Ankle fractures are common among all populations, although incidence increases in the elderly. They are most often the result of simple falls and athletic injuries but also may be caused by underlying pathology. A thorough patient evaluation with description of the mechanism of injury is key to proper diagnosis.

This article examines the use of radiography and other imaging modalities in diagnosing ankle injuries, as well as several classification systems available to describe the pattern of injury and aid in treatment planning. Treatment, rehabilitation techniques and possible complications of ankle fractures also are discussed.

This article is a Directed Reading. Your access to Directed Reading quizzes for continuing education credit is determined by your area of interest. For access to other quizzes, go to www.asrt.org/store.

After reading this article, readers should be able to:

- Review ankle joint anatomy and the role of ligament structures in providing stability.
- Describe the role of imaging in patient diagnosis, treatment planning and follow-up.
- Discuss classification systems for ankle injury patterns.
- Determine when surgical reduction and internal fixation of ankle fractures is required and complications that may result from surgery.
- Describe rehabilitation techniques and functional recovery prognosis.

Injuries to the ankle are common in the general population and in athletes. It is estimated that 260,000 Americans sustain an ankle fracture each year and that ankle fractures occur in about 100 per 100,000 people in major cities. They constitute 21% of all sports-related injuries. One study reported that the incidence of ankle fractures has increased in recent decades, especially among the elderly.

Ankle fractures often are complicated by associated ligamentous injuries that must be repaired to ensure joint stability. The most common cause of ankle injury is excessive inversion stress. Fractures also may result from abnormal stress applied to the joint or when the strength of the bones is insufficient to support normal stress. Two classification systems, the Lauge-Hansen and the Danis-Weber, or Weber, are used widely to aid in the diagnosis and treatment of ankle fractures resulting from an acute injury. Several other fracture types do not fit into these classification schemes, including stress fractures and pathologic fractures. Diagnostic imaging techniques used to evaluate these injuries may include conventional radiography, magnetic resonance (MR) imaging, computed tomography (CT), radionuclide bone scanning and ultrasonography.

Stable fractures are effectively treated with casts and removable braces. Unstable fractures must be reduced promptly and accurately to optimize healing and minimize the length of hospital stay. When surgery is required, a wide variety of fixation devices and surgical techniques are used for open reduction and internal fixation of the ankle. Following surgery, these fractures also are treated with a period of immobilization, then rehabilitation to attempt functional recovery of the joint. Patient age, severity of injury, quality of treatment and use of rehabilitation interventions are parameters used to predict the outcome of ankle fractures.

Epidemiology

Ankle fractures are common to all groups of the population. Most ankle fractures are inversion injuries caused by sports activities or simple falls. Several
studies have shown that the incidence of ankle fractures has continued to rise, especially in postmenopausal women. The peak age range for men to suffer ankle fractures is 15 to 24 years, whereas the peak age range for women is 65 to 75 years. The injuries also occur frequently in the pediatric population. According to Davis, fractures of the ankle make up 5% of all pediatric fractures and 15% of physeal injuries with a peak incidence between 8 and 15 years. Sports that reportedly lead to unstable ankle fractures include football, baseball, cheerleading, softball, wrestling, basketball, gymnastics, motocross, rock climbing, rodeo, rugby, soccer and volleyball.

Risk factors for ankle fracture include obesity, diabetes, osteoporosis, prior injury and the level and type of physical activity. Falls are more common in the elderly, but one study reported that a higher rate of falls did not correlate with an increased rate of ankle fractures. Obesity is a risk factor for ankle fractures in children and adults and also is a predictor of poorer outcome following ankle fractures in adults. Type 2 diabetes has been associated with increased rates of foot and ankle fractures and corresponds to a higher fracture severity. Osteoporosis also is a risk factor for ankle fracture and subsequent re-fracture. Known risk factors for osteoporosis include female gender, older age, lower body mass index and a family history of the disease.

The risk of re-fracture also is significant for elderly patients. Center et al found that re-fracture risk of low-trauma ankle fracture in men and women was equal to the initial fracture risk of a man 20 years older or a woman 10 years older. For example, a woman who is aged 60 to 69 years has the same re-fracture risk as a woman aged 70 to 79 years has of initial fracture. Refractures reported in this study were most likely to occur in the first 2 years following the first fracture. The authors reported that incidental low-trauma fractures are a sign that subsequent osteoporotic fractures are likely and that these patients should receive preventative therapy.

**Ankle Anatomy and Biomechanics**

The ankle comprises 3 bones: the distal tibia, distal fibula and talus. It also includes the joint capsule and supporting ligaments (see Figure 1). Tibia and fibula are long bones, whereas the talus is short and squarish in shape. Long bones have a shaft called the diaphysis, which is located between 2 larger ends called the epiphyses. The epiphysis connects the diaphysis and epiphyses. The diaphysis is made up of compact bone that surrounds a medullary cavity containing marrow. The epiphysis consists of spongy bone covered by compact bone. Hyaline cartilage covers the end of each epiphysis.

![Figure 1. Posterior aspect of right ankle joint depicting bony and ligamentous anatomy.](image)
ossification centers appear to have a regular shape and have a well-defined cortex on radiographs.19

Joint Mechanics
Two separate articulations allow movement at the ankle. The true ankle joint, also known as the talocrural joint or mortise joint, consists of articulations between the lateral malleolus of the fibula, the inferior surface and medial malleolus of the tibia and the talus.1,18,19 The mortise is formed by the inner and distal articular surfaces of the tibia and the fibula, which serve as a roof over the talus, creating a uniplanar hinge joint.21 The medial and lateral malleoli allow controlled plantar flexion (as when pointing the toes down and lifting heels off the floor) and dorsiflexion (as when pulling the toes up from the floor).19,21 The talus is slightly wider anteriorly, making the ankle more stable when in dorsiflexion because the talus is effectively locked between the malleoli.19 The posterior malleolus, located on the posterior aspect of the tibia, may be fractured in association with other ankle fractures or ligament injuries. Posterior malleolus fractures often are associated with fibula fractures and are considered to be unstable.7 The talus and calcaneus are connected to the malleoli by the lateral and medial collateral ligament complexes.19

The tibiofibular syndesmosis joint allows slight widening between the tibia and fibula. The syndesmotic ligament is located between the tibia and fibula at the level of the tibial plafond (ceiling). This ligament allows 1-2 mm of widening at the mortise during plantar flexion and dorsiflexion.21 The posterior and anterior tibiofibular ligaments strengthen this joint.19

