CHAPTER 17

The Foot, Ankle, and Lower Leg

OBJECTIVES

Upon completion of this chapter, the reader should be able to:

- Describe the anatomy of the foot and ankle
- Cite primary extrinsic and intrinsic muscles of the lower leg
- Explain the common injuries and conditions affecting the foot, ankle, and lower leg
- Describe medial tibial stress syndrome and its treatment

KEY TERMS

Achilles tendon  
anterior compartment  
compartment syndrome  
cramp  
deep posterior compartment  
extrinsic muscles  
intrinsic muscles  
lateral longitudinal arch  
malleoli  
medial longitudinal arch  
medial tibial stress syndrome  
peroneal compartment  
plantar fascia  
shin splints  
subtalar joint  
superficial posterior compartment  
talocrural joint  
transverse arch
THE LOWER LEG

The lower leg, including the ankle and foot, is exposed to numerous types of trauma during athletic practices and events. Even with protective equipment, such as the shin pads used in soccer, the lower leg is still susceptible to injury. Common injuries to the lower leg include contusions, strains, tendonitis, tendon ruptures, medial tibial stress syndrome (shin splints), stress fractures, compartment syndrome, and fractures.

THE FOOT AND ANKLE

It has been estimated that 15 percent of all sports injuries involve the ligaments, bones, and tendons of the ankle. Because the ankle absorbs three times the force of the body during running and jumping, it is not surprising that there are more than 20,000 ankle sprains in the United States every day (Figure 17–1). Acting as shock absorbers, the feet cushion up to one million pounds of pressure during a single hour of strenuous exercise. Taking all this into consideration, the feet log approximately 1,000 miles per year.

The foot is responsible for some of the most minor, yet potentially debilitating, conditions suffered by athletes. These conditions include athlete’s foot, turf toe, calluses, ingrown toenails, and blisters. If these conditions are not treated, they can be just as disabling for an athlete as more serious foot problems.

Basic Anatomy of the Foot and Ankle

The foot stabilizes and supports the rest of the body during standing, walking, running, or jumping. Individually, the parts of the foot (bones, muscles, ligaments) are relatively weak. As a whole, however, the foot is strong enough to withstand most of the demands of athletics. The key to the foot’s function is a set of three arches, which help in absorbing the impact of walking, running, and jumping. These are the transverse arch, the medial longitudinal arch, and the lateral longitudinal arch. The medial longitudinal arch is the highest and most important of the three arches. It is composed of the calcaneus, talus, navicular, cuneiforms, and the first three metatarsals. The lateral longitudinal arch is lower and flatter than the medial arch. It is composed of the calcaneus, talus, cuboid, and the fourth and fifth metatarsals. The transverse arch is composed of the cuneiforms, the cuboid, and the five metatarsal bases. The arches of the foot are maintained by the shapes
of the bones as well as by ligaments. In addition, muscles and tendons play an important role in supporting the arches. Figure 17–2 illustrates the arches of the foot.

The feet contain about one-fourth of the total number of bones in the body. Each foot has 26 bones (7 tarsals, 5 metatarsals, and 14 phalanges), along with 38 joints. The tarsal bones consist of the talus, calcaneus, navicular, cuboid, and the medial, intermediate, and lateral cuneiform bones. The mid-foot region is made up of the five metatarsal bones. The toes have 14 bones known as the phalanges. Figure 17–3 illustrates the complicated bone structure of the foot and ankle.

**Fun Facts**

How many bones are in the human foot?
(a) 17  (b) 32  (c) 26  (d) 12

Answer: (c) 26

**lateral longitudinal arch**

One of the three arches of the foot; composed of the calcaneus, talus, cuboid, and the fourth and fifth metatarsals; lower and flatter than the medial longitudinal arch.
The ankle joint—the joint most commonly injured in athletics—is actually formed by a combination of two joints: the **talocrural joint**, made up of the tibia, fibula, and talus; and the **subtalar joint**, made up of the talus and calcaneus. The talus and calcaneus are the two largest bones of the foot. Large, bony prominences called **malleoli** are located on either side of the ankle. They are the distal ends of the tibia (medially) and the fibula (laterally). The joints of the ankle are illustrated in Figure 17–4.

The tibia transmits the weight of the body to the talus. The fibula extends from the distal lateral side of the tibia, forming the lateral malleolus. This acts as a lateral stabilizer of the ankle joint. The talocrural is a hinge joint with most of its movement in dorsiflexion and plantar flexion. The subtalar joint has movement around the oblique axis.

