in the middle of the talus on the external oblique view, $\alpha/(\alpha + \beta)$ is close

to 0.5. Therefore, the position or measurement of the fibula relative to the talus on the lateral oblique film is the favorable evidence for diagnosis.

The characteristic indicators are concealed due to severe pain and lack of an X-ray in the standard position, although X-ray has more imaging features, Therefore, for suspected patients, CT and three-dimensional reconstruction are recommended. Not only can a clear diagnosis be made as early as possible, but it can also reduce the risk of further injury and complications, and it can lead to effective diagnosis and early treatment.

2☒Difficulty in manipulative reduction

The reduction of Bosworth fracture-dislocation is difficult, which is why it is called an irreversible ankle fracture dislocation.¹¹ Cho et al.⁵ collected data on about 15 patients with Bosworth fracture-dislocation. The average number of manual restorations was 2.24, and only 1 case was successfully reset by manual restoration. Jan et al.¹² analyzed 88 cases from the literature, and only 5 patients were successfully reset by manual manipulation. A total of 6 cases have reported to our hospital since 2011, and only 1 case underwent successful repair with plaster fixation. In this case, the tibiotalar joint was closed during the surgery, and there was an obvious sound which indicated that the tibiotalar joint has been successfully reset. However, the proximal fibula fracture is still inserted in the fractured end of the posterior malleolus. The tibia can dislocate again due to the fracture at the distal fibula, just like the acromioclavicular key sign. The key to intraoperative reduction is to resolve the incarceration of the fibula. First of all, surgical treatment will reset the fibula fracture. Afterwards the posterior malleolus fracture, the medial malleolus fracture, the lower tibiofibular joint, and the medial collateral ligament are resolved.¹³

3☒Intraoperative position

For Bosworth fracture-dislocation, it is generally recommended to adopt the posterolateral approach to the ankle joint, which can fully expose the lateral ankle fracture and resolve the posterior ankle fracture. If only the posterolateral approach is selected, the prone position can be used routinely. If accompanied by a fracture of the medial malleolus, floating positions are generally used. In cases where patients fall sideways, patients are positioned on the healthy side, and the back of the buttocks is fixed with baffles. The posterolateral approach was used to deal with the lateral malleolus and posterior malleolus fracture, and the posterior baffle is removed for supine positioning to treat a medial malleolus fracture. Since there was no medial malleolus fracture, the prone position was selected. After intraoperative reduction and the fixation, conventional C-arm fluoroscopy was performed. The intraoperative ankle radiographs showed that the ankle points were in place, the inferior tibia and fibula were in place, and the fracture ends were in good alignment. The intraoperative lateral radiograph only indicated that the anterior space of the ankle was too large because the standard lateral radiograph could not be taken. Considering the rupture of the joint capsule and ligament, the first surgery was unsuccessful. In the second surgery, the floating position and the posterolateral approach were used to reset the fibular fracture in front of the peroneus longus and brevis, which could fully expose the fractured end and the inferior tibiofibular joint. In addition, the

floating position can be used to routinely photograph the lateral ankle joint, which is more conducive in deciding on reduction. Another advantage is that the floating position can simultaneously handle medial malleolus fractures, saving time in secondary disinfection and other surgeries. Therefore, it is suggested that the floating position and the posterolateral approach should be adopted to avoid the failure of surgical reduction and expose the posterior ankle fracture in the gap between the peroneus longus muscle and flexor pollicis longus.

4 Emergency surgery

Compared with conventional ankle fracture and dislocation, the incidence of complications in Bosworth fracture-dislocation is high including skin necrosis, wound infection, osteofascial compartment syndrome, traumatic arthritis, talus necrosis, and joint stiffness.^{7,12,14-18} In addition, Bosworth fracture-dislocation is often accompanied by severe soft tissue injuries, and improper manipulative reduction can also aggravate the injury.² Won et al.² retrospectively analyzed 51 patients with Bosworth fracture-dislocation including 36 emergency surgeries and 15 delayed surgeries. After 1 year of follow-up, it was found that the American Orthopedic foot and ankle society (AOFAS) score of emergency surgery patients was significantly higher than that of delayed surgery patients. Besides, swelling in patients with delayed surgery had not improved significantly, and the complications of nonunion and osteoarthritis were significantly higher than patients who had emergency surgery. Cho et al.⁵ conducted a follow-up study on 16 patients and found that the prognosis of patients undergoing one or two closed reductions was significantly better than that of patients with three or more closed reductions, and the prognosis of patients who undergo surgery within 24 hours after injury was obviously better. In conclusion, early diagnosis and reduction of Bosworth fracture-dislocation can significantly reduce complications.¹⁹⁻²¹ Most scholars^{2,12,20,21} suggested that early open reduction and internal fixation is the first choice due to the difficulty associated with manual reduction.

