Case Report

Rare variants of Bosworth fracture-dislocation: Bosworth fracture-dislocation with medial malleolus adduction type fracture

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A R T I C L E  I N F O

Keywords:
Fracture dislocation
Supination
Rotation
Ankle injuries
Complications

A B S T R A C T

Bosworth ankle fracture-dislocation is rare, known to be an irreducible type of ankle injury, with a high incidence of complication. We present two cases of even rarer variants of Bosworth ankle fracture-dislocation. The first case is a type of supination external rotation adduction, and the second case is a type of supination external rotation adduction. These types have not been described before. In both of the cases we failed to achieve close reduction, and therefore proceeded with emergency surgeries, with open reduction and internal fixation. Both of the cases were performed with a postero-lateral approach to reduce the dislocations, and fix the fractures successfully. Unfortunately in one of the cases, acute compartment syndrome developed post-surgically. However, both cases showed good functional outcomes.

Introduction

Bosworth ankle fracture-dislocation is a rare injury. Most of these cases show supination and external rotation patterns according to the Lauge-Hansen classification, in other words, Danis-Weber C or Maisonneuve pattern. Bosworth injury with medial malleolus fracture caused by an adduction force is not well described previously. We report two cases of this variant of Bosworth fracture-dislocation with medial malleolus fracture as an adduction pattern; the first case is a type involving supination external rotation adduction, and the second case pronation external rotation adduction.

Case report

Case 1

A 19-year-old male, twisted his ankle when he fell off a motorbike. He could not remember his foot position when the accident happened. He went to a local hospital where a radiograph was performed and then he was transferred to our emergency department by ambulance. A severe deformity, with the foot fixed in an external rotation position, was noticed. The skin tenting at the lateral edge of the fractured distal tibia was easily palpated. The pulses of the dorsalis pedis artery and the arteria tibialis caudalis could not be detected.

The radiographs showed a trimalleolar fracture with posterior dislocation of the talus. The tibiofibular relationship showed no obvious diastasis in an anteroposterior radiograph view, but the fibula showed posterior translation with a lateral radiograph.

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The fracture of the distal fibula had a Danis-Weber B oblique pattern, which matched the Lauge-Hansen supination and external rotation type. However, the fracture of medial malleolus showed an oblique fracture line starting from the superomedial corner of the mortise dome and ending 4 cm above the syndesmosis level, matching a Lauge-Hansen supination adduction type (Fig. 1). An urgent attempt at closed reduction resulted in failure, and then CT was performed. The distal fibula had rotated, sticking out from the tibiofibular notch and trapped behind the posterior aspect of the tibia (Fig. 2).

Emergency surgical management with open reduction and internal fixation was performed immediately after CT scan, under general anesthesia. A postero-lateral approach was applied. The distal fibula was put back in the tibiofibular notch using a bone elevator to reduce ankle dislocation. The reduction was confirmed by...
an intra-operative radiograph. Three screws were used to fix the posterior malleolus fracture. A lateral malleolus plate, a medial malleolus buttress plate, and a syndesmosis screw were used (Fig. 3).

Unfortunately, compartment syndrome developed the day after surgery. We performed a fasciotomy immediately with secondary wound closure two days afterwards. Post-operative short-leg cast immobilization was applied for two weeks, changed to an airboot for touch-weight-bearing and then regular physiotherapy started. The syndesmosis screw was removed after eight weeks post-surgery. Follow-up after two years showed full functional recovery of the ankle. The patient had no subjective complaints.

Case 2

A 19-year-old male sprained his left ankle when playing Rugby. He was running and jumped to his left side, landing awkwardly on his left foot. When he was brought to hospital, physical examination showed a severe external rotation deformity. The skin was tenting at the lateral edge of the fractured distal tibia. There was no tenderness at the proximal fibula. The pulse of the dorsalis pedis artery could be detected but that of the arteria tibialis caudalis pulses could not.

Radiographs showed an oblique medial malleolus fracture, but no fibular fracture. The distal tibiofibular relationship showed increased overlap in an anteroposterior view, and the distal fibula moved posteriorly in a lateral view. Immediate trial of close reduction was not successful under sedation. The fracture of the medial malleolus showed an oblique fracture line starting from the superomedial corner of the mortise dome, ending at 4 cm above the syndesmosis level, indicating that an adduction force was imposed on the medial malleolus (Fig. 4). A CT scan showed the distal fibula had rotated out of the tibia fibula notch, and was entrapped at the postero-lateral position of tibial tuberosity (Fig. 5).