The talus moves anteriorly and posteriorly in a cup-like cavity formed by the distal heads of the tibia and fibula. The talus acts as a movable saddle for the tibia and fibula. The talus sits forward and on top of the calcaneus.

**Ligaments of the Foot and Ankle**

Ligaments are tough bands of tissue that connect bones to each other. They provide strength and support to joints. Ligaments are named for the bones they connect. The ligaments most commonly injured on the
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In the ankle, injuries to the ligaments, called sprains, are usually caused by unexpected twists of the joint. A sprain can be a stretch, tear, or complete rupture of one or more of the ankle ligaments.

KEY CONCEPT

- The foot has three arches: transverse, medial longitudinal, and lateral longitudinal.
- The foot has 26 bones (7 tarsals, 5 metatarsals, and 14 phalanges).
- The foot has 38 joints.
- The ankle joint is made up of the talocrural and subtalar joints.
- There are five main ligaments in the ankle: anterior talofibular, anterior tibiofibular, calcaneofibular, posterior talofibular, and the deltoid.

lateral aspect of the ankle are the anterior talofibular, anterior tibiofibular, calcaneofibular, and posterior talofibular. On the medial aspect of the ankle the deltoid ligament is commonly injured. The triangular-shaped deltoid ligament consists of a superficial and deep layer that connect the talus to the medial malleolus. Figure 17–5 shows the ligament structure of the ankle.

In the ankle, injuries to the ligaments, called sprains, are usually caused by unexpected twists of the joint. A sprain can be a stretch, tear, or complete rupture of one or more of the ankle ligaments.

BASIC ANATOMY OF THE LOWER LEG

The lower leg consists of two bones: the tibia and the fibula (Figure 17–6). The tibia is the largest of the two lower leg bones. It is also known as the shin. In proportion to its length, the fibula is the slenderest bone in the body. It lies parallel with and on the lateral side of the tibia.

Muscles of the Lower Leg and Foot

The muscles of the foot are classified as either intrinsic or extrinsic. The intrinsic muscles are located within the foot and cause movement of the toes. These muscles are plantar flexors, dorsiflexors, abductors, and adductors of the toes. Several intrinsic muscles also help support the arches of the foot (Figure 17–7).
The extrinsic muscles are located outside the foot, in the lower leg (Figure 17–8). The powerful gastrocnemius muscle is among them. They have long tendons that cross the ankle and attach on the bones of the foot to assist in movement. The talus, however, has no tendon attachments.

**Figure 17–6** The tibia and fibula: (A) anterior view; (B) posterior view.

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**Figure 17–7** Major intrinsic muscles of the lower leg and foot.

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**extrinsic muscle**
Muscle that is outside a body part, organ, or bone.
Figure 17–8  (A) Front view of the muscles of the foot (B) Side view of the muscles of the foot (C) Back view of the muscles of the foot.
COMMON INJURIES OF THE FOOT AND ANKLE

Foot and ankle problems are among the most common health concerns in the United States. Studies show that at least three-quarters of the American population experiences foot problems of some degree of seriousness at some time in their lives.

Healthy feet are critical to a successful fitness program. The importance of foot care in exercising is stressed by the American Podiatric Medical Association (APMA). According to the American Academy of Podiatric Sports Medicine, an APMA affiliate, people do not realize the intrinsic muscles cause movement of the toes and help support the arches of the foot. The extrinsic muscles aid in movement of the ankle and foot. Table 17-1 lists the names and functions of each muscle in the lower leg and foot.

<table>
<thead>
<tr>
<th>Table 17-1</th>
<th>Muscles Moving the Foot and Toes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Muscles Moving the Foot</strong></td>
<td><strong>FUNCTION</strong></td>
</tr>
<tr>
<td>MUSCLE</td>
<td></td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>Plantar flexes foot, flexes leg, supinates foot</td>
</tr>
<tr>
<td>Soleus</td>
<td>Plantar flexes foot</td>
</tr>
<tr>
<td>Tibialis posterior</td>
<td>Plantar flexes foot</td>
</tr>
<tr>
<td>Tibialis anterior</td>
<td>Dorsally flexes foot</td>
</tr>
<tr>
<td>Peroneus tertius</td>
<td>Dorsally flexes foot</td>
</tr>
<tr>
<td>Peroneus longus</td>
<td>Everts, plantar flexes foot</td>
</tr>
<tr>
<td>Peroneus brevis</td>
<td>Everts foot</td>
</tr>
<tr>
<td>Plantaris</td>
<td>Plantar flexes foot</td>
</tr>
<tr>
<td><strong>Muscles Moving the Toes</strong></td>
<td><strong>FUNCTION</strong></td>
</tr>
<tr>
<td>MUSCLE</td>
<td></td>
</tr>
<tr>
<td>Flexor hallucis brevis</td>
<td>Flexes great toe</td>
</tr>
<tr>
<td>Flexor hallucis longus</td>
<td>Flexes great toe</td>
</tr>
<tr>
<td>Extensor hallucis longus</td>
<td>Extends great toe, dorsiflexes ankle</td>
</tr>
<tr>
<td>Interossei dorsales</td>
<td>Abduct, flex toes</td>
</tr>
<tr>
<td>Flexor digitorum longus</td>
<td>Flexes toes, extends foot</td>
</tr>
<tr>
<td>Extensor digitorum longus</td>
<td>Extends toes</td>
</tr>
<tr>
<td>Abductor hallucis</td>
<td>Abducts, flexes great toe</td>
</tr>
<tr>
<td>Abductor digiti minimi</td>
<td>Abducts little toe</td>
</tr>
</tbody>
</table>
tremendous pressure that is put on their feet during exercise. For example, when a 150-pound jogger runs 3 miles, the cumulative impact on each foot is more than 150 tons.

