DISLOCATION OF THE ANKLE JOINT: A Review

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INTRODUCTION

There are over a quarter of a million ankle fractures each year in the United States (1), and they are among the most commonly treated fractures (2). These injuries occur when supraphysiologic loads force the talus against its mortise confines. The malleoli and soft tissue supports often fail in predictable patterns, depending on foot position and movement of the leg, as classified by Lauge-Hansen and others. The velocity of the injury can impact whether soft tissues or bones fail (1). Continued movement of the talus, beyond the point of bone failure, can result in displacement of fracture fragments, open fracture injuries, and/or dislocation of the ankle joint. The purpose of this update is to review ankle joint dislocations.

BACKGROUND

Pertinent Ankle Joint Anatomy

The ankle is a modified hinge joint in which six articular surfaces of three bones articulate to allow the foot to move on the leg. The distal tibia and fibula are held tightly together by the syndesmotic ligaments, and together, form the ankle mortise. The medial, lateral, and posterior malleoli buttress the talus inside the mortise. The deltoid and lateral ankle ligaments provide collateral stability. The weaker capsular ligaments provide anterior and posterior joint support.

The inherent stability of the ankle joint is dependent on foot position. The talus and tibial plafond are wider anteriorly than posteriorly. Therefore, as the talus plantarflexes, the ankle mortise is relatively less confining to the narrower posterior talar surface and the ankle joint is less stable. With ankle dorsiflexion, the talus is locked into the mortise; the wider anterior talus forces the fibula to externally rotate through the syndesmosis (3).

Ankle Fracture Dislocations

High-energy forces transmitted through the ankle, can fracture the malleoli. These injuries can result in failure of the mortise and supportive soft tissues, destabilizing the talus confines. With the ankle in plantarflexion, the joint is not stable, and translational forces can dislocate the talus from its mortise.

Ankle fracture dislocations most frequently occur in young males, and are caused during motor vehicle accidents, sports trauma, or falls (4-6). These injuries typically result from high-energy trauma (5,7,8). Low-energy, rotational ankle fracture dislocations have been less frequently reported (9).

The direction of the joint dislocation is determined by the position of the foot and the direction of the force being applied (6). Inversion injuries result in medial joint dislocation after the anterior talofibular and calcaneofibular ligaments are compromised (10, 11). Eversion injuries can disrupt the deltoid ligament and medial ankle joint capsule, progressing to lateral ankle dislocation (10). Risk factors for these injuries include excessive ankle joint laxity, medial malleolar hypoplasia, weakness of the peroneals, and a history of chronic ankle sprains (8,9,12).

Classification of Ankle Fracture Dislocations

In 1965, Fahey and Murphy classified ankle fracture dislocations based on the direction of dislocation (13). This classification system defined dislocations to be Anterior, Posterior, Medial, Lateral, Superior, or a combination of these directions (13). The direction of dislocation is described by the location of the more distal bone segment (the talus).

The AO Classification Supervisory Committee and the Orthopaedic Trauma Association's 2007 revision of the "Compendium on Fracture Classification" defined ankle dislocations under section 80-A (14). Like most AO joint dislocation classifications, there are five types which are defined by direction of dislocation: Anterior (80-A1), Posterior (80-A2), Medial (80-A3), Lateral (80-A4), and Other (80-A5).

Anterior ankle dislocations occur with forced ankle dorsiflexion, when the foot is stabilized, and the lower leg is forced posteriorly. The dorsalis pedis arterial supply is at risk due to the anteriorly displaced talus. This mechanism is rarely reported (5).

Posterior ankle dislocations are most common (4,7,12,15). These injuries occur when a high-energy axial force drives the inverted foot backwards, trapping the wider

Figure 1. Posterior Ankle Fracture Dislocation - most common direction of ankle dislocation, confirmed with radiographs. Following closed reduction, the fracture is reduced and the joint is confirmed to be congruous.

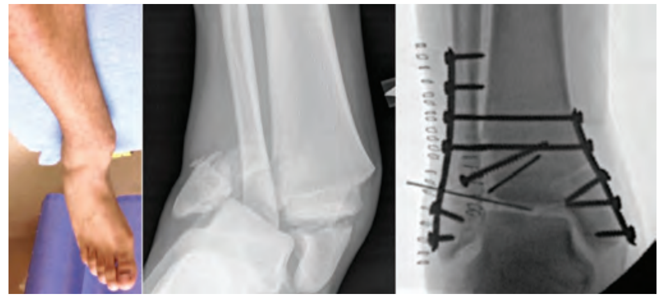

Figure 2. Lateral Ankle Fracture Dislocation - failure of the lateral malleolus with lateral dislocation of the talus. ORIF reduces the fractures, restoring the talus in the mortise, with its stable malleolar buttresses.