The gliding movements of the intertarsal joints allow other slight movements of the ankle joint.18 The subtalar joint often is included in ankle injury evaluation because it is where inversion (facing the sole of the foot inward) and eversion (facing the sole of the foot outward) occur. The joint comprises the talus and calcaneus.7

The distal tibia absorbs the compressive loads and stress placed on the ankle.21 Joint motion is guided and stabilized through a close interaction between the geometry of the ligaments and the shapes of the articular surfaces.22 Ankle stability is largely the role of the ligament structures. The deltoid ligament stabilizes the medial side of the ankle and has superficial and deep components.1 The superficial component consists of the tibiotalar, tibionavicular and tibiocalcaneal ligaments. The deep component is the primary medial stabilizer of the ankle. Eversion or external rotation of the ankle may damage this ligament.1

Laterally, 3 major ligaments resist inversion, anterior displacement of the talus and internal rotation. They are the anterior talofibular ligament, the calcaneofibular ligament and the posterior talofibular ligament. The anterior talofibular ligament resists inversion when the ankle is in plantar flexion and the calcaneofibular ligament resists inversion when the ankle is in dorsiflexion.1

Computer models used to design ankle prostheses demonstrated that during dorsiflexion, some fibers within the calcaneofibular and tibiocalcaneal ligaments rotate isometrically around their origins and insertions while all other more anterior ligament fibers slacken. During plantar flexion, however, the more posterior ligament fibers slacken. In addition, the point of articular contact moves from the posterior part of the mortise in plantar flexion to the anterior part in dorsiflexion. This causes the talus to roll forward during dorsiflexion and backward during plantar flexion.22

There are 2 fat pads around the ankle that are useful for detecting joint effusion and injury on radiographs: the anterior (or normal) pretalar fat pad and the posterior pericapsular fat pad.23 Beneath the anterior pretalar fat pad is a fibrous, synovial-lined capsule that is attached to the tibia, fibula and talus. When injured, it secretes synovial fluid that distends the fibrous capsule and causes displacement of the fat pad. Similarly, the posterior fat pad, located within the space between the posterioribia and talus bones, is displaced when a joint is injured, but requires more fluid build-up in the fibrous capsule that displaces the fat pad to be noticeable.23

Fracture Patterns
When a fracture occurs, the rigid structure and continuity of the bone or bones involved also breaks.20 The ring principle may be used to describe the injury pattern of the ankle joint and its supporting ligaments. This means that when a fracture or ligament rupture occurs on 1 side of the joint or “ring,” another fracture or rupture is likely to be present elsewhere.19 Blood vessels within the bone are damaged as well as surrounding soft tissues. The fractured bone undergoes 5 stages of healing: hematoma formation, granulation tissue formation, callus formation, bony callus formation (ossification) and remodeling.

After ankle fracture, a hematoma first forms between the ends of the bone fragments and an inflammatory response develops. The hematoma serves as the basis for a fibrin network to support and promote granulation tissue growth. New capillaries extend
into the granulation tissue and phagocytic cells, which remove debris. During the granulation tissue formation stage, fibroblasts, which lay down new collagen fibers, move to the site. Chondroblasts start to form cartilage as well. The bone fragments then are held together by this delicate procallus or fibrocartilaginous callus during the callus formation stage. Osteoblasts then begin to generate new bone to fill in the gap and osteogenic activity eventually transforms the fibrocartilaginous callus into bony callus. The repaired bone then is remodeled in the final stage by osteoblastic and osteoclastic activity in response to mechanical stresses on the bone. Over time, mature compact bone replaces the excess callus.  

**Medical History and Evaluation**

During initial evaluation of a patient suffering from an ankle injury, the clinician should obtain a detailed medical history that includes the mechanism of injury. Ankle fractures may be mistaken for sprains. Some fractures, including the “snowboarder’s fracture” are difficult to distinguish on physical examination from a lateral ankle sprain. Ankle-inversion trauma may result in physeal injuries in children, which may lead to joint deformity if not properly diagnosed and treated.

Patients with ankle fractures frequently have pain, swelling and an inability to bear weight on the affected ankle. If the ankle is dislocated, it should be manipulated as soon as possible to restore the anatomy and reduce risk of neurovascular compromise and skin necrosis. This reduction must be performed by a trained clinician and adequate analgesia should be given to the patient. The neurovascular status of the foot should be assessed both before and after the manipulation. Radiologic technologists should ensure that the joint is immobilized before imaging.

Syndesmosis injuries often are associated with ankle fractures and are important to detect because the ligament structures are crucial for ankle stability. Patients often have pain, ecchymosis (large purplish patch of blood under skin) and swelling in the lateral aspect of the ankle, and are unable to bear weight on the affected ankle. They also may have swelling on the medial side when a deltoid injury or medial malleolus fracture is present. An external rotation test may be performed to confirm a syndesmosis injury. It is performed by rotating the patient’s foot externally, which reproduces pain at the ankle.

When fracture is suspected, the American College of Radiology (ACR) recommends using the Ottawa Ankle Rules to determine whether radiographs are needed. The rules state that the patient must meet 1 of 3 criteria for radiographs to be deemed appropriate. The criteria include:

- Inability to bear weight immediately after the injury.
- Point tenderness over the medial malleolus, on the talus or calcaneus, or the posterior edge or inferior tip of the lateral malleolus.
- Inability to walk 4 steps in the emergency department.

Other imaging modalities may be used when the results of conventional radiography are inconclusive or in cases of multiple trauma.

**Diagnostic Imaging**

Conventional radiography is considered the most appropriate initial and low-cost examination for suspected ankle fractures and associated syndesmosis injuries. Other more sensitive and more expensive imaging exams may be used to better identify ankle injuries or for treatment planning. These include CT, MR, ultrasonography and radionuclide bone scanning. Imaging techniques also are used during surgery for open reduction of fractures and during follow-up examinations to monitor healing.

Both conventional radiography and CT are considered low-dose exams. The effective dose for radiography of the extremities is about 0.01 mSv and 1.0 mSv for a multidetector CT (MDCT) exam. It still is important to minimize radiation exposure to the patient. An important method for reducing exposure during conventional radiography is to collimate the x-ray beam to the anatomic area of interest. This also reduces scatter, which improves image contrast. Gonadal shielding also is required during extremity imaging because the shielding does not interfere with diagnostic information. This reduces the gonadal dose to 0. Radiologic technologists also should verify that female patients are not pregnant before imaging to reduce the risk of radiation exposure to the fetus. If it is necessary to perform an exam on a pregnant patient, the radiographer should carefully position lead shields over her abdomen and tightly collimate the x-ray beams.