Even without exercise-induced stress, foot problems contribute to pain in the knees, hips, and lower back, and also diminish work efficiency and leisure enjoyment.

**Ankle Sprains**

Dr. Carol Frey, associate professor at the University of Southern California, noted that sprains are the most common presentation in an orthopaedic practice, and also the most common reason for emergency room visits (Frey, 1998) (Figure 17–9). There are about 27,000 sprains per day in the United States, accounting for 45 percent of basketball injuries, 31 percent of soccer injuries, and 24 percent of volleyball injuries.

The ankle is susceptible to a variety of injuries, ranging from muscle strains and ligament sprains to dislocations and fractures. The most common injury is the ankle sprain. The mechanism of injury is usually a combination of excessive inversion and plantar flexion. More than 80 percent of all ankle sprains are of this type. The ligament most often injured is the anterior talofibular ligament. Other ligaments commonly involved in an inversion sprain are the calcaneofibular and posterior talofibular ligaments. Less common is the eversion sprain. On the medial side of the ankle, the tough, thick deltoid ligament helps prevent excessive eversion (turning outward of the heel).
Signs and Symptoms

Whether the sprain is of the inversion or eversion type, it is usually placed into one of three categories: first degree (mild), second degree (moderate), or third degree (severe).

In a *first-degree sprain*, one or more of the supporting ligaments and surrounding tissues are stretched. There is minor discomfort, point tenderness, and little or no swelling. There is no abnormal movement in the joint to indicate lack of stability.

In a *second-degree sprain*, a portion of one or more ligaments is torn. There is pain, swelling, point tenderness, disability, and loss of function. There is slight abnormal movement in the joint. The athlete may not be able to walk normally and will favor the injured leg.

In a *third-degree sprain*, one or more ligaments have been completely torn, resulting in joint instability. There is either extreme pain or little pain (if nerve damage has occurred), loss of function, point tenderness, and rapid swelling. An accompanying fracture is possible.

Treatment

Immediate treatment of an ankle sprain consists of protection, rest, ice, compression, and elevation (an approach known by the acronym PRICE). Splinting, taping, or bracing the ankle can help protect it from further injury. All activities that cause pain should be eliminated. For the first 24 hours, ice should be applied for 15 minutes with an hour and a half allowed between applications. Use a compressive wrap around the ankle and up the calf until the swelling subsides. Elevate the ankle above the level of the heart.

Rehabilitation

To restore function to the ankle, begin range-of-motion exercises. Stretching exercises will also help to loosen the muscles around the ankle and prevent stiffness. Strengthening exercises, too, help in the recovery from an ankle sprain. It is important to have a sports medicine professional monitor and assist in the rehabilitation of all athletic injuries.

Arch Sprains

Each arch of the foot contributes to balance, movement, support, and shock absorption. Any of the arches of the foot (transverse, medial longitudinal, or lateral longitudinal) can suffer supportive ligament sprains. Once the ligaments are stretched, they fail to hold the bones...
of the foot in position. When an arch is weakened, it cannot absorb shock as well as it normally would. Causes of arch problems include overuse, overweight, fatigue, training on hard surfaces, and wearing shoes that are nonsupportive or in poor condition.

**Treatment**

Treatment, as with other ligament sprains, includes cold, compression, and elevation. Most arch sprains are to the lateral arch or inner longitudinal arch.