Figure 3. Superior Ankle Fracture Dislocation - high-energy axial force pushes the talus into the mortise, disrupting the syndesmosis and allowing for talar dislocation.

anterior talus behind the tibial plafond (16) (Figure 1). These injuries are commonly accompanied by syndesmotic failure or fracture of the lateral malleolus (16). This dislocation can potentially compromise the posterior tibial neurovascular structures.

Medial and lateral ankle dislocations are caused by forced eversion, inversion or rotational mechanisms (17). These are usually associated with malleolar fractures, (16) (Figure 2).

Superior ankle dislocations occur when the talus is driven up into the mortise, and results in joint diastasis (18) (Figure 3). Upward tibiotalar dislocations can occur with or without associated fracture (19,20).

"Pure" Ankle Dislocations

"Pure" ankle dislocations, without associated fractures are rare; however, multiple case studies have been presented in the literature (5-7,9,16,21-24). Low-energy rotation injuries have been presented and described by Fernands. In a cadaver study, medial and lateral ankle dislocation, without associated malleolar failure, was possible following sequential failure of the anterolateral joint capsule, anterior talofibular ligament, and calcaneofibular ligament (11). "Pure" ankle dislocations can also occur with syndesmotic failure, with widening of the ankle joint mortise. The mechanism for these injuries is maximal ankle plantarflexion, usually with foot inversion (25). These injuries have been successfully managed with either open repair or closed reduction and immobilization (5-7,9,21).

In 2003, Ramasamy and Ward classified ankle joint (distal tibiofibular syndesmosis) dislocations as Type 1 injuries (dislocations without a medial malleolar fracture) and Type 2 injuries (dislocations with medial malleolar fracture) (26). The 2007 "Compendium on Fracture Classification" defined distal tibiofibular dislocations under section 40-D (14).

There are other dislocations. Hawkins classified talar neck fractures and the progressive joint dislocations that occur with excessive force. Ankle dislocation is noted in Hawkins type III and IV injuries. High-energy trauma can also result in talar extrusion. These injuries are not the focus of this article.

HISTORY AND PHYSICAL EXAMINATION

Initially, the patient is surveyed and made hemodynamically stable. A thorough history may provide insight to the mechanism of the injury. Clinically, a dislocated ankle joint usually presents as an obvious injury, which necessitate immediate assessment and treatment. The clinical diagnosis may be more difficult if the dislocation is subtle, the patient is obese, or if there is swelling. See Figures 4A-4B.

Neurovascular status should be assessed immediately. Pedal pulses should be palpated and a Doppler ultrasound used, if necessary, to confirm arterial perfusion of the foot (1). It is rare to completely occlude pedal arterial flow since three main arteries perfuse the foot; neurovascular compromise with ankle dislocations has been reported in approximately 10% of cases (6). Ischemic limb changes caused by joint dislocation or an associated compartment syndrome must be identified quickly as they are considered limb-threatening surgical emergencies. Vascular compromise can result in permanent sensory or motor deficits, talar avascular necrosis, soft tissue necrosis, gangrene and ultimately death (13).

Closed ankle joint dislocations often present with tenting/blanching of the soft tissues. In these areas, local ischemia can cause tissue breakdown and wound formation. Open wounds can complicate the osseous injury and therefore require open fracture treatment protocols. When assessing the soft tissues, fracture blisters may also present over the distal leg, and delay planned open repair (27).

On clinical examination, it may be impossible to rule out other fractures or dislocations. Differentials diagnoses should include the displaced (not dislocated) ankle fracture, ankle joint dislocation without fracture, displaced talar fracture, and subtalar joint dislocation (Figures 4). The last panel in Figure 4 depicts a displaced tibia growth plate injury with a congruous ankle joint. Radiographs are helpful to rule out differentials and confirm ankle fracture dislocation and direction of dislocation, define fracture characteristics, and to assess for other fractures. This information is important to have prior to closed reduction, however, if neurovascular status is compromised, closed reduction should not be delayed for radiographs.

Figure 4. Clinical Presentations and Differentials - (A) Common presentation with noticeable deformity, tenting of soft tissues with small punchture wound, (B) Deformity is less obvious with subtle dislocations and in obese patients or patients with swelling (C) Differential of STJ dislocation, (D) Tibia growth plate fracture dislocation with congruous ankle joint.

CLOSED REDUCTION

The goal is to immediately reduce the dislocated joint and relieve pressure on the soft tissues and neurovascular structures. Reduction generally requires analgesia; conscious sedation and hematoma block have been advocated (28-30).