The patient was immediately taken open reduction and internal fixation. The postero-lateral approach was applied, and the distal fibula was put back in the tibiofibular notch, and the ankle dislocation was reduced. A buttress plate was applied in order to fix the posterior malleolus, another buttress plate was used to fix the medial malleolus, and a syndesmosis screw was applied to fix the syndesmosis diastasis (Fig. 6).

Post-operative short-leg cast immobilization was applied for two weeks, changed to an airboot for touch-weight-bearing and then regular physiotherapy started. The syndesmosis screw was removed after eight weeks post-surgery. At follow-up after 18 months, the patient showed full functional recovery with a pain-free, normal range of motion in his ankle joint.

Discussion

It has been reported that Bosworth fracture dislocation can be divided into three types. The first is the distal fibula dislocation, associated with epiphysis fracture of distal tibia. This type of lesion occurs in children and adolescents. The second is the distal fibula
Fig. 3. (A) Postoperative radiograph showing reduction and fixation of the lateral malleolus fracture, syndesmosis diastasis and medial malleolus fracture. A buttress plate was applied to support the medial malleoli. (B) Reduction and fixation of the posterior malleolus fracture and posterior translation of the fibula.

Fig. 4. (A) AP radiograph showing a distal tibiofibular joint excessive overlap and a vertical shear fracture of the medial malleolus; (B) Lateral radiograph demonstrating a posterior translation of the fibula.
dislocation without fibula fracture, similar to the Maisonneuve lesion, in young adults. The third is the fibula dislocation with fibula fracture, including Danis-Weber B and C fibular fractures. This type happens in older adults.1

The general mechanism of Bosworth fracture dislocation is due to the force of an extreme external rotation, in which the talus external rotates in the ankle mortise and pushes the lateral malleolus out of the fibular notch externally and posteriorly and is trapped in behind the posterior tibia tubercle. Meanwhile, the dislocated distal fibula exerts an external rotation force pushing the fractured posterior malleolus and making the medial malleolus rotate externally.

Perry et al.2 reported the Bosworth injury mechanism through cadaver experiment, and showed that there are five steps when Bosworth fracture dislocation occurs. The first step is rupture of the anteromedial part of the capsule. The second step is rupture of the interosseous membrane at a point of 4–6cm above the ankle mortise level. The third step is fracture of the fibular, pushed by the lateral rotation of the talus and pulled by the intact lateral collateral ligament of the ankle. In the meantime, the distal fibula moves out of the fibiofibular notch and becomes entrapped behind the tibia. The fourth step is that the talus, continuing to rotate, causes a distal fibula fracture according to the Lauge-Hansen supination external rotation pattern. Finally, the fifth step is fracture of the medial malleolus or rupture of the deltoid ligament rupture. Bartonicek et al.3 reported that 88% of Bosworth fracture dislocations had a Weber type B fracture pattern. However, there are plenty of different forces working in combination to produce different types of Bosworth fracture dislocation, with or without distal fibular fractures.

We think that Bosworth lesions of supination external rotation happen according to the same mechanism as Lauge-Hansen supination external rotation ankle fractures. In the Lauge-Hansen classification, the talus rotates externally in the ankle mortise in a supinated foot position. The injuries are divided into four grades. Grade I is the anterior-inferior tibiofibular ligament (AITFL) tear. Grade II is a typical Danis-Weber B lateral malleolus fracture with the distal fibula rotating postero-laterally to the tibia tuberosity. In Grade III, the distal fibula pushes the posterior malleolus producing a posterior malleolus fracture. The fracture segments rotate externally to the posterior of the medial malleolus. In Grade IV, the external rotation force is imposed on the deltoid ligament producing a deltoid ligament rupture or a transverse medial malleolus fracture at the ankle dome level.