**Radiography**

Based on the ring principle, it is likely that the patient with an ankle fracture has multiple injuries. Therefore, when a medial joint fracture is detected and the patient has associated lower leg pain, the
entire lower leg may be radiographed with anteroposterior (AP) and lateral projections to rule out a fibula fracture.\textsuperscript{18,19} The ACR recommends AP, lateral and 15° to 20° internal oblique (mortise) projections with additional projections added in questionable cases.\textsuperscript{25} The additional projections may include a 45° internal oblique or an off-lateral and a 45° external oblique radiograph, which may help demonstrate the malleoli and the tibiofibular articulation.\textsuperscript{8,18} Stress studies of the ankle can verify the presence of a ligament tear.\textsuperscript{18}

For a true AP projection, the radiologic technologist positions the patient supine on the exam table with the affected limb extended fully and no rotation. The ankle joint should be flexed, with the long axis of the foot placed vertically to the table. The technologist should center the central ray midway between the malleoli and perpendicular to the ankle joint (see Figure 2).\textsuperscript{18} When more of the leg needs to be imaged, the radiographer can use a larger cassette, but still should center the central ray at the joint and place a flat contact shield over the extended radiation field to prevent backscattered radiation from reaching the imaging plate.\textsuperscript{18,23} This projection may demonstrate ruptured ligaments or other types of separations if either the tibiofibular or talofibular articulations are shown in profile (see Figure 3). In a normal ankle, the tibiofibular articulation overlaps the anterior tubercle and the talus slightly overlaps the fibula, but no there is no overlapping of the medial talomalleolar articulation.\textsuperscript{18}
Rotating the ankle laterally or medially during patient positioning obscures the medial mortise. If the ankle is rotated laterally, the tibia and talus will be more superimposed over the fibula and the posterior aspect of the medial malleolus will be seen laterally to the anterior aspect. Medial rotation causes minimal superimposition of the fibula over the talus.

The degree of openness of the tibiotalar joint also indicates whether the ankle is properly positioned. If the proximal lower leg is elevated, the anterior tibial margin will be projected distally, which results in a narrowed tibiotalar joint space. If the distal lower leg is elevated, the anterior tibial margin will be projected proximally to the posterior margin, which results in an expanded tibiotalar joint space. During dorsiflexion, the talus is wedged into the anterior tibial region, which results in a narrow-appearing joint space; during plantar flexion, the calcaneus is moved proximally, resulting in a talocalcaneal superimposition.

Mediolateral or lateromedial positioning of the patient facilitates the lateral projection. For mediolateral positioning, the patient is supine and rotated toward the affected side until the ankle joint is lateral and the patella is perpendicular to the horizontal plane. The technologist should place a support under the patient’s knees to maintain this position and place the foot in dorsiflexion to prevent lateral rotation of the ankle. The central ray should enter the medial malleolus and be projected perpendicular to the joint. For lateromedial positioning, the patient is supine with the body turned away from the affected side until the extended leg is lateral. This position offers improved detail because the joint is closer to the cassette. The patella should be perpendicular to the horizontal plane and, if necessary, the technologist should place a support under the patient’s knee. The perpendicular central ray should enter one-half inch superior to the lateral malleolus. The technologist should include the lower one-third of the tibia and fibula, the entire calcaneus and all the tarsal bones to the base of the fifth metatarsal in the lateral radiograph. The medial and lateral talar domes should be superimposed and the lateral malleolus should be seen more inferior to the medial malleolus (see Figure 4).

If the talar domes are not superimposed, the lower leg or foot may be rotated or the lower leg may not be parallel to the cassette. The lateral talar dome will appear proximal to the medial talar dome when the proximal tibia is further from the table than the distal tibia. The medial talar dome will appear proximal to the lateral dome if the distal tibia is further from the table than the proximal tibia. Evaluating the height of the longitudinal arch can help determine which dome appears proximal. The navicular bone superimposes over most of the cuboid bone when the lateral dome is proximal and very little of the cuboid bone when the medial dome is proximal.

For the AP oblique projection of the mortise joint, the radiographer should place the patient in the supine position with the entire leg and foot angled 15° to 20°.
medially, until the internalleolar plane is parallel with the cassette. The foot should be in dorsiflexion so that the plantar surface of the foot is perpendicular to the leg. The central ray should be perpendicular to the joint and enter midway between the malleoli (see Figure 5).\textsuperscript{18}

On the AP mortise view, the mortise joint space should be uniform, with the lateral joint space visible and the fibula not overlapping the talus.\textsuperscript{18,19} When the ankle has been properly positioned, the space between the medial mortise and tarsi sinus (opening between the calcaneus and the talus) should be visible (see Figure 6). The ankle may be under-rotated if the tarsi sinus is not visible, and over-rotated if the tarsi sinus is visible but the medial mortise is closed.\textsuperscript{23} Widening of the joint space may be due to medial ligament rupture associated with a fracture.\textsuperscript{19}

It is important that the lower leg be parallel with the exam table for proper visualization of the tibiotalar joint space. When accurately positioned, the anterior margin of the distal tibia should be about 3 mm proximal to the posterior margin. When the proximal tibia is elevated, the joint space will appear narrowed or obscured. Elevating the distal tibia makes the tibiotalar joint space appear expanded and demonstrates the tibial articulating surface.\textsuperscript{21}

The radiographer can obtain the 45° medial-oblique projection with the patient supine and with the affected limb fully extended and rotated internally 45°. It is important that the foot remain in dorsiflexion so that the ankle is at nearly 90° flexion. The foot may be supported by a foam wedge. The central ray should pass perpendicularly midway between the malleoli. The resulting radiograph clearly demonstrates the tibiofibular syndesmosis and the distal tibia and fibula without superimposition over the talus. For the 45° lateral oblique projection, the patient is positioned the same as for the medial oblique except the leg is rotated externally 45°. This projection is useful for determining fractures at the subtalar joint and the superior aspect of the calcaneus.\textsuperscript{18}

Stress radiographs usually are requested when a patient has suffered an inversion or eversion injury. The patient is placed supine with the injured leg extended and the ankle in dorsiflexion. The radiographer must turn the foot opposite the site of the injury and obtain an AP radiograph with the perpendicular central ray passing midway between the malleoli.\textsuperscript{18} If the applied stress is too painful for the patient, the physician or orthopedic surgeon may inject a local anesthetic into the sinus tarsi.\textsuperscript{9} When a ligament has ruptured on the side of the injury, the radiograph will demonstrate a widening at the affected joint space.\textsuperscript{18}

\textit{Computed Tomography}

According to the ACR, CT is not recommended for initial evaluation of suspected ankle fractures. However, CT has proven to be an effective diagnostic tool in cases of high-energy multiple trauma or when joint effusion is present without a visible fracture on radiographs.\textsuperscript{25} CT also is frequently used for surgical treatment planning. Haapamaki et al reported that MDCT is superior to radiography in cases of multiple trauma or when complex ankle fractures are suspected.\textsuperscript{27} Advantages of this modality are that ankle positioning is not critical.

