CHAPTER **43**

CLOSED REDUCTION OF DISPLACED ANKLE FRACTURES

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INTRODUCTION

The ankle joint is highly susceptible to injury due to its relative mobility, and the weight bearing stresses it accommodates. The ankle must endure forces greater than five times a person's body weight during vigorous exercise or activities. It must support more weight per unit area than any other joint in the body. The ankle joint is comprised of the distal tibia, distal fibula, and the talus. Additional support and stabilization of the ankle arise from the medial and lateral collateral ligaments along with the interosseous membrane of the tibia and fibula.

Ankle fractures can be defined as single malleolar, bimalleolar, or trimalleolar. Ankle dislocations result from complete disruption of the articular elements of the ankle. Most ankle dislocations are usually associated with fracture of single or multiple bones.[1] Isolated ankle dislocation without associated fracture, although quite rare, has been reported.[1,2] When this does occur, the overlying skin is usually torn or lacerated.

HISTORY

Closed reduction of displaced ankle fractures was the standard treatment for many years. The practice of internal fixation was brought into the mainstream with the concepts of AO. Early ankle fixation techniques emphasized stabilization of the medial malleolus, believing that the lateral malleolus contributed little to ankle stability. No importance was attached to the fibula in transmitting the weight of the body from the femur to the foot.[3] This was later proven false, with current emphasis on the lateral malleolus for ankle reduction and stability. Interest in the operative treatment of fractures began to supersede interest in nonoperative treatment. It has been suggested that a reason for the trend towards open reduction may be that good operative techniques were being unfairly contrasted with poor manipulative techniques.[4] An attempt to re-emphasize the nonoperative method of closed reduction may show, that far from being a crude and uncertain art, the manipulative treatment of fractures can be resolved into something of a science.[4] Closed reduction with external stabilization is again being used, and compared as a means of a nonsurgical approach to ankle fracture/dislocation management.

CLINICAL EVALUATION

Determining the mechanism of injury is critical for diagnosis of the injury. A detailed history of the trauma is essential, since the magnitude and the direction of the forces will determine the most likely injury pattern. A reasonable historic profile would include date and time of injury, any previous trauma, relevant medical conditions, and any treatment already initiated. Information such as onset of symptoms, sensations or sounds heard during the traumatic event, and the ability to ambulate should be ascertained.

The physical examination must be thorough and conducted in an organized fashion. It is useful for assessing ligament disruption, joint instability, neurovascular compromise, and the extent of soft tissue injury. The injured side should be compared with the uninjured side for ecchymosis, edema, deformity, and interruptions in the integrity of the skin. Palpation should begin at a site away from the injury, both proximal and distal, to determine if other injuries are present. Radiographic studies are then obtained of the appropriate areas of interest.

LAUGE-HANSEN CLASSIFICATION

The Lauge-Hansen classification is the classic way to describe typical ankle fractures. It attempts to describe the mechanism of injury, by classifying the foot in terms of both the position of the foot and motion that occurred creating the fracture. The first name in this system is the position of the foot when the fracture occurs. The second name is the direction of movement responsible for the fracture. This classification system predicts locations of soft tissue and bony injuries that may not be easily seen on radiographs.

Supination-Adduction

Stage I involves either a lateral ligament injury, or a transverse avulsion fracture of the lateral malleolus below or at the level of the ankle mortise. Stage II is characterized by a stage I injury coupled with an oblique (vertical) fracture of the medial malleolus.

Pronation-Abduction

Stage I involves a rupture of the deltoid ligament or a transverse fracture of the medial malleolus. Stage II is a stage I with a rupture of the anterior and posterior inferior tibiofibular ligament, or avulsion fracture from the tibia (Tillaux-Chaput fracture) or fibula (Wagstaff fracture). Stage III has the addition of a short oblique fracture of the lateral malleolus origination at the level of the ankle joint.

Supination-Eversion (External Rotation)

Stage I involves either a rupture of the anterior-inferior tibiofibular ligament or avulsion fracture of the tibia (Tillaux-Chaput fracture) or fibula (Wagstaff fracture). Stage II includes a spiral oblique fracture of the lateral malleolus. Stage III adds a disruption of the posterior-inferior tibiofibular ligament or avulsion fracture of the posterior malleolus (Volkmann's fracture). Stage IV includes a rupture of the deltoid ligament or transverse fracture of the medial malleolus.

Pronation-Eversion (External Rotation)

Stage I is a rupture of the deltoid ligament or a transverse fracture of the medial malleolus. Stage II adds a rupture of the anterior-inferior tibiofibular ligament or avulsion fracture of the tibia (Tillaux-Chaput fracture) or fibula (Wagstaff fracture). In stage III the interosseous membrane is torn above the syndesmosis but below the fibular head. This is followed by a high fibular fracture (Maisonneuve fracture). Stage IV includes disruption of the posterior-inferior tibiofibular ligament or avulsion fracture of the tibia (Volkmann fracture) or fibula.

