Ankle Sprains and Fractures in Adults

Kelly Small

The orthopaedic nurse will undoubtedly care for patients with ankle injuries. Ankle sprains and fractures are common injuries seen in orthopaedic practices in the United States. To provide comprehensive nursing care of these injuries, nurses should understand ankle biomechanics as well as anatomy. Knowledge of fracture classification schemes, pathology of injury, and treatment modalities is also important. Fracture classification schemes vary as do treatment modalities. Ankle sprains and fractures can be treated operatively or nonoperatively, and orthopaedic nurses play an important role in the care of patients with such ankle injuries.

Ankle sprains and fractures are common injuries encountered in the orthopaedic setting. Five million ankle injuries occur annually in the United States with ankle sprains accounting for 40% of sports injuries (Griffen, 2005). The orthopaedic clinician must understand ankle biomechanics, fracture classification schemes, pathophysiology of injury, and treatment modalities to care for the patient with an ankle injury.

Ankle Anatomy and Biomechanics

Understanding ankle anatomy and biomechanics is important to understanding ankle injuries. The ankle has several bony landmarks. Three bones articulate to form the ankle joint: the fibula, the tibia, and the talus (see Figure 1). The lateral malleolus of the fibula and the medial malleolus of the tibia provide the palpable landmarks of the ankle. The distal tibial articular surface is called the plafond or pilon. The plafond articulates with the talus and together, the plafond and talus distribute the stress of weight bearing through the ankle joint (Carr, 2008; Griffen, 2005; Koval & Zuckerman, 2002).

Laterally, the ankle is supported by three ankle ligaments: the anterior talofibular ligament (ATFL), calcaneal fibular ligament (CFL), and the posterior talofibular ligament (PTFL; see Figure 2). All three lateral ankle ligaments work together to provide lateral stability to the ankle joint. The ATFL connects the fibula and talus and maintains stability of the anterior aspect of the lateral ankle. The ATFL provides stability against anterior movement of the talus when the ankle is plantarflexed. The ATFL is the weakest of the lateral ankle ligaments and is often the ligament sprained when a patient sustains an ankle sprain. The PTFL, like the ATFL, connects the talus and tibia but provides stability to the posterior aspect of the lateral ankle. The CFL provides ankle stability by connecting the calcaneus and the lateral malleolus and limiting ankle inversion. The CFL is the strongest of the lateral ankle ligaments. It is at risk of a sprain if the ankle is dorsiflexed and an inversion force is applied (Griffen, 2005; Koval & Zuckerman, 2002).

Medially, the ankle is stabilized by the deltoid ligament. This ligament complex has a deep and superficial component. The deltoid ligaments are stout and require a higher energy of force (compared with the lateral ankle ligaments) before injury occurs. The deltoid ligament provides stability against lateral displacement of the talus. Isolated injuries to the deltoid ligaments are rare and occur from an eversion injury (Carr, 2008; Griffen, 2005; Koval & Zuckerman, 2002).

The ankle syndesmotic ligaments are located just proximal to the ankle joint. The syndesmotic ligaments connect the tibia shaft and the fibula shaft and hold them into position within the tibial plafond or ankle joint. The syndesmosis of the ankle consists of three main ligaments: the anterior inferior tibiofibular ligament, the interosseous ligaments, and the posterior inferior tibiofibular ligament (Carr, 2008; Griffen, 2005; Koval & Zuckerman, 2002). The syndesmotic ligaments resist axial and rotation forces against the ankle. These ligaments are important in the maintenance of ankle joint alignment. Even a slight 1-mm shift of the position of the tibia's articulation with the talus can result in alteration of weight distribution upon the talus, leading to early arthritis (Carr, 2008; Koval & Zuckerman, 2002).