---

\textbf{Figure 5.} AP oblique medial rotation (mortise joint) ankle position. Note the malleoli are equidistant from the imaging plate, indicating adequate joint rotation. Image courtesy of Jennifer G Hayden, MS, R.T.(R)(M), and Caroline B Goffena, MPH, R.T.(R)(MR), instructors at the University of North Carolina at Chapel Hill division of radiologic science.
ankle exams required 2 consecutive scans in perpendicular orientations. This technology can produce 3-D images in numerous planes from the raw isotropic data collected in 1 acquisition. The data can be reconstructed to any plane of choice for the reviewer, including axial, coronal, sagittal and infinite oblique planes.

Patient positioning is not as critical because of the ability to reformat the data. This adds to patient comfort and reduces the need for repeat exams. These improvements over single-slice CT reduce the need for sedation of pediatric patients and lower radiation dose to the patient. The protocol for a pediatric ankle evaluation using 16-slice MDCT is 120 kV, 20 to 80 mAs (depending on patient weight), with 0.5 second rotation time, 0.75 mm collimation and 0.75 mm thick sections at 0.5 mm intervals. The raw data are transferred to a workstation for reformatting into 3-D CT images. The entire process of 3-D manipulation of the data set and interpretation of the results usually takes less than 5 minutes.

One study described MDCT as an important tool in evaluating musculoskeletal disease in pediatric patients. Children who are afraid benefit from shorter scan times. The exam is useful for defining the extent of displacement of the physeal component in Salter fractures or displacement involving the epiphyseal plate. Determining the extent of physeal displacement also assists in decisions regarding whether the patient will need internal fixation. Identifying when surgery is needed for Salter injuries is an added benefit of CT because the injuries are associated with growth arrest. CT also can be useful for follow-up to assess the development of deformities or premature physeal closure, compartment syndrome and ligament laxity.

Techniques for manipulating CT data include volume rendering, shaded surface display and maximum intensity projection. These techniques better display anatomic relationships and disease processes of soft tissues in the foot and ankle joints. One report stated that 2-D multiplanar reformatted images most often were used for diagnosis, especially of small fractures. Volume rendering helps depict the relationships between ankle tendons and the bony structures beneath. When a fracture extends to the articular surface, shaded surface display may be used to isolate the fractured surfaces from overlapping structures.

MDCT is useful for postoperative open reduction and internal fixation evaluation. Streak artifacts due to x-ray attenuation from orthopedic hardware have been a problem in the past. The attenuation would lead to
missing data on reconstructed axial images. With 3-D imaging, data reformation into other planes weights the true signal over the randomly distributed artifact, enhancing the true signal and reducing the metal-related artifact on volume-rendered 3-D CT images.

CT arthrography may be used to delineate cartilage covering and loose bodies within the joint. It also is an effective tool for diagnosing pediatric stress fractures because it demonstrates endosteal bone response, which may otherwise resemble a tumor.

Atesok et al described the use of intraoperative CT imaging using the Siremobil Iso-C3D (Siemens Medical Solutions, Malvern, Pennsylvania). The device is a mobile fluoroscopic C-arm with a specially designed computerized image processing workstation. The C-arm has a motor unit that transports it steadily and continuously over a 190° arc for visualization of a 119 mm area. A set of 2-D fluoroscopic images in fixed angular steps is recorded during this rotation. The images are transported from the C-arm to the hard disk and then to a computerized workstation. Multiplanar CT images and a 3-D reconstruction set are available 5 seconds after scanning. According to the study, surgeons could identify unacceptable reduction and inappropriate position of joint fragments, enabling them to make corrections during surgery instead of having to perform a second surgery.

CT or MR imaging can determine the extent of a stress fracture and assist with treatment planning and follow-up. CT is less sensitive than MR but is useful for determining the extent of the fracture and when surgical repair is required. A CT scan may show the disruption on the bony cortex and evidence of periostitis.

**Magnetic Resonance Imaging**

The usefulness of MR imaging to detect fractures has been debated. Campbell and Warner stated, "MR imaging is exquisitely sensitive for detection of fractures." Remplik et al, however, found no statistical difference in detection of acute fractures of the distal extremities between MR and conventional radiography. MR is used to evaluate ligament or tendon injuries associated with ankle fractures and is an effective tool for evaluating questionable joint stability. Gardner et al found that the appropriate clinical application of MR findings still is unclear because of the debate regarding which combination of ligament injuries results in joint instability.

MR imaging of the ankle is performed with an extremity coil. The technologist should place the patient in a supine position and the affected extremity in a neutral position. The scan sequences used depend on the pathology in question. Fluid sensitive T2-weighted fat-suppression and short T1 inversion recovery (STIR) sequences may demonstrate effusion. Gardner et al used transaxial T2-weighted fast-spin-echo, sagittal T1-weighted spin-echo, fast inversion recovery and coronal fast-spin-echo imaging sequences. In the study, an MR radiologist used the axial T2-weighted images to evaluate the syndesmotic, talofibular and deltoid ligaments to determine whether the ligaments were intact, partially torn or completely torn.

MR imaging provides better spatial resolution and specificity than CT for evaluating stress fractures and can detect minor stress reactions on a STIR sequence or fat-suppressed T2-weighted fast spin echo sequence. Muthukumar et al suggested a T1-weighted sequence and an edema-sensitive sequence or a T2-weighted sequence with frequency-selective fat suppression for evaluating stress fractures. The authors described the appearance of a stress fracture as a line of low signal intensity on all MR sequences. The most common pattern demonstrated was a fatigue-type fracture demonstrating the fracture line surrounded by an ill-defined zone of edema. When evaluating ankle stress injuries, MR best demonstrates viability, bone marrow response and mechanical stability. MR also is noninvasive, uses no ionizing radiation and can be performed more quickly than scintigraphy.