Abbreviations

CT = computerized tomography; AOFAS = American Orthopedic Foot and Ankle Society Score

Declarations

Ethics approval and consent to participate

Informed written consent was obtained from the patient for publication of this case report and accompanying images.

Consent for publications

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors have no conflicts of interest, including specific financial interests and relationships and affiliations, relevant to the subject of this manuscript.

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Authors' contributions

The cases were provided by JL and ZL. ZW, YD, XL analyzed and interpreted the patient data with supervision and participation from HJ. ZW, PY, YY, XL read and collected the relevant literature. ZW, QF, YD drafted the first manuscript with contributions from the other authors. All authors read and approved the final manuscript.

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Figures

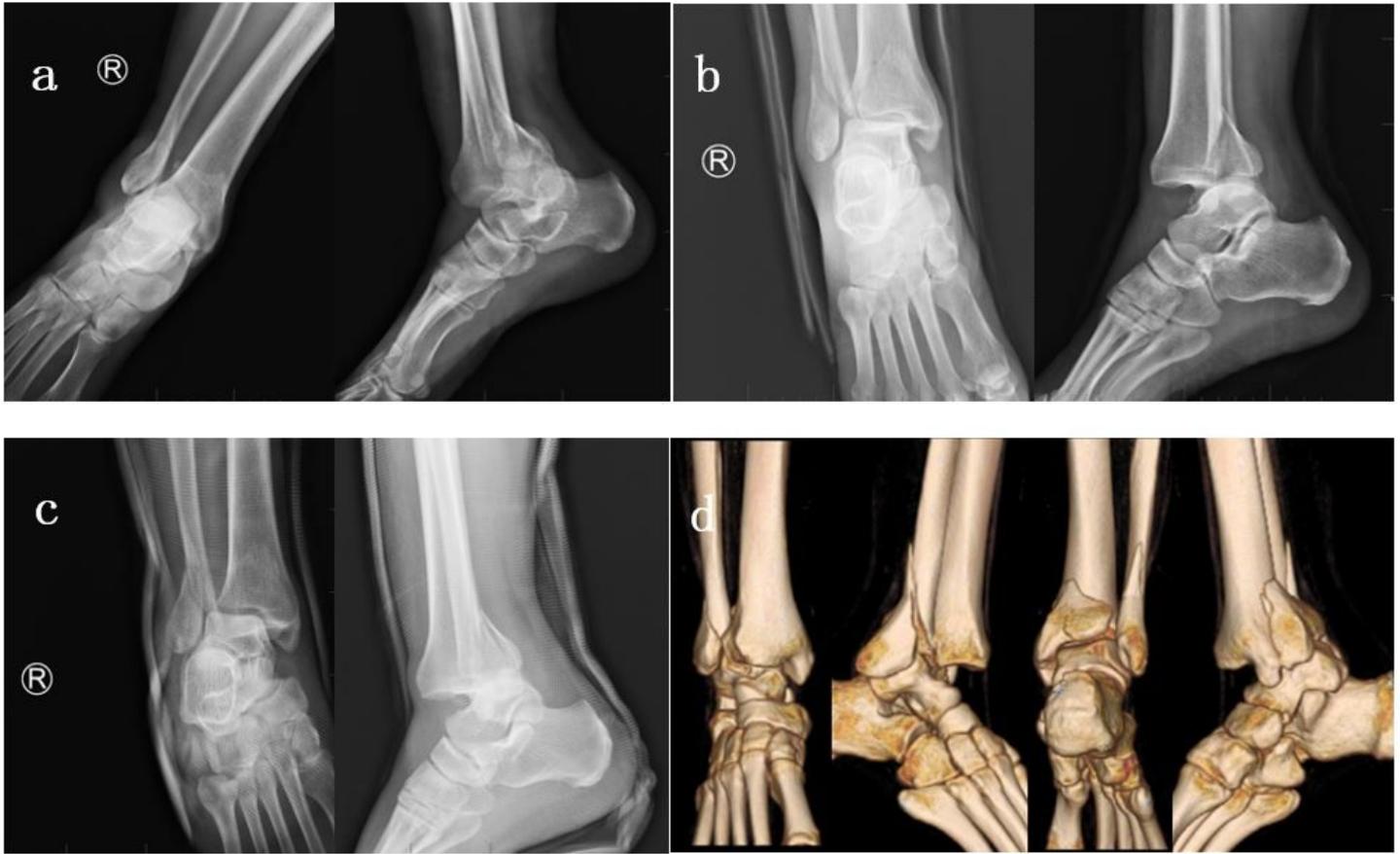


Figure 1

a: X-ray showed fracture and dislocation of ankle joint at the time of treatment; b: X-ray after the first reduction, fracture-dislocation was not corrected; c: X-ray after the second reduction, fracture-dislocation was still not remedied; d: The second review of CT with three-dimensional reconstruction was diagnosed as Bosworth fracture-dislocation.