Ankle biomechanics can vary slightly from person to person. However, even a small shift of tibiotalar alignment can result in poor outcome after ankle injury as ankle injury outcomes are highly dependent on the alignment of the ankle mortise (McConnell, Creevy, & Tornetta, 2004). In the stance phase, the ankle carries

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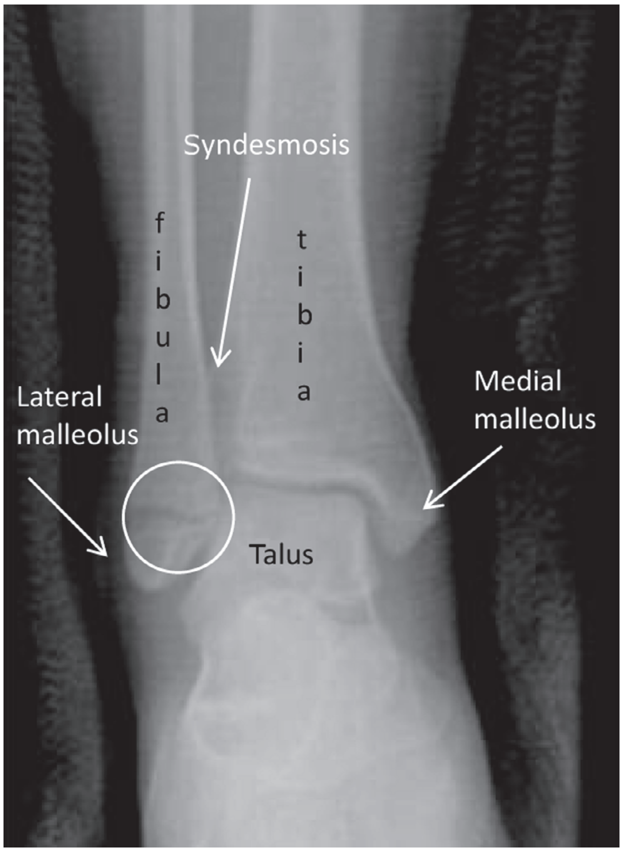

FIGURE 1. Landmarks of the ankle joint. The circle demonstrates a lateral malleolus fracture (Weber type A). This lateral malleolus fracture was treated without surgery, and the patient was allowed to weight bear as tolerated in a fracture boot.

up to four times an individual's body weight (Koval & Zuckerman, 2002).

Dorsiflexion and plantarflexion are the primary motions that occur at the ankle joint. Normal ankle range of motion (ROM) is 30° of ankle dorsiflexion and 45° of plantarflexion. However, only 10° of dorsiflexion and 20° of plantarflexion are needed for normal gait (Koval & Zuckerman, 2002). Inversion and eversion movements of the ankle are also important for normal gait. The subtalar joint (joint between the talus and calcaneus) allows for inversion and eversion movements of the ankle.

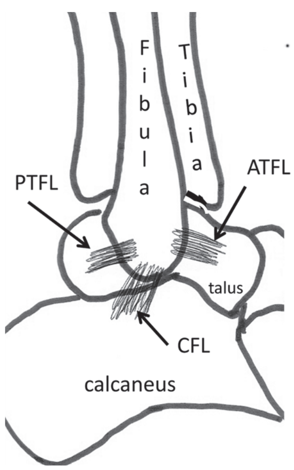

FIGURE 2. Lateral ankle ligaments and ankle anatomy. ATFL, anterior talofibular ligament; CFL = calcaneal fibular ligament; PTFL = posterior talofibular ligament.

Ankle Examination

When assessing a patient with ankle injury, a history of the injury should be obtained from the patient first. The clinician should ask the patient to describe the activity or movement that caused the injury and when the injury occurred. It is important to note whether pain prevented the patient from weight bearing after the injury. This information will help guide the clinician in the determination of the need for radiographs. The clinician will find it helpful to ask the patient to point to specifically where the pain occurs and to inquire about alleviating and aggravating factors. The patient should be assessed for comorbidities such as diabetes that can prolong healing times and increase the risk for wound and other complications. The patient should also be questioned about prior injuries to the ankle or chronic feelings of ankle instability.