**Blisters**

Blisters can occur on any part of the body where there is friction. In athletics, blisters are most often found on the feet. As the layers of the skin rub together, friction causes separation. The body responds with fluid formation in this separation. This fluid creates pressure on nerve endings, which is perceived as pain. Once formed, blisters cannot be ignored. A neglected blister may break, creating an open wound. Proper treatment of a blister is mandatory to ensure maximum comfort of the athlete and to reduce the possibility of infection. Blisters can be very painful, and even debilitating, if not properly treated.

**Treatment**

The goal of blister treatment is to relieve the pain, keep the blister from enlarging, and avoid infection. Signs of infection include red or warm skin around the blister, and pus coming from the blistered area. Small, intact blisters that do not cause discomfort usually need no treatment. The best protection against infection is a blister’s own skin. Skin should not be removed from the blister unless it is flapping and causing additional discomfort. Finally, the blister should be covered with a bandage that is changed daily.

To prevent blisters, friction must be eliminated. Methods include the use of appropriate shoes and socks. Shoes should be the right size and type for the sport.

**Great Toe Sprain (Turf Toe)**

The great toe is very important in balance, movement, and speed. Occasionally, the ligaments supporting the toe will become sprained, severely limiting the athlete’s performance. *Turf toe* is the name given to such a sprain. Often, the mechanism of the injury is the foot sliding backward on a slippery surface, which forcefully hyperextends the big toe. Figure 17–10 illustrates the mechanism of a turf-toe injury.

**Treatment**

As with any acute sprain, immediate care of turf toe is protection, rest, ice, compression, elevation, and support. The physician may
take x-rays to rule out a more severe injury. Most sprains of the great toe are minor. Once normal function returns, the certified athletic trainer will encourage constant foot/toe support to limit movement.

**Plantar Fasciitis**

The *plantar fascia* is a wide, nonelastic ligamentous tissue that extends from the anterior portion of the calcaneus to the heads of the metatarsals, supplying support to the longitudinal arch of the foot. This tissue can become strained from overuse, unsupportive footwear, a tight Achilles tendon, or running on hard surfaces. Figure 17–11 illustrates the plantar fascia region of the foot.

Most often, the cause of plantar fasciitis is chronic irritation. Cross-country and track athletes are prone to overuse injuries in which the plantar fascia is continually strained from running and jumping. Basketball and volleyball players are also susceptible to plantar fasciitis from repeated jumping and landing. An athlete with plantar fasciitis will experience pain and tenderness on the bottom of the foot near the heel. Untreated, this condition causes bone imbalance, which can lead to heel spurs, muscle strains, shin splints, and other problems.

**Treatment**

Basic treatment includes correcting training errors, icing, and massage. The athlete’s shoes and activity level should be evaluated. Wearing shoes with more arch support may help decrease stress on the

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*Figure 17–11* The plantar fascia region of the foot extends from the calcaneus to the base of the toes.
plantar fascia area. The use of a heel cup or cushion will help reduce the amount of shock and shear forces during activity.

**Heel Bruise**

The heel receives, absorbs, and transfers much of the impact from sports activities, especially running and jumping. Therefore, the ligaments, tendons, and fat pad of the heel are all subject to stress and injury. The heel bruise is among the most disabling contusions in athletics. The heel must be protected during physical activity.

**Treatment**

Cold application before activity, and cold and elevation afterward, can help reduce swelling and pain. The certified athletic trainer can also supply the athlete with heel cups to help absorb the force of impact with the ground or floor; or a pad can be constructed to protect the bruised area.

**Heel Spur**

A *heel spur* is a bony growth on the calcaneus that causes painful inflammation of the accompanying soft tissue. This type of condition is aggravated by exercise. As the foot flattens, the plantar fascia is stretched and pulled at the point where it attaches to the calcaneus. Over a period of time, the calcaneus reacts to this irritation by forming a spur of bony material.

**Treatment**

The certified athletic trainer can locate a heel spur by pressing on the heel. The team physician may recommend taping the arch or using shoe inserts to help reduce the plantar fascia’s pull on the calcaneus.

**Fractures**

Fractures of the foot and ankle immediately impair an athlete’s ability to perform competitively in virtually any sporting activity. Athletes who suffer an ankle fracture usually cannot bear weight and have more swelling and pain than those with just a ligament sprain.

**Signs and Symptoms**

Often, a site of point tenderness is present, and an obvious deformity may be seen. Fractures of the ankle and foot usually occur acutely in a traumatic episode.