**Scintigraphy**

Scintigraphy, or radionuclide bone scanning, can show a stress fracture 1 to 2 weeks before it may be detected radiographically but the modality is nonspecific. Little patient preparation is needed for these exams. Patients are instructed to wear normal clothing, but to remove all metal objects both outside and inside of the clothing so the objects do not cause artifacts that could appear as pathologic conditions on the images. Radioactive tracers are injected and localize in areas of increased osteoblastic activity. The tracers emit gamma rays that are detected with a gamma, or scintillation, camera. The camera transforms the gamma emissions into images that are recorded on a computer or film.

The radiopharmaceuticals commonly used to evaluate bone pathology are technetium Tc 99 hydroxymethylene diphosphonate 99 and 99mTc methylene diphosphonate. The adult dose is 20 mCi (740 MBq) and the pediatric dose is adjusted according to the patient’s weight. The time between injection of the radiopharmaceutical and the bone scan is 2 to 3 hours and the
scan takes approximately 30 to 45 minutes. Differential diagnoses may include bone infection or tumor.

**Ultrasonography**

Ultrasonography is an effective tool for evaluating bony avulsion at a ligamentous insertion and ankle ligament integrity. It is much less expensive than MR imaging for evaluating the same anatomic region, costing only 19% of the professional and technical fees charged for MR. Inversion injuries often result in lateral ankle ligament tears, most commonly the anterior talofibular ligament, followed by the calcaneofibular ligament. Additionally, chronic ankle joint instability may result from sprains. The diagnostic accuracy of ultrasound for anterior talofibular tears has been reported to be 90% to 100%. Accuracy is lower for calcaneofibular tears (87% to 92%) and anterior tibiofibular tears (85%).

Three categories have been created for ultrasonic classification of sprains. Mild acute sprains result in a normal or slightly thickened ligament. The moderate to severe (partial tear) sprains show an anechoic area where partial interruption in the ligament has occurred and the ligament remains taut on examination. In the complete ligamentous tear, there is a complete avulsion of fibers appearing as a hypoechoic gap.

Regardless of the modality used, careful elicitation of the patient history and clinical findings are key to image analysis. Alternative diagnoses to ankle fracture include tendinitis, strain, sprain, claudication, infection, and tumor.

**Classification of Ankle Fractures**

According to Skinner, “The purpose of any classification scheme is to provide a means to better understand the extent of injury, describe an injury, and determine a treatment plan.” Neither the Lauge-Hansen nor the Weber classification system encompasses all fracture types. Isolated fractures of the talus, stress fractures and pathologic fractures are some examples that are not included in these schemes. The Salter-Harris anatomic system commonly is used to classify pediatric ankle fractures. Ankle fracture dislocations may be called bimalleolar when the medial and lateral malleoli are involved and trimalleolar when the posterior malleolus also is fractured.

**Lauge-Hansen**

The Lauge-Hansen system was created to enable prediction of the mechanism of injury and pattern of ligament injury based on the radiographic appearance of ankle fractures. The system is based on foot position (pronate or supinate) and the direction of force applied (adducting, abducting or externally rotating) at the time of injury. It was derived after studying cadaver feet placed under different stresses and in different positions. Lauge-Hansen determined that injury to the ligaments and bones occurred in a predictable sequence when placed under a deforming force. The time at which the deforming force ceases during the injury sequence determines the degree of injury. The 4 basic mechanisms of injury described by the Lauge-Hansen system are:

- Supination-adduction.
- Supination-inversion.
- Pronation-abduction.
- Pronation-external rotation.

Another type of injury later was added to the system to describe the mechanism for tibial plafond fractures, called the pronation dorsiflexion injury. A drawback to this classification scheme is the difficulty patients have stating exactly how their foot was positioned at the moment of injury.

A study by Gardner et al found that of the 59 ankle fractures they evaluated, only 49 fit into Lauge-Hansen categories and that 26 of these had ligament injuries that were not predicted by the Lauge-Hansen scheme. The authors compared MR images with radiographs to determine the extent of soft-tissue injury in these patients. They suggested using the Lauge-Hansen system simply as a guide for the diagnosis and management of ankle fractures and using MR imaging to evaluate atypical injuries and plan surgical treatment.

Arimoto and Forrester devised an algorithm based on the Lauge-Hansen system to improve the diagnostic usefulness for radiologists. They determined that the direction of deforming force could be derived from reviewing the radiograph for the presence and location of a fibula fracture, including its location in relation to the tibial plafond and the direction of the fracture. The medial and posterior malleoli then were evaluated to help establish the type of force applied and degree of injury completeness. The authors claimed that the algorithm helps radiologists accurately diagnose fractures and ligament tears based solely on the radiographic exam even without full knowledge of the mechanism of injury.
■ **Type A.** An avulsion fracture of the fibula distal to the joint line with the syndesmotic ligament left intact and the medial malleolus either normal or with a shear-type fracture pattern.

■ **Type B.** A spiral fracture of the fibula extending from the joint line in a proximal-posterior direction up the fibular shaft. The tibiofibular joint syndesmosis is usually intact. The medial or posterior malleoli may sustain avulsion fractures or be intact. When the medial malleolus is not fractured, the deltoid ligament may be torn.

■ **Type C.** A fibula fracture proximal to the syndesmotic ligament complex with disruption of the syndesmosis. The medial malleolus also includes an avulsion fracture or deltoid ligament rupture; a posterior malleolus avulsion fracture may be present.

Posterior malleolar fractures also may be classified as the posterior-oblique type, medial-extension type or the small-shell type. One study reported that CT was preferred over radiography for determining the size of a posterior malleolar fracture fragment because the angle of the fracture line is highly variable and the fracture lines often are irregular.\(^5\)

**Other Types of Fractures**

Ankle fractures that are not included in the Lauge-Hansen or Weber schemes include fractures of the lateral process of the talus (a common snowboarding injury), stress fractures of the distal tibia or distal fibula and medial malleolus and pathologic fractures.\(^1,20\)

Lateral process fractures of the talus usually result from an external rotation force while the ankle is in fixed dorsiflexion and inversion. There are 3 basic types of lateral process fractures of the talus:\(^1\):

■ **Type I.** An extra-articular fracture of the anterior/inferior aspect.

■ **Type II.** A nondisplaced simple fragment extending from the talofibular joint surface to the posterior subtalar joint surface. Type IIB helps to differentiate a displaced fragment with the Type II pattern.