Physical examination of the ankle begins with inspection of the skin for ecchymosis and swelling, which are usually present. Palpation of the ankle for areas of point tenderness is necessary. Areas of maximal tenderness are used to determine the need for radiographic studies (Bachmann, Kolb, Koller, Steurer, & Riet, 2003). The clinician should palpate over the medial and lateral ankle ligaments as well as over the syndesmotic ligament to assess for pain. Pain with palpation of the ligaments suggests a ligamentous injury. ROM and strength of the ankle should be assessed; however, the patient seen after an acute injury will have decreased strength and ROM due to pain.

Several tests have been described in the literature to assess the ankle, but the sensitivity and specificity of these tests are unknown (Williams, Jones, & Amendola, 2007). Examination of ankle stability includes the talar tilt and anterior drawer test. The anterior drawer test (see Figure 3) is performed by stabilizing the distal tibia area with one hand and pulling forward on the foot with

FIGURE 3. Demonstration of the anterior drawer test.

FIGURE 4. Talar tilt test.

the other hand. This should be performed on the uninjured side to compare. Greater anterior translation when compared with the uninjured side is positive for an ankle sprain involving the ATFL. The talar tilt (see Figure 4) involves stressing the CFL by placing one hand on the distal tibia and providing inversion stress on the ankle with the other hand. A positive talar tilt occurs when the ankle inverts more than the contralateral, uninjured side (Griffen, 2005). It is often impossible to use these tests in examination of the acute ankle sprain because of the amount of pain the patient is experiencing. These tests are often used to assess ligament stability after adequate healing time.

Next, the clinician should evaluate the syndesmosis. The squeeze test (see Figure 5) is used to evaluate syndesmotic injury. This is performed by squeezing the tibia and fibula together at mid-calf. Pain in the area of the syndesmosis (anterior ankle, just above the ankle joint) can be a clue to syndesmotic injury. Pain in the syndesmotic area with external rotation of the ankle is also indicative of syndesmotic sprain (Koval & Zuckerman, 2002).

FIGURE 5. Squeeze test. A positive test is noted if there is pain in the area of the syndesmosis (noted by the circle).

Radiography

The need for radiographing patients with ankle injury is guided by the Ottawa Ankle Rules. The Ottawa Ankle Rules have 100% sensitivity in determining the need for ankle radiographs of patients with a history of ankle injury (Bachmann et al., 2003). Table 1 outlines findings that require the clinician to order ankle radiographs, according to the Ottawa Ankle Rules.

If the need for radiographs is determined, the ankle should be evaluated with anterior posterior, lateral, and mortise views. A mortise view is taken with the leg internally rotated 15°–20° (Koval & Zuckerman, 2002). Sometimes a stress view of the ankle is used. In the external rotation stress view, the clinician holds the leg in an internally rotated position with one hand as if taking a mortise view. With the other hand, the clinician dorsiflexes the ankle to neutral position and externally rotates the ankle. This view stresses the medial ankle ligaments and syndesmotic ligaments to assess for complete rupture or injury. If there is severe enough injury, the medial mortise space is increased and the talus will displace laterally toward the fibula (Koval & Zuckerman, 2002; McConnell et al., 2004).

Ankle Sprains

Sprains of the ankle are common. Lateral ankle ligament injuries account for most sprains because the ankle biomechanics and anatomy place it at most risk to sustain inversion injuries (Carr, 2008). Most sprains occur from a plantarflexed and inverted injury to the ankle (DiGiovanni, Partal, & Baumhauer, 2004; Griffen, 2005). Usually, the ATFL is injured first and if the force is great enough, the CFL sustains an injury. Ankle sprains are sometimes graded from 1 to 3, depending on the severity of the injury. Grade 1 sprains are considered mild sprains; grade 3 sprains are the most severe.