DANIS-WEBER

The Danis-Weber classification system is less complicated, and simply describes the location of the injury in relationship to the syndesmosis

Type A

This type occurs beneath the level of the syndesmosis. It corresponds to the Lauge-Hansen supination-adduction fracture, associated with a vertical fracture of the medial malleolus.

Type B

Fracture occurs at the level of the syndesmosis. It corresponds to either the supination-external rotation, or pronation-abduction fracture pattern. The posterior portion of the tibial may also be fractured.

Type C

This occurs above the level of the syndesmosis. It corresponds to the pronation-external rotation fracture type. It may be associated with an avulsion fracture of the tibia, delta ligament rupture, and fractures of the posterior malleolus.

TREATMENT CONSIDERATIONS

Treatment options for ankle fractures and dislocations include nonsurgical closed reduction with immobilization, and surgical open reduction with internal fixation. Conservative management has been recommended for most nondisplaced fractures. This is usually seen with single malleolar injuries. Operative repair is usually considered with multimalleolar fractures, dislocations, and open injuries. There are instances that the recommended treatment option may need to be modified when extenuating circumstances are present.[5]

Significant reduction may be seen with closed manipulation even with severely comminuted and displaced injuries (Figures 1-4). Surgical postponement may be due to skin conditions such as severe edema, or fracture blister formation. Other significant injuries or patient medical history requiring surgical clearance may delay operative correction. In the geriatric patient, it has been reported that both conservative care and surgical intervention has yielded successful results to ankle fractures and dislocations.[6,7] When good alignment is achieved and adequately maintained, closed reduction may be used to avoid surgery, or when surgical delays are inevitable.

Figure 1. Prereduction.

Figure 2. Prereduction.

Figure 3. Postreduction.

Figure 4. Postreduction.

TECHNIQUES IN CLOSED REDUCTION

Closed reduction[8] is usually accomplished with some form of sedation. Success has been reported with regional Hematoma Block, IV sedation, or general anesthesia.[9] To reduce an ankle dislocation, the foot and ankle are maneuvered in a way that reverses the forces applied during the injury. The injured extremity is flexed to 90 degrees at the knee, thus reducing the pull of the gastrocnemius-soleus complex (Figure 5). Longitudinal traction is applied throughout this process with countertraction by pulling up on the thigh. When reduction is completed in proper sequence, adequate reduction, decreased risk of skin ischemia, and restoration of neurovascular integrity should result.

In the supination-adduction type injury, the foot should be grasped by the heel and forefoot. The heel and foot should be rotated with an inverting motion. Distal traction is then applied pulling the foot away from the tibia and reversing the direction of motion, everting the heel and forefoot to bring the foot and ankle back beneath the tibia.

In the pronation-abduction injury, the foot is grasped in a similar manner. The heel and foot are everted, thus recreating the injury. Distal traction is applied to the foot followed by rotation of the heel and foot into inversion, relocating the foot and ankle, and reducing both the fibular and tibial malleolar fractures.

The supination-external rotation type injury is more complicated and requires greater skill to obtain accurate reduction of the fracture. With the knee flexed and proximal tibia stabilized, the foot is grasped at the heel and lateral aspect of the forefoot. The injury is recreated by external rotation, and slight eversion of the foot. With distal traction applied, the heel is pulled forward while the foot is rotated in the direction of internal rotation and slight plantarflexion. This initially opens the fibular fracture and allows distraction. The forward pull on the heel allows reduction to occur around the posterior surface of the fibular fracture. Plantarflextion is necessary to maintain distal traction on the fibula as the internal rotation closes the fracture gap.

The pronation-external rotation injury is easier to reduce due to soft tissue instability. The injury is again recreated by external rotation of the foot with slight eversion. The reduction technique is similar to that used for the supination-external rotation type injury. The knee is flexed and proximal tibia stabilized, the foot is grasped and injury recreated. Distal traction is created with slight anterior pull on the heel. The foot is rotated in the direction of internal rotation with supination and slight plantarflexion.

Following the reduction, the injured extremity is stabilized in a compressive dressing and posterior splint or cast. The leg has a natural tendency to externally rotate, so the foot can be held by the digits to remain inverted and internally rotated during cast application (Figure 6). Once the cast material is applied, the molding process can begin. Pressure is applied over the lateral malleolus below the fracture site. Additional pressure is applied over the medial aspect of the tibial metaphysis above the ankle joint. The reduction pressure is maintained until the cast has hardened. This process is utilized