■ **Type III.** A comminution of both the fibular and posterior subtalar articulating surfaces. These fractures are best demonstrated on lateral and internal oblique radiographs and CT.\(^1\)

A stress fracture may be partial or complete and is caused by the repetitive application of stress at a level lower than the amount required to fracture the bone in a single loading. Stress fractures begin with an increased rate of osseous remodeling. Resorption and rarefaction follow, and focal trabecular microfractures occur. They can progress to a linear stress fracture and a periosteal or endosteal response.\(^31\) Stress fractures often present with vague, poorly localized and aching-type pain.\(^1\) They are common in sports that cause repetitive load to the lower extremity, such as track and field, distance running, court-based sports and dancing.\(^31\) Factors that have been associated with the etiology of stress fractures include an underlying medical disorder, lack of flexibility, poor strength or muscle imbalance, rapid changes in athletic training, increased physical activity, failure to wear proper shoes while exercising, diet and artificial training surfaces or switching from one type of training surface to another.\(^1,8,31\)

Symptoms usually develop over the course of 2 to 3 weeks, but may occur sooner or last longer. The patient may have localized pain, redness, swelling and warmth and palpable periosteal new bone with reduced activity, poor strength or muscle imbalance, rapid changes in athletic training, increased physical activity, failure to wear proper shoes while exercising, diet and artificial training surfaces or switching from one type of training surface to another.\(^1,8,31\)

Radionuclide bone scans may help to evaluate stress fractures because the fractures rarely are seen on conventional radiographs.\(^1\) The sensitivity of radiography is only 15% to 35% for initial evaluation of stress fractures and 30% to 70% during follow-up. Whether the stress fracture is detected depends on how much time has elapsed since the injury developed and the type of bone involved. These fractures are easier to detect in cortical bone than cancellous bone.\(^8\)

**Salter-Harris**

The Salter-Harris classification system divides injury patterns in skeletally immature patients into types I through V (see Figures 7 and 8). They are described as follows:\(^13\):

■ **Type I.** This is a physeal injury without radiographic evidence of bony injury.

■ **Type II.** Has a fracture line that extends transversely through the physis and exits proximally through the metaphysis.

■ **Type III.** The fracture line transverses the physis and exits distally through the epiphysis.

■ **Type IV.** The fracture line traverses the epiphysis and physis and exits the metaphysis.

■ **Type V.** This is a crush injury to the physis.\(^15\) Injuries to the syndesmosis are common with ankle fractures and are divided into types I through III. A type I syndesmosis injury presents with normal
alignment of the ankle and stability is maintained on supine inversion/eversion stress views. A type II appears stable on nonstressed views, but demonstrates widening and instability on stress views. The type III shows widening of the medial clear space and often widening at the tibia-fibula articulation.13

**Pathologic Fractures**

Pathologic fractures are caused by bone tumors or osteoporosis and occur spontaneously or with little stress on the bone. Most primary bone tumors are malignant. Osteosarcoma, Ewing sarcoma and chondrosarcomas are some examples of primary bone tumors. Treatment of primary bone tumors often requires amputation or excision, sometimes followed by chemotherapy. Secondary bone tumors usually result from metastatic spread of breast, lung or prostate cancers.20

**Treatment**

Several methods are available for managing ankle fractures. Most emphasize the importance of early and accurate reduction of the joint and initiation of joint motion as soon as possible. Jelinek and Porter described the priorities for managing ankle injuries. They stated that the ankle first should be evaluated for adequate blood flow, which is demonstrated by normal flesh color and palpable pulses. Provisional reduction of marked deformity or dislocation should be completed next. This may be performed on site by a trained emergency responder or by a physician in the emergency department. Next, a clinician should care for open wounds or soft-tissue injuries. It is only after these issues have been addressed that precise reduction of skeletal deformity and repair of any associated injuries can take place. Rehabilitation and the
care of potential complications are the final steps in fracture management. Jelinek and Porter wrote that joint mobilization as soon as possible, without compromising the reduction, is key to achieving an optimal functional outcome.15

Others have reported similar management, but specifically that 4 criteria must be met for optimal treatment. The first criterion is to reduce dislocated fractures as soon as possible. Next, all joint surfaces should be restored precisely. The fracture then must be held in a reduced position during the period of bony healing.21 Lastly, joint motion should be initiated as early as possible, although there is debate over exactly when to initiate motion.21

According to Gardner et al, “The first decision to make when treating ankle fractures is whether surgical reduction and fixation are necessary. The most important underlying factor in this decision is whether the ankle is stable or unstable.”99 Bimalleolar, trimalleolar, fracture-dislocations and some isolated fibula fractures that present with more than 5 mm of medial clear-space widening or syndesmotic widening radiographically are considered unstable.10 The integrity of the ligament structures is important for determining overall ankle joint stability. Stable fractures usually are treated successfully with conservative care, but unstable fractures require internal fixation to maintain joint reduction until the fracture(s) have healed.39 A consideration in treating athletes is how rapidly the patient desires a safe return to sports, and surgery often establishes stability sooner. The type of hardware chosen for surgical fixation depends on the degree and type of injuries.13

Approximately 25% of ankle fractures are treated with surgical stabilization each year in the United States.3 When surgery is indicated for treatment, it is best performed as soon as possible to reduce the risk of complications, such as blistering or swelling, and extra costs of an extended hospital stay. One study reported that the total length of hospital stay for patients undergoing surgery within 48 hours of diagnosis was 5.4 days, compared with 9.5 days when surgery was delayed more than 48 hours.4 Surgical risk factors include infection and reaction to the osteosynthetic material used to correct the fracture.5

Patients with stable undisplaced fractures, such as isolated Weber A or B fractures with no talar shift or medial joint tenderness, often are given an ankle brace or elastic support for comfort and are encouraged to fully bear weight immediately.11 A wide variety of hardware is available for surgical fixation. Porter et al reported that they treated Weber A injuries with retrograde intramedullary 4.5 mm or 5.5 mm cannulated screw fixation after anatomical reduction.40 Clinicians may choose to follow up patients with these fractures to be certain no talar shift occurs.11

If a fracture is potentially unstable, such as an isolated Weber B or C fracture, the patient’s ankle may be placed in a below-knee back slab to allow for swelling. A back slab has a plaster back that extends from the tibial tubercle posteriorly to the calf, ankle, heel, sole and toes. The slab is left open on top to allow for swelling, but a soft bandage is wrapped around the back slab and anterior portion of the lower leg and ankle to keep it in place. After a 1-week follow-up appointment with imaging of the ankle to ensure adequate positioning of the joint, the back slab usually is replaced with a lightweight cast. Immobilization with no weight bearing for the initial 6 to 8 weeks is required.11