Treatment of ankle sprains is usually accomplished in phases. Phase 1 consists of a common acronym—PRICE (Osborne & Rizzo, 2003) used in the treatment of ankle sprains. Another acronym, PRINCE, is preferred by the author. **P**rotection, **R**est, **I**ce, **N**onsteroidal anti-inflammatory drugs (NSAIDS), **C**ompression, and **E**levation are all important in healing of an ankle sprain. The ankle should be protected from further

TABLE 1. OTTAWA ANKLE RULES

Inability to bear weight immediately after injury and when seen for examination
Complaints of pain in the midfoot or around the medial/lateral malleoli
Pain to palpation on the posterior half or tip of the lateral malleolus
Pain to palpation on the posterior half or tip of the medial malleolus
Pain to palpation on the base of the fifth metatarsal
Pain to palpation of the navicular bone

Note. Based on "Accuracy of Ottawa Ankle Rules to Exclude Fractures of the Ankle and Mid Foot," by L. M. Bachmann, E. Kolb, M. T. Koller, J. Steurer, and G. Riet, 2003, *British Medical Journal, 326*, pp. 417–419.

injury and rested for the first 2–3 days. This is usually accomplished by avoiding weight bearing on the ankle and having the patient utilize crutches. Icing should be instituted during the first days following the injury. Application of ice for 15–20 min every 1–2 hr helps with pain relief and swelling. NSAIDS are helpful in pain control. Ibuprofen 600 mg every 6 hr for a week is commonly used as long as the patient has no history of gastric ulcers or upset. Compression wraps can be used initially to control swelling and pain. Elevation of the ankle above the level of the heart should be instituted early and helps with swelling (DiGiovanni et al., 2004; Griffen, 2005).

The second phase of ankle sprain treatment usually occurs 2–3 days after the injury. Ankle ligaments heal stronger when healing in the presence of a gentle load; thus, early weight bearing is encouraged early after an ankle sprain (Carr, 2008). Patients are usually placed in a stirrup type of brace for several days until ankle strength begins to return. Physical therapy is important in recovery. ROM exercises are instituted early. Once the patient can bear weight and perform ROM without increased pain, formal rehabilitation begins. Resistance exercises are added and proprioceptive ankle training is begun. Proprioceptive, agility, and endurance training are included once the patient reaches about 80% of his or her baseline ankle strength (Griffen, 2005). In a severe sprain, completion of an ankle rehabilitation program may take up to 8 weeks. In minor sprains, it may only take 1 or 2 weeks (Griffen, 2005). Some minor sprains can be treated with a home physical therapy program, whereas more severe sprains require formal physical therapy under a physical therapist's supervision. For a home physical therapy program, the author includes clockwise and counterclockwise ankle circles, "tracing" the alphabet using both upper- and lowercases and dorsiflexion and plantarflexion stretches using a kitchen towel. Once these movements are nonpainful, patients are given a resistance band for dorsiflexion, plantarflexion, inversion, and eversion strengthening exercises. To regain proprioception, the author has the patient balance on the injured foot during a daily activity such as brushing his or her teeth.

Patients should be cautioned to notify their provider if continued ankle instability, pain, or recurrent sprains occur. If patients continue to notice instability or recurrent sprains after rehabilitation of an ankle sprain, they may need to be evaluated by an orthopaedic ankle specialist. Patients complaining of frequent ankle sprains or instability may also have an underrehabilitated ankle and therefore will benefit from referral to formal physical therapy, if not already done. In cases of chronic instability and pain after ankle sprain, patients may not have adequately healed the ankle ligaments. These patients may benefit from operative ligamentous repair and/or joint arthroscopy (DiGiovanni et al., 2004; Griffen, 2005).

"High" Ankle Sprains

Ankle syndesmotic sprains account for 1%–11% of ankle sprains and are commonly referred to as "high ankle sprains" (DiGiovanni et al., 2004; Lin, Fross, & Weinhold, 2006). External rotation combined with dorsiflexion and axial loading is the mechanism of injury that leads to syndesmotic injuries. Skiers, football player, and soccer players are at greatest risk for these injuries (Griffen, 2005). These athletes make cutting movements while planting the foot, a movement that puts the syndesmosis at risk for injury. Patients who are diagnosed with a traditional ankle sprain and who continue to have pain despite adequate healing time (6 weeks) should be examined for a overlooked syndesmotic injury. Patients with syndesmotic injuries seen in the clinic avoid excessive ankle dorsiflexion in order to avoid the pain incurred with push-off (Lin et al., 2006). Magnetic resonance imaging can be helpful if syndesmotic injury is suspected as the physical examination does not always provide definitive diagnosis of this injury. Magnetic resonance imaging has a 100% sensitivity and 93%–100% specificity for identifying syndesmotic injuries (Oae et al., 2003).