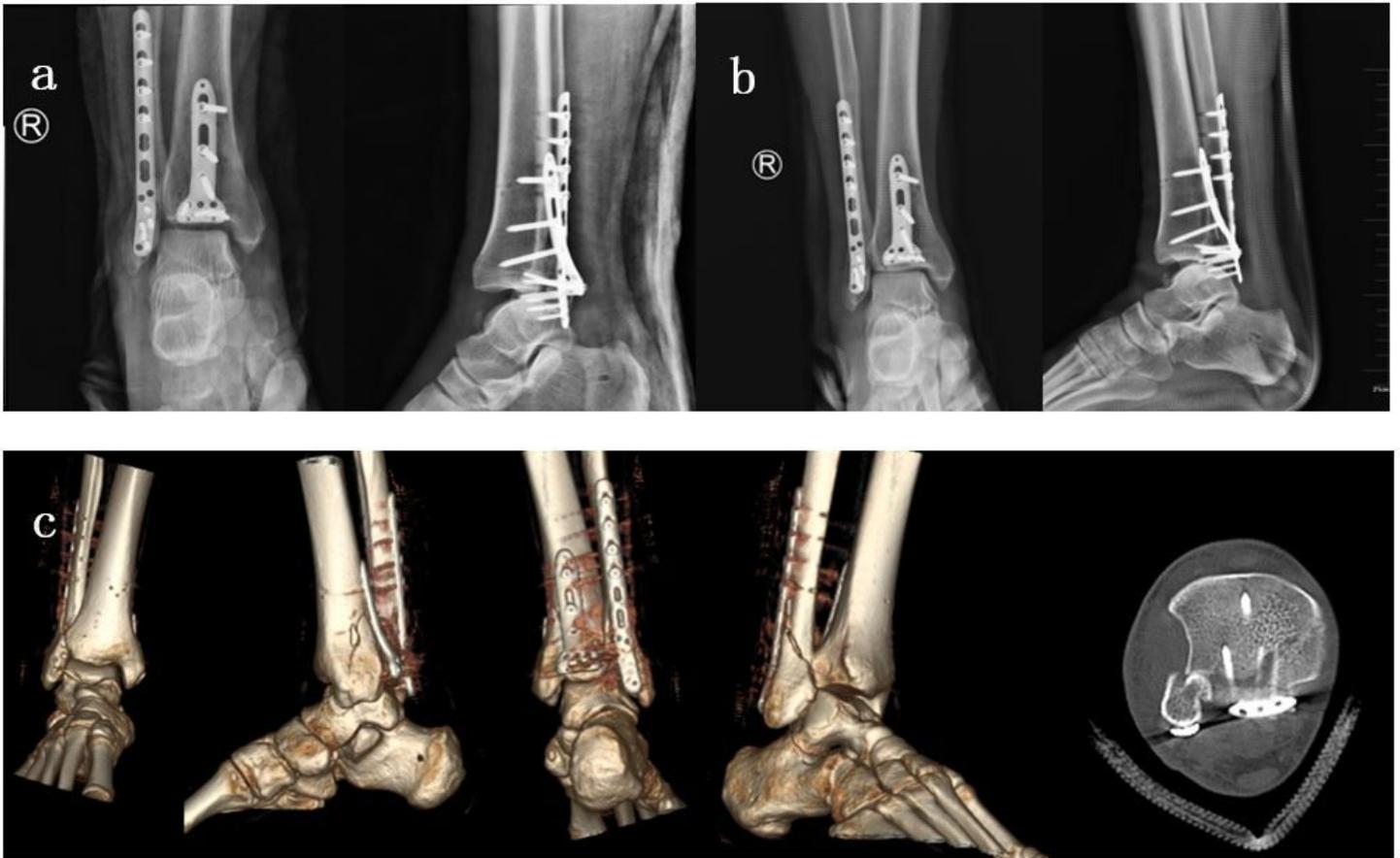


Figure 2

a: The first review of X-ray after operation showed that the anterior space of the ankle joint is too large;
b: The X-ray of the post-operative dorsal flexion cast fixation showed that the anterior gap of the ankle joint decreases, but the ankle point still showed poor result ;
c: Postoperative review of CT plus three-dimensional reconstruction, Bosworth fracture-dislocation was not corrected.