Unstable injuries that require surgical stabilization include bimalleolar or trimalleolar fractures, dislocated fractures and lateral malleolar fractures with deltoid ligament injury, syndesmosis injury or talar shift. Surgery to restore the fibular length and mortise integrity should be carried out as soon as possible or once significant swelling has subsided. During surgery, the syndesmosis is evaluated clinically and with fluoroscopic imaging. When instability of the syndesmosis is suspected, repair may be performed by passing 1 or 2 screws from the distal fibula to the tibia (see Figures 9 to 11).21

Jelinek and Porter described treating Weber B injuries with anatomical reduction and anterior-to-posterior lag screw fixation, and a posterolateral one-third semitubular antiglide plate. They also described stabilizing the fibula for Weber C injuries with a lateral plate and occasionally a 2.7 mm or 3.5 mm lag screw; the plate thickness depends on the amount of comminution and length of fracture. When the syndesmosis remains unstable to external rotation stress the authors recommend placing 1 to 2 cannulated syndesmosis screws (size 4.5 mm) through the lateral fibular plate and across the 3 cortices. They also use these techniques for bimalleolar fractures with additional direct repair of the deltoid ligament, which is achieved with 2 size 1 Vicryl (Ethicon Inc, Somerville, New Jersey) absorbable horizontal mattress sutures in the deep deltoid and 2 size 0 Vicryl sutures in the superficial deltoid.21 Patients should not fully bear weight for 6 to 12 weeks following deltoid ligament repair, at which time the screws are removed.11,12 A below-knee cast is applied and patients are encouraged to elevate the foot to prevent swelling. Some clinicians,
medial malleolus fracture is present. Advantages to this approach stem from the direct visualization of the posterior fragment, which promotes anatomical reduction and better inspection for osteochondral fragments and talar chondral damage. The approach also allows the orthopedic surgeon to clean the fracture of interposed callus or periosteum when surgery has been delayed.\(^1\)

Open fractures must be treated with debridement, irrigation, antibiotics and internal fixation. Because of the likely contamination of these wounds, intravenous broad-spectrum antibiotics may be required. Complications for these wounds include swelling, infection and soft tissue loss, which may inhibit skin closure over the orthopedic hardware.\(^1\)

Treatment of stress fractures includes rest, flexibility exercises and use of nonsteroidal anti-inflammatory drugs (NSAIDs). Return to activity is progressive and usually takes 6 to 12 weeks. A chronic nonunion fracture may require surgery and bone grafting.\(^1\)
They support the use of a removable brace because patients have been shown to return to normal activity sooner and because, unlike casts, braces do not require special orthopedic services for placement or removal. When physeal injuries occur, however, open reduction and internal fixation may be required to decrease the risk for physeal arrest and enhance articular congruity. Surgery is recommended when displacement is > 2 mm at the articular surface or 3 to 4 mm at the physis after closed reduction or if any rotational or angular deformity is present.

Age is a predictor of outcome. One study determined that patients older than 40 years had a less functional recovery than younger patients. Another study claimed it was more important for elderly patients to recover function of the ankle joint as quickly as possible because bone mass density, proprioception and muscle force already reduced because of their age. Severely dislocated fractures also have a poorer prognosis. Diabetes increases the rate of in-hospital mortality, in-hospital postoperative complications, length of hospital stay and the total cost of treatment for ankle fractures. On average, patients with diabetes are in the hospital 1 day longer than patients without diabetes and incur approximately $2000 more in charges for treatment.

Rehabilitation and Functional Recovery

A wide variety of rehabilitation interventions are available, with the goal of obtaining functional recovery of the joint. According to Egol et al, factors predicting functional recovery at 1 year include younger age, male sex and absence of diabetes. A review of current intervention techniques found that there is no consensus regarding which immobilization device works best, when weight bearing ideally should begin or how effective postimmobilization stretching and manual therapy are. This review reported that after surgical fixation, beginning exercise while in a removable brace improved activity limitation but also led to a higher rate of adverse events.

Initial Rehabilitation

Rehabilitative exercises may begin during or following immobilization, depending on joint stability and whether open reduction and internal fixation was required. Postoperative rest, use of ice, compression and elevation of the ankle help decrease swelling and reduce pain. Gentle exercise or weight bearing, manual therapy and more rigorous exercise may be prescribed. Egol et al recommended bearing weight

Lateral process fractures of the talus usually are repaired with open reduction and internal fixation when the fracture is displaced by more than 1.5 cm. This is followed by wearing a short-leg cast for 4 weeks before beginning flexibility exercises. Weight bearing is encouraged when osseous union is detected, usually at about 4 to 6 weeks after injury. Nondisplaced type I and II fractures usually are immobilized for 6 weeks. Gehrmann recommended excising a lateral process fracture of the talus involving significant cartilage damage or one that is < 1.5 cm comminuted. Long-term complications from these fractures include pain with weight bearing and degeneration of the subtalar joint, impingement in the sinus tarsi or talofibular joint and symptomatic nonunion.

Casts still are used widely in pediatric patients for low-risk fractures of the ankle. The casts usually remain on the child for 3 to 4 weeks. Some authors suggest this is unnecessary and expensive, and may present greater complications than those associated with the fracture.
6 weeks after surgery when a syndesmotic screw has been placed unless the patient requested removal of the screw. In that case, the authors suggested an additional 4 weeks of nonweight-bearing activity. They also required patients with diabetes to wait an additional 2 to 4 weeks after syndesmotic screw placement to begin weight-bearing activity.

Farsetti et al suggested that immediate use of continuous passive motion (CPM) after open reduction and internal fixation of ankle fractures allowed for complete and quick recovery of range of motion and decreased the risk of early degenerative joint disease. In their study they used a CPM machine for at least 8 hours a day and overnight. When applied to the treated ankle, it alternated the foot and ankle between 5° of dorsiflexion and 10° of plantar flexion. Over a 2-week period, the passive movements were increased to maximum dorsiflexion and plantar flexion. At follow-up, the authors reported an average of 52° range of motion in patients who received CPM compared with 34° for the control group.