Patients with syndesmotic injuries usually require a specialist referral. Syndesmotic injures can be treated with a fracture boot or short leg cast and non–weight bearing (Koval & Zuckerman, 2002). Sometimes surgery is required. Rehabilitation programs supervised by a physical therapist are then prescribed (Lin et al., 2006).

Ankle Fracture Definitions and Classifications

Ankle fractures are a common type of fracture. *Ankle fractures* are commonly defined as unimalleolar, bimalleolar, or trimalleolar. Unimalleolar fractures involve isolated injuries to one side of the ankle (either the medial or lateral malleolus). Bimalleolar fractures refer to fractures involving both the medial and lateral malleolus (see Figure 6). However, sometimes the lateral malleolus is fractured and the deltoid ligament is completely ruptured instead of the medial malleolus sustaining a fracture. This type of fracture is considered a bimalleolar equivalent and must be treated similarly to a bimalleolar fracture. Figure 6 depicts a bimalleolar

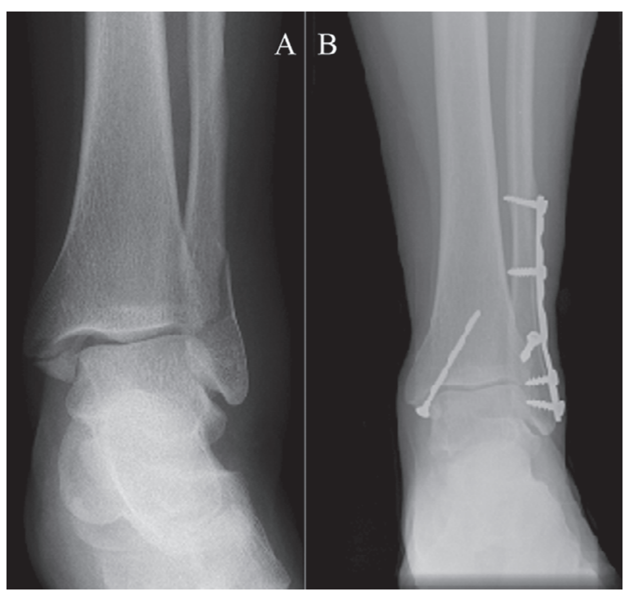

FIGURE 6. Bimalleolar ankle fracture before (A) and after (B) surgical fixation.