We also think that Bosworth lesions of pronation external rotation have a similar mechanism to Lauge-Hansen pronation external rotation ankle fractures. In Lauge-Hansen pronation external rotation fractures, Danis-Weber C fractures can be located in the middle 1/3 of the fibula or the proximal fibula. In Grade I, the deltoid ligament ruptures or the medial malleolus breaks in the transverse fracture at the ankle mortise dome level. Grade II is the anterior inferior tibiofibular ligament rupture. Grade III is the fibula rotating...
postero-laterally, with or without fibular fractures, depending on the patient’s age and bone quality. Grade IV involves the external rotation force of the distal fibula producing posterior malleolus fracture or distal inferior posterior fibio-fibular ligament rupture. The distal fibula is trapped behind the posterior tibia tubercle.

Interestingly, the two cases we report here do not fit in all the types above. Both of the cases showed adduction mechanism which provided a shearing force leading to an oblique fracture of the medial malleolus. Case 1 was similar to Lauge-Hansen supination-external rotation type IV, except that it had an oblique fracture of the medial malleolus. This only can be explained as supination, external rotation, and adduction. Case 2 appeared to be like a Maisonneuve lesion, however, the last stage of this injury should be an adduction force. Therefore, we think our two Bosworth dislocation-fractures involve complicated forces of pronation, external rotation, and adduction.

In terms of the management of Bosworth dislocation-fractures, all trauma and orthopedic surgeons should be aware the irreducible nature of this injury. Some literature suggests that close reduction can be achieved if you pay attention to the mechanism of the injury. Bartonicek et al. reported that reduction could be achieved by paying attention to the mechanism of the injury. Some literature suggests that close reduction may be one of the most important reasons, but severe complications, such as compartment syndrome, skin necrosis, talus necrosis and function loss. Compartment syndrome rate is high even if the injury is treated urgently, and preparation of the fasciotomy will be needed. Lastly, the postero-lateral approach is an effective method of achieving full access to treat difficult Bosworth fracture-dislocations.

Funding
None.

Ethical statement
This study has been approved by the local committee and informed consent has been obtained from all patients or relatives.

Conflicts of interest
There are no conflicts of interest.

References

1. Cappuccio M, Leonetti D, Di Matteo B, et al. An uncommon case of irreducible ankle fracture-dislocation: the “Bosworth-like” tibio-fibular fracture. Foot Ankle Surg. 2017;23:e1–e4. https://doi.org/10.1016/j.jfas.2016.07.001.
2. Perry CR, Rice S, Rao A, et al. Posterior fracture-dislocation of the distal part of the fibula. Mechanism and staging of injury. J Bone Joint Surg Am. 1983;65:1149–1157.
3. Peterson ND, Shah F, Narayan B. An unusual ankle injury: the Bosworth-Pilon fracture. J Foot Ankle Surg. 2015;54:751–753. https://doi.org/10.1053/j.jfas.2014.09.016.
4. Schepers T, Hagenaars T, Den Hartog D. An irreducible ankle fracture dislocation: the Bosworth injury. J Foot Ankle Surg. 2012;51:501–503. https://doi.org/10.1053/j.jfas.2012.04.011.
5. Bartonicek J, Fric V, Svatko F, et al. Bosworth-type fibular entrapment injuries of the ankle: the Bosworth lesion. A report of 6 cases and literature review. J Orthop Trauma. 2007;21:710–717. https://doi.org/10.1097/BOT.0b013e31815affb7.
6. Ellanti P, Hammad Y, Grieve PP. Acutely irreducible ankle fracture dislocation: a report of a Bosworth fracture and its management. J Emerg Med. 2013;44:e349–e352. https://doi.org/10.1016/j.jemermed.2012.11.013.
7. Lui TH, Chan KB, Kong CC, et al. Ankle stiffness after Bosworth fracture dislocation of the ankle. Arch Orthop Trauma Surg. 2008;128:49–53.
8. Molinari M, Bertoldi L, De March L. Fracture dislocation of the ankle with the fibula trapped behind the tibia. A case report. Acta Orthop Scand. 1990;61:471–472.
9. Beekman R, Watson JT. Bosworth fracture-dislocation and resultant compartment syndrome. A case report. J Bone Joint Surg Am. 2003;85:2211–2214.
10. Hockenbury RT, Frieroon TG. Dislocation of the distal tibiofibular joint. J Orthop Trauma. 1992;6:120–124.