Obremskey et al reported that adult patients make significant improvements in functional return up to 1 year after open reduction and internal fixation. Functional factors they evaluated included mobility, return to daily activities and work and emotional status. Their study suggested that the most drastic improvements are made during the first 2 postoperative months, but significant improvements are made in all areas for up to 6 months. Emotional status continued to improve for up to 1 year. Being more than 50 years of age was related to a worse functional outcome and longer time until return to work, but did not correlate with increased risk for complications in this study. Egol et al also reported their patients had significant improvement in functional recovery with little or no pain after 1 year. Patients who were older than 40 years, had diabetes and were women had delays in healing.

Another study by Egol et al evaluated the time it took for patients to recover braking function with a driving simulator after open reduction and internal fixation of unstable ankle fractures. The authors reported that it took 9 weeks for patients to perform at the level of the control group.

Jelinek and Porter found that early range of motion and weight bearing led to faster healing in athletes who had undergone open reduction and internal fixation. They reported that the benefit of early range of motion is the controlled ligament stress, which stimulates strength, decreases risk for muscle atrophy and arthrofibrosis, and reduces the time to achieve functional recovery. Passive range of motion is performed by relaxing the muscles while the joint is mobilized, whereas active range of motion engages the muscles. It is important to work range of motion in the opposite direction from the mechanism of injury to protect the ligament until it heals. Patients must gain range of motion in the rehabilitation process before strengthening exercises can begin.

Weight bearing early in the recovery phase with the ankle protected in a brace or cast increases the stability of the lateral ankle ligaments and decreases muscle atrophy, joint stiffness and proprioception dysfunction. Types of strengthening exercises that may be introduced include isometric, isotonic and isokinetic.

Additionally, proprioception exercises help to decrease the chance of continued or recurrent injury. Injury alters the normal proprioceptive mechanism in the extremity, which comes from receptors in the muscles, ligaments, tendons and receptors in the joint. Examples of these proprioception exercise techniques include early weight bearing, double leg stance and single leg stance.

In athletic patients, cardiovascular activities also are an important part of recovery. The activities increase cellular metabolic levels and enhance blood flow to the extremity. They also increase motivation and improve the athlete’s psychological well-being.

Three-phase Approach for Unstable Injuries

Jelinek and Porter described a 3-phase process for postoperative rehabilitation of unstable ankle injuries in athletes. The first phase focuses on soft-tissue inflammation and edema, and emphasizes pain control, decreasing inflammation and restoring of joint range of motion. They proposed placing the patient in a walking boot with a Cryo Cuff (Aircast, Austin, Texas) for cold and compression immediately after surgery. The patient receives instructions to rest, elevate the ankle and use the Cryo Cuff while awake. The patient also is told to perform toe curls, knee bends and leg lifts every 1 to 2 hours to prevent thrombosis. At 1 week following surgery, the wound is evaluated and the physician checks stability on radiographs. Additional activity, such as light biking, range of motion exercises, light resistive tubing exercises and stretching are prescribed. The patient may be told to begin partial weight bearing with axillary crutches, which progresses to full weight bearing in a boot. At about 2 weeks, when the patient can walk without a
lump in the boot, a stirrup brace with an athletic shoe replaces the boot and the biking program is increased to 30 to 40 minutes per day. The brace should be worn for 2 to 6 weeks during all types of activity, then only during athletic activity for 6 to 12 more weeks, depending on the fracture type.13

**Strengthening Exercises**

The second phase of rehabilitation includes flexibility and functional strengthening with cardiovascular conditioning, proprioceptive training and light sport-specific functional training. Rehabilitation usually begins about 1 month after operative fixation. New exercises may include standing calf stretches, balancing exercises, double-to-single leg calf raises, elliptical exercise and stair-climbing exercise. Resistive tubing exercises also may increase in repetition and include more directions. The patient should use a stair or incline board for the calf-stretching exercises. The balancing exercise program progresses from wearing a shoe to a bare foot on a hard surface and holding for 60 seconds. Soft surfaces or a balance board may be introduced last. Bicycling exercises may be exchanged for elliptical and stair-climbing exercises at this point.13

**Return to Normal Activity**

The third rehabilitative phase involves a gradual return to sporting activity with maintenance of flexibility and strength and proper body mechanics. This phase usually begins 2 months after surgery. The patient may transition into running exercises once he or she can use a stair-climbing or elliptical machine for 30 minutes, 4 to 5 days a week without complication. The return to running and sport-specific functions should be gradual.13

Regardless of a patient’s age, activity level and underlying disease or conditions, it is important to counsel patients and their families about the expected functional recovery after an ankle injury. By identifying patients who are at risk of delayed or limited recovery, physicians can develop altered care strategies.10

**Complications**

The risk of complication from ankle fracture depends on injury severity and quality of fracture reduction and stabilization.11,13 Arthritic changes, stiffness, infection, malunion, nonunion, synostosis formation, deep vein thrombosis and thrombophlebitis are common complications. Surgical complications include sensory neuropathy, delayed union, loss of reduction of the syndesmosis and infection.42 Patients with diabetes and those who are elderly often have poorer outcomes. Open and comminuted fractures also have a higher rate of postoperative problems.11 Prolonged immobilization may cause muscle atrophy, arthrofibrosis, cartilaginous degeneration and bone atrophy. The fear of reinjury may limit patients’ return to preinjury activity levels.13

A study by Saltzman et al suggested that proper alignment of the subtalar joint is crucial to long-term strength of the ankle.45 The authors stated that ankle arthritis is associated with rotational ankle fractures and that it is relatively rare to develop primary ankle osteoarthritis because of ankle articular cartilage properties.45 Thangarajah et al reported that postoperative infections are more prevalent in patients who smoke or who have had bimalleolar injuries.46 Superficial infections were treated with oral antibiotics. Patients with a deep infection, diagnosed through microbial confirmation of an organism, were readmitted to the hospital and were treated with surgical washout and debridement, removal of hardware or intravenous antibiotics.46

**Conclusion**

Ankle fractures are common in people of all ages and activity levels and in both sexes. Optimal treatment planning and delivery are made possible through detailed patient evaluation and understanding of the mechanism of injury. Quality diagnostic imaging, including radiography and appropriate use of other imaging modalities, aids in ankle fracture evaluation and management.

**References**


Anne M Scott, BSRS, R.T.(R), is a part-time writer and stay-at-home mother of 2 children in Cape Carteret, North Carolina. She has written 2 previous articles for Radiologic Technology titled Improving Communication for Better Patient Care and Thyroid Cancer in Adults. Ms Scott last worked as a radiologic technologist in the sports medicine clinic at Duke University Medical Center in Durham, North Carolina.