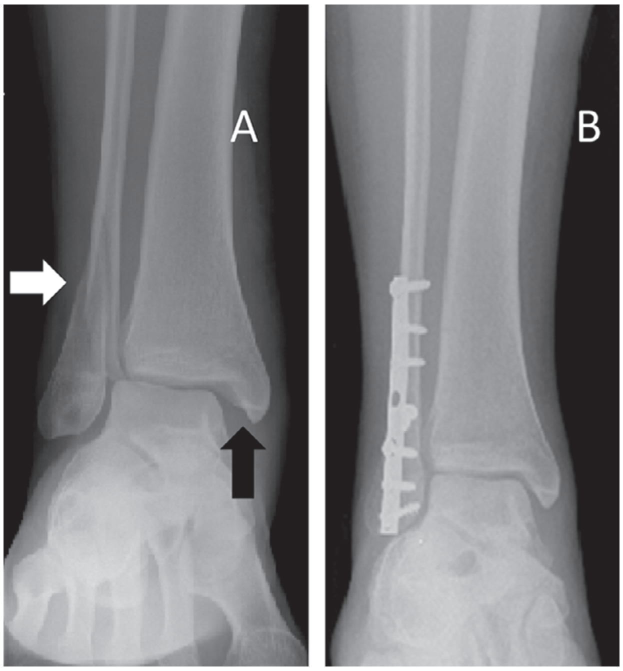

FIGURE 7. Radiographs of a bimalleolar equivalent ankle fracture. This fracture can also be classified as a Weber type B fracture or supination-external rotation fracture according to Lauge-Hansen. (A) Radiographs taken after injury. The white arrow demonstrates the fracture of the lateral malleolus. The black arrow demonstrates medial mortise widening consistent with deltoid and syndesmosis ligament injury. (B) Postoperative x-rays. This patient required only fixation of the lateral malleolus because there was enough ligamentous intactness to keep the joint stable after lateral fixation alone.

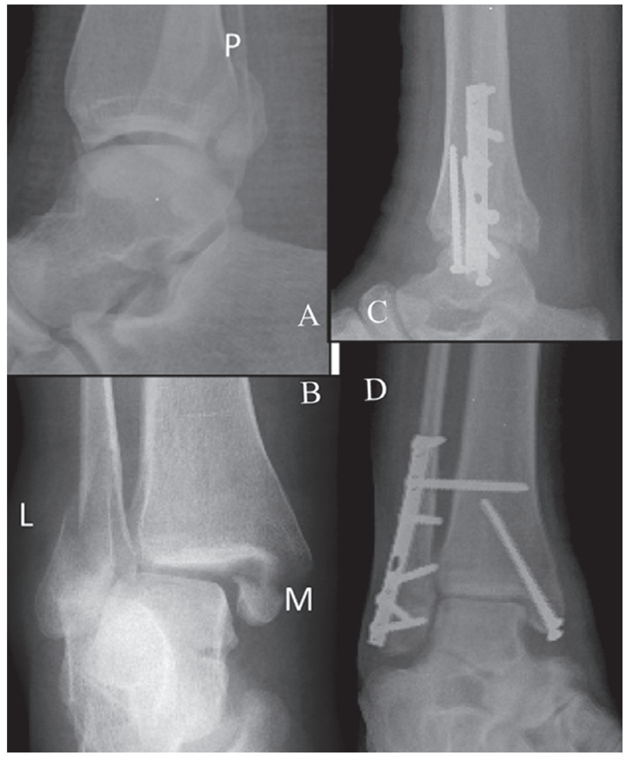

FIGURE 8. Trimalleolar ankle fracture. (A) Lateral radiograph showing the posterior malleolus fracture (P) and (B) anterior posterior radiograph showing the lateral malleolus fracture (L) and medial malleolus fracture (M). Radiographs (C and D) taken postoperatively showing fixation of the medial and lateral malleolus fracture. A screw was placed across the syndesmosis because it was unstable on intraoperative examination.

ankle fracture, and Figure 7 depicts a bimalleolar equivalent fracture. Trimalleolar fractures (see Figure 8) refer to fracture of the medial malleolus (or deltoid ligament rupture) and a lateral malleolus fracture with the addition of a posterior malleolar, or posterior tibia, fracture (Carr, 2008; Koval & Zuckerman, 2002).

Pilon fractures (see Figure 9) are a variant of ankle fractures of the tibia that involve the major weight-bearing part of the ankle joint, the tibial plafond. Pilon fractures are severe in nature and occur from axial loading mechanisms (Koval & Zuckerman, 2002). The force sustained, when a person falls off a ladder and lands on the feet, is an example of an axial loading mechanism that can lead to a pilon fracture. Pilon fractures require much more extensive fixation than a basic ankle fracture. Patients are required to be non–weight bearing longer and have longer recovery periods (Pollak, McCarthy, Bess, Agel, & Swiontkowski, 2005).