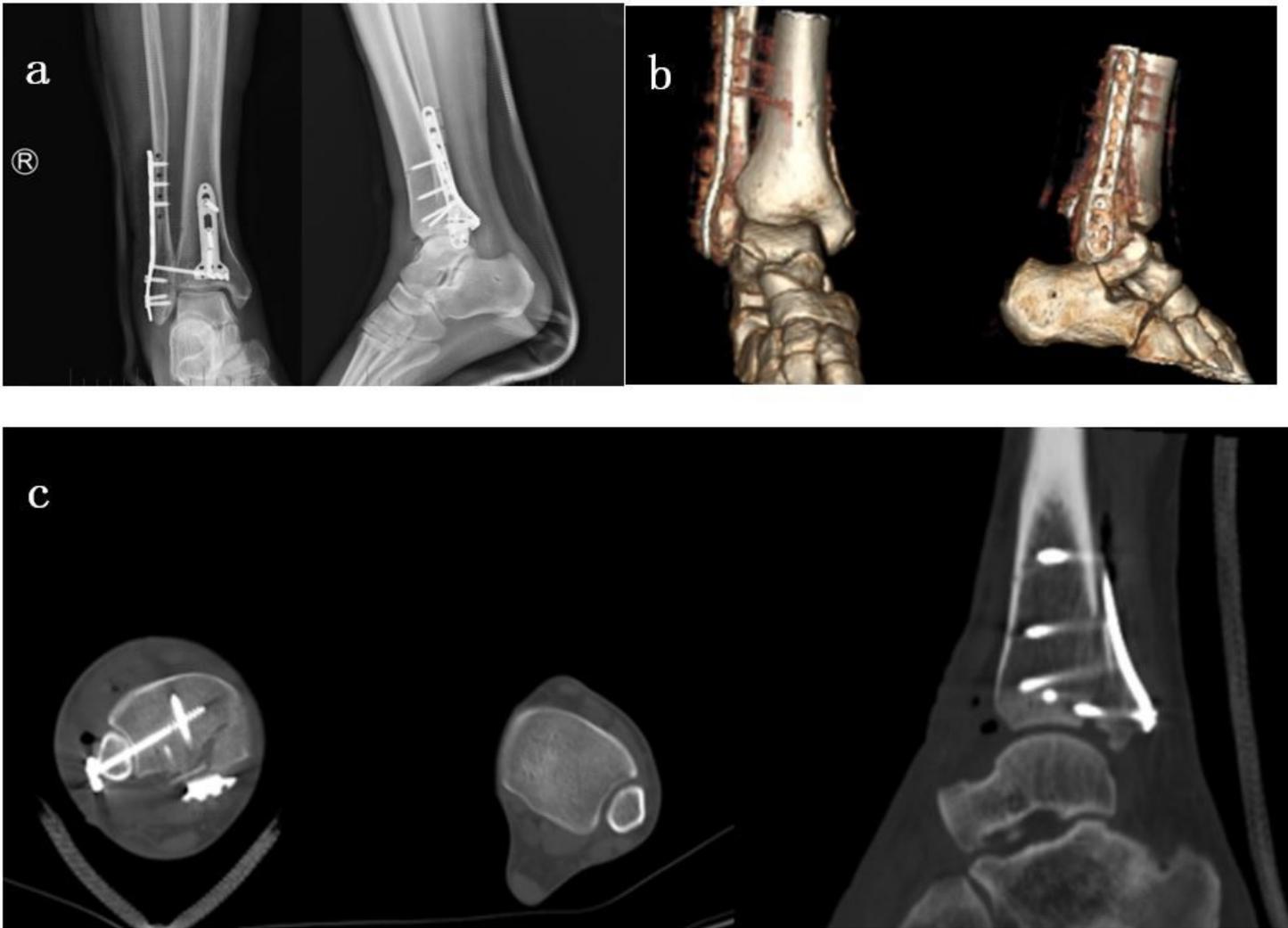


Figure 3

a: The first review of the X-ray after operation indicates that the ankle is in place, and the alignment of the fracture can be aligned; b-c: Postoperative review of CT with three-dimensional reconstruction shows the Bosworth fracture-dislocation had been reset.