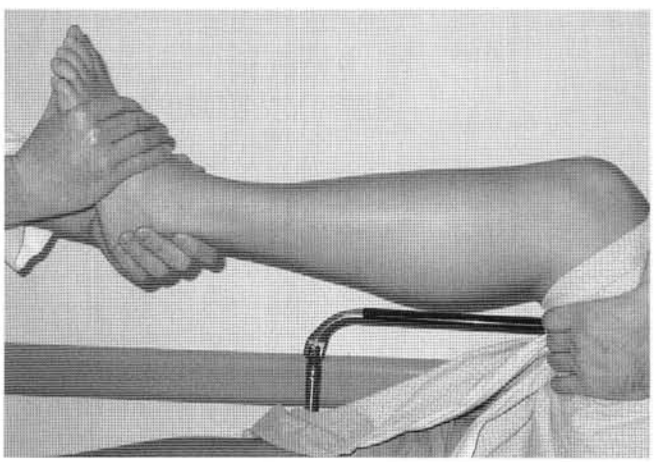

Figure 5.

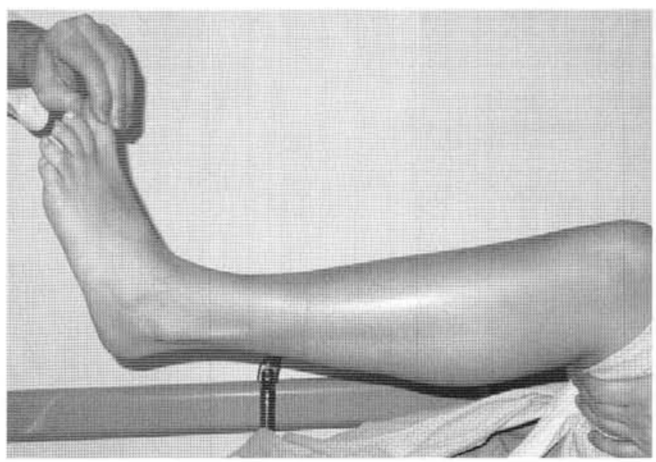

Figure 6.

to maintain the correction while the extremity is immobilized. Following the reduction and immobilization, radiographs are taken to evaluate the adequacy of the reduction.

CONCLUSION

Ankle fractures and dislocations can be a source of significant disability. Despite the frequency of these fractures, controversy still exists regarding the best treatment option.[10-12] The patient age, body mass index, general medical conditions, and social support structure, are only a few of the factors taken into consideration in determining the type of treatment to be provided.[5,8,13] Prompt identification and early anatomic reduction usually provides a more favorable prognosis and can be accomplished by either closed or open means. Closed reduction serves a valuable role of relocation of displaced joints, and reapproximation of bony segments. The methods of closed reduction, when applied appropriately, may preclude or delay subsequent surgical open reduction in fracture and dislocation management.

REFERENCES

1. Rivera F, Bertone C, De Martino M, Pietrobono D, Ghisellini F. Pure dislocation of the ankle. *Clin Orthop* 2001;382:179-84.
2. Colville MR, Colville JM, Manoli A. Posteromedial dislocation of the ankle without fracture. *J Bone Joint Surg Am* 1987;69:706-10.
3. Lauge N. Fractures of the ankle. *Arch Surg* 1948;56: 259-317.
4. Charnley J. The Closed Treatment of Common Fractures 3rd Edition. New York: Churchhill Livingstone; 1961.
5. Gumann G. Fractures of the Foot and Ankle. Philadelphia: Elsevier Saunders;2004.
6. Pagliaro AJ, Michelson JD, Mizel MS. Results of operative fixation of unstable ankle fractures in geriatric patients. *Foot Ankle Int* 2001;22:399-402.
7. Makwana NK, Bhowal B, Harper WM, Hui W. Conservative versus operative treatment for displaced ankle fractures in patients over 55 years of age. *J Bone Joint Surg Br* 2001;83:525-9.
8. Banks A, Downey M, Martin D, Miller S. McGlamry's Comprehensive Textbook of Foot and Ankle Surgery, 3rd Edition. Philadelphia: Lippincott Williams & Wilkins; 2001
9. Alioto RJ, Furia JP, Marquardt JD. Hematoma block for ankle fractures: a safe and efficacious technique for manipulations. *J Orthop Trauma* 1995;9:113-6.
10. Bauer M, Bergstrom B, Hemborg A, Sandegard J. Malleolar fractures: nonoperative versus operative treatment. *Clin Orthop* 1985;199:17-27.
11. Wei S, Okereke E, Winiarsky R, Lotke PA. Nonoperative treated displased bimalleolar and trimalleolar fractures: a 20-year follow-up. *Foot Ankle Int* 1999;20:404-7.
12. Konrath G, Karges D, Watson T, Moed BR, Cramer K. Early versus delayed treatment of severe ankle fractures: a comparison of results. *J Ortho Trauma* 1995;9:377-80.
13. Spaine LA, Bollen SR. The bigger they comeÖ: the relationship between body mass index and severity of ankle fractures. *Injury* 1996;27:687-9.