Two common classification schemes are used to classify ankle fractures. Danis-Weber classification is a simple classification of three basic types of ankle fractures based on the level of the fibula fracture. Type A fractures are fractures of the fibula distal to the joint line or ankle mortise. Type B fractures are fractures occurring at the level of the mortise. One half of Weber type B injuries have concurrent injury to the syndesmotic ligaments as well (Baumhauer, Nawoczenski, DiGiovanni, & Flemister, 2004). Type C fractures refer to fibular fractures occurring proximal to level of the ankle joint. The majority of these fractures have an associated injury to the ankle syndesmosis (Carr, 2008; Koval & Zuckerman, 2002).

A downfall of the Danis-Weber classification system is that it accounts only for injuries to the fibula. Often, injuries to the posterior and medial aspects of the ankle

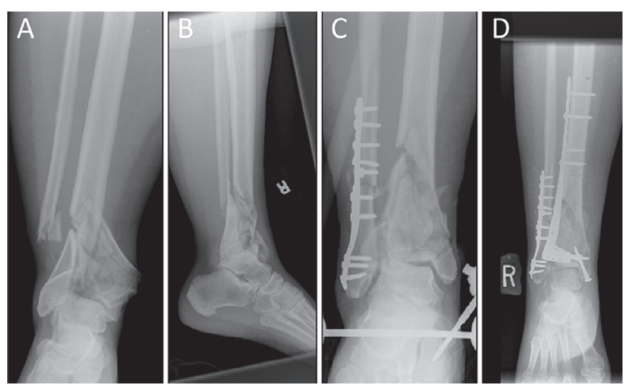

FIGURE 9. Radiographs of a pilon fracture. Anterior posterior view (A) and lateral view (B) of the patient on initially presentation to emergency department. The fibular fracture was fixed and an external fixator was placed (C), and then the patient was taken to the operating room 10 days later for definitive fixation of the tibia (D).

joint also occur in addition to lateral injuries of the fibula. A second classification, Lauge-Hansen, accounts for the full set of injuries. Ankle fractures are classified on the basis of mechanism of injury and pathology. The first part of the classification scheme refers to the position of the ankle at the time of injury. Two positions are identified: pronation and supination. Second, the type of force applied to the ankle is noted. This can be adduction, external rotation, or abduction (Carr, 2008; Koval & Zuckerman, 2002).

There are four Lauge-Hansen classifications combining the position and type of force: supination-adduction, supination-external rotation, pronation-abduction, and pronation-external rotation. Lauge-Hansen further divided each classification into phases (Carr, 2008; Koval & Zuckerman, 2002). Some ankle injuries can pass through a total of four phases or stop at the first, second, or third phase. In supination injuries, the force of injury starts on the lateral ankle and these structures fail first. In pronation injuries, the medial ankle is placed under tension first and the medial ankle is injured first.

Ankle Fracture Treatment

In the emergency department, ankle fractures are reduced under conscious sedation, and splints are placed. If the fracture is open or a dislocation is unable to be reduced, the patient is taken to the operating room urgently (Carr, 2008).

Some fractures are able to be treated without surgery. Isolated Weber type A (unimalleolar fractures below the syndesmosis; see Figure 1) can be treated without surgery in a fracture boot or an air splint. Early weight bearing is allowed. Treatment plans for stable Weber type B fractures vary among institutions as there is not a clear consensus on a "gold standard" for nonoperative treatment of these fractures. Weber type B fractures considered to be stable on stress radiographs are those isolated fibular fractures with no syndesmotic widening on stress radiographic views of the ankle (see Figure 10). These injuries are usually treated in fracture boots or ankle splints. Early weight bearing is usually allowed, although sometimes weight bearing is restricted for 6 weeks (Port, McVie, Naylor, & Kreibich, 1996).

Unstable Weber type B fractures and all Weber type C fractures require surgical management. If surgery is required for an ankle fracture, the patients most often undergo open reduction and internal fixation. Open reduction refers to incisional exploration of the fracture site with reduction of the fracture fragments. Internal fixation involves placement of implants, usually plate and screws, to hold the fracture in place. After fixation of the lateral malleolus, the ankle is stressed during surgery to determine the stability of fixation. If lateral malleolus fixation alone is not stable enough, more fixation is required (see Figure 9). Patients are placed in splints immediately after the operation and are usually placed in a removable fracture boot after 1–2 weeks. Usually, patients are required to be non–weight bearing for 6 weeks until radiographic findings show adequate healing (Carr, 2008; Koval & Zuckerman, 2002). After healing, patients are allowed to progress their weight bearing and wean out of the fracture boot.