Sir John Charnley outlined closed reduction principles, which can be successfully employed for most ankle dislocations (31). These have been outlined specifically for ankle fracture injuries (32,33). Reduction of the ankle joint dislocation is generally easily accomplished (6). Joint reduction may be audible or palpable, result in a noticeable improvement of the deformity, and result in pain relief. The Quigley maneuver can be used to maintain reduction while a cast or splint is applied (34,35). Post-reduction radiographs should be taken to confirm fracture reduction and joint congruence. See Figure 1. Poor closed reduction techniques will not be successful in restoring the joint and could damage the fracture fragments or cartilaginous surfaces.

In 1947, Dr. David Bosworth described an irreducible ankle fracture dislocation injury, in which the fractured fibula is abutted against the posterior tibial tubercle (36). Bosworth fractures are commonly irreducible via closed reduction techniques. Reduction can also be difficult or impossible if soft tissues are interposed at the joint or fracture level (37). Early open reduction and internal fixation of these injuries yield better outcomes (38).

SURGICAL PLANNING

Many factors can influence the surgical plan of dislocated ankle injuries. Time to surgery is not delayed if the patient has impaired neurovascular status with failed closed reduction attempts or if the patient presents with compartment syndrome.

Approximately 33-50% of ankle dislocations are open injuries (7,39,40). Open injuries warrant antibiotics, wound irrigation, debridement, and appropriate fracture management (41). Clean lacerations can usually be closed primarily without significant tension on the wound edges

(4). At times, delayed closure and wound VAC therapy are warranted. Closed injuries, treated with successful closed reduction can be treated surgically within 6-8 hours of the injury or treated definitively once soft tissue swelling is resolved (1).

Patient variables should not be overlooked. The patient's age, nutrition, medical comorbidities, compliance, tobacco use, ability to be non-weightbearing, etc., must be considered. Pediatric patients with open growth plates may necessitate reduction with fixation that respects the open growth plates; whereas, geriatric patients with osteoporotic bone may require lock plate technology, double plating, or a more limited open approach. Non-compliant patients, diabetics, immunocompromised patients, patients with severe peripheral vascular disease, etc., are more likely to have poor healing potential. Minimal invasive surgical techniques and external fixation are utilized as needed. Some patients may fare best with closed reduction and conservative management.

When planning for surgery, advanced imaging may be warranted. Osteochondral damage can be assessed via magnetic resonance imaging (MRI). Post-reduction computed tomography scanning can provide further understanding of a complicated fracture pattern (8) or help determine the extent of a posterior malleolar fragment.

SURGICAL TREATMENT

There are no specific surgical treatment protocols for ankle fracture dislocations (4). The goal of ankle fracture repair remains the same – restore fibular length and rotation and to stabilize the anatomic reduction. In most cases, reduction of the fibular fracture reduces the talus. The reconstructed mortise restores the confines to stabilize the talus. Syndesmotic instability is assessed intraoperatively and managed. Intraoperative imaging should confirm joint congruency. Putting the ankle through its range of motion can confirm reduction and stability of the joint.

Osteochondral damage, not appreciated at the time of surgical repair, can result in unsatisfactory clinical outcomes despite anatomic reduction and stable fixation. Osteochondral damage is possibly more common with ankle joint dislocation injuries due to the high-energy nature of the injury and prolonged impaction of the joint surfaces; however, this has not been specifically studied. Pre-operative MRI studies and intraoperative assessment of the talar dome should be performed when osteochondral damage is suspected (42). Inferior retraction of the fractured malleoli can allow for direct exposure of the talar dome during surgery.

Hamilton et al have noted that anecdotally, redislocation or subluxation is higher in anterior-lateral ankle dislocations (4). The thin anterior ankle joint capsule and compromised in these injuries (4). Some recommend temporarily fixating the tibiotalar joint with smooth Steinman pins (34), however, long-term arthritis has been reported in 25% of these cases (39). Alternatively, the anterior ankle joint capsule can be directly visualized via the lateral ankle incision and directly repaired. Following surgery, the patient is kept non-weightbearing for 6-12 weeks until fracture healing is seen radiographically. Physical therapy and range of motion exercises can help minimize long-term joint stiffness.

OUTCOMES

Few studies have specifically studied the long-term outcomes of ankle fracture dislocation injuries. The largest prospective study by Lindsjo, reviewed 306 ankle fracture dislocation injuries that were surgically treated (43). Mean follow-up was not reported but most patients were followed between 2 and 6 years postoperatively. Clinical results were reported to be "excellent or good" in 82%, "acceptable" in 8% and "poor" in 10% (43). Post-traumatic arthritis occurred in 10% of the patients and strongly correlated with poor clinical outcomes. Severity of the fracture and degree of dislocation may correlate with long-term clinical outcomes; however, this was not specifically assessed (43).

Immediate joint reduction and maintaining intact neurovascular status are crucial for successful patient outcomes. Neglected ankle dislocation injuries are fortunately rare. Neglected ankle joint dislocation injuries, ankle joint redislocation and subsequent advanced arthritic changes may be best treated with ankle joint arthrodesis (44).

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