FIGURE 10. Stable external rotation stress view. The medial mortise and syndesmosis do not widen when external rotation stress is applied while the x-ray is taken. This patient can be treated without surgery and was treated in a walking boot for 6 weeks and allowed to weight bear as tolerated.

Nursing Care

The patient with an ankle sprain or fracture will require astute nursing care. Education for patients with ankle injuries is paramount. These patients do not plan for the injury or surgery (if needed) and thus patients are often frustrated and anxious. Helping the patients understand their injuries is an important role of the nurse. Educating on the rationale for weight-bearing restrictions and fracture boots/casts as protecting the ankle from further injury helps the patients adhere to their restrictions. Many patients are frustrated by restrictions of their daily activities but need to understand the importance of adhering to their discharge plan (Kneale & Davis, 2006; Maher, Salmond, & Pellino, 2002).

Patients should also be counseled about the effects lifestyle and comorbidities may have on their injury. Tobacco cessation should be encouraged and resources for tobacco cessation should be provided for all tobacco users, as nicotine can cause wound complications and delayed bone healing. Patients with diabetes should be counseled on tight glycemic control so that healing is not delayed. Patients with diabetes will also need to be monitored more frequently with postoperative clinic visits, especially if diabetic neuropathy is present. Patients with diabetic neuropathy are at higher risk of skin breakdown, wound problems, and development of postoperative Charcot foot and ankle abnormalities (Kneale & Davis, 2006; Maher et al., 2002). In addition, patients should also be counseled to avoid NSAIDS as they can delay bone healing (Simon, Manigrasso, & O'Connor, 2002).

Postoperative pain management is also important. Monitoring for pain and providing pain relief are important in the immediate postoperative period. After 24 hr, most patients can be managed with oral pain medications at home (Smith, Agudelo, Parekh, & Shank, 2006).

Recovery

Return to full activities is usually not encouraged until around 6–8 weeks after an ankle sprain (DiGiovanni et al., 2004; Osborne & Rizzo, 2003). At this point, the collagen fibers are strong enough to withstand most stressors (DiGiovanni et al., 2004).

Recovery time is longer after an ankle fracture. Patients should use caution as total healing and remodeling of the injured ligaments and bones can take up to 6–12 months. Most patients are allowed to begin returning to normal activities after about 3 months as long as the fracture shows signs of healing on radiographs (Carr, 2008). However, when returning to daily activities, such as driving, patients should be counseled on being cautious. Egol, Shelkhazadeh, Mogatederi, Barnett, and Koval (2003) found that it took up to 9 weeks after an ankle fracture for braking reaction time to return to normal.

Prevention of future injury is important after ankle fracture and injury. Muscle weakness and imbalance can lead to recurrent ankle sprains, so adequate physical therapy is important to decrease the chance of future ankle sprain and injury (Baumhauer et al., 2004). Ankle taping and lace-up ankle braces are two mechanisms that have been found to reduce recurrence of ankle injuries in athletes (DiGiovanni et al., 2004).

Determining when an athlete can return to sports after ankle injury is not an exact science. Richie (2006) recommended assessing for several tasks before the patient returns to play. One method includes asking the patient to run down stairs. The patient with unstable or weak ankle ligaments will be apprehensive to do this. In addition, assessing to see whether the patient can stand on his or her toes and heels and balance solely on the injured leg can be used to assess for readiness to return to play (Richie, 2006).

Ankle injuries and fractures are common orthopaedic diagnosis encountered by the orthopaedic clinician. Proper knowledge, assessment, and management of these injuries are important for orthopaedic nurses in a wide variety of settings.

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