An ankle fracture often presents with symptoms similar to those of an ankle sprain. It is important to complete a thorough examination of the involved extremity to avoid misassessment of the injury. (Review Chapter 11 on assessment and evaluation of sports injuries.)
REHABILITATION OF FOOT AND ANKLE INJURIES

Returning an athlete to competition before healing is complete leaves the player susceptible to further injury. The best way to determine when healing is complete is by the absence of pain during stressful activity and the return of full range of motion, strength, power, and endurance to the affected muscle group. Before the beginning of any rehabilitation exercise program, the certified athletic trainer should consult with the sports medicine team to establish an program tailored for the individual athlete and the specific injury to be rehabilitated. The following list of exercises can be used as rehabilitative or preventive exercises (Figures 17–12 through 17–15). All exercises should begin with a few repetitions and sets, then gradually increase in intensity as the muscle groups get stronger.

COMMON INJURIES TO THE LOWER LEG

Injuries to the lower leg are common in athletics. These include contusions, sprains, strains, fractures, and inflammation of tendons and compartments of the lower leg. Prompt recognition and treatment will allow the athlete to continue activity.

Figure 17–12 Using a towel spread out on the floor, the athlete curls the toes, bunching the towel underneath. This exercise strengthens the muscles in the foot.

Figure 17–13A–B This exercise is for strengthening the tibialis anterior muscle of the lower leg. Using an elastic band, the athlete steps on one end while pulling up with the end wrapped around the foot.
Contusions

Contusions occur most often over the shin. The tibia lies just below the skin (subcutaneously) and is very sensitive to direct trauma. Trauma to this area of the leg can be very painful and disabling.

Contusions can also involve the muscular areas of the leg. A possible complication of a severe contusion to any of the leg muscles is significant swelling within the various compartments. In these closed spaces, swelling is not only uncomfortable but may also lead to compartment syndrome (discussed in greater detail later in this section).
Another possible complication of a direct blow to the leg is damage to the peroneal nerve. This nerve is particularly vulnerable because it passes around the head of the fibula. A severe blow to this area may cause peroneal nerve injury, with pain radiating throughout the distribution of the nerve. Transient tingling and numbness to the lateral surface of the leg or dorsal surface of the foot may remain for a period of time. Occasionally, peroneal nerve damage will result in loss of function to the dorsiflexors and evertors of the foot, resulting in a condition known as foot drop. These symptoms are often temporary and recovery is usually complete.

Strains

The lower leg is the site of origin for the primary muscles responsible for transmitting power to the foot and ankle. The explosive and repetitive nature of various athletic activities subjects these muscles to extreme dynamic forces. Frequent and powerful use of leg muscles commonly results in injuries. Strains can occur anywhere along the muscles and normally result from a violent contraction, overstretching, or continued overuse. Symptoms may be present in the leg, about the ankle, or in the foot.

The most common leg strains occur to the calf muscles. Forcible contraction of these muscles during most athletic activities puts these muscles at risk.

Strains frequently occur in the area of the musculotendinous junction or at the insertion of the Achilles tendon into the calcaneus. These injuries may result from repetitive overuse or a single, violent contraction. Acute strains to the Achilles tendon have a tendency to become chronic and an area frequently complicated by tendonitis.

Muscle Cramps

A cramp is a sudden, involuntary contraction of a muscle. Although the cause is unknown, several factors may contribute to the occurrence of a cramp:

- **Fatigue**: Working a muscle beyond its limits may cause the muscle to cramp.
- **Fractures**: After a fracture has healed, muscles usually atrophy. If the muscles involved are not strengthened to pre-injury status, cramps may occur.
- **Dehydration**: Lack of fluids can cause muscle cramps. An athlete who is exercising vigorously may lose 3.5 mL of water per hour. This rate of loss over a three- to four-hour period may account for loss of 4–6 percent of the athlete’s total body weight. This causes a drop in blood volume and lessens the ability of the body to cool itself. Muscle cramping may result.
Lack of nutrients in diet: A lack of fluids in the system may lead to an electrolyte imbalance that causes muscles to cramp. Electrolytes are minerals, such as sodium, magnesium, calcium, and potassium, that help the cells to function normally. An imbalance occurs when there is too much or too little of one or more electrolytes in the system. The main electrolytes affecting muscle cramping are potassium, sodium, and calcium.

Poor flexibility: Good flexibility allows muscles to work through their full range of movement. Poor flexibility does the opposite, creating a situation in which the muscles may be worked beyond their limits. This may cause muscle strains or cramping.

Improperly fitted equipment: Poorly fitted equipment may cause excessive strain. Excessive strain on any part of the body can result in a breakdown, which may be in the form of cramping or other injuries.

Treatment

Treatment for muscle cramps includes passive stretching, fluid replacement, massage, rest, and ice. Water, sports drinks, or juice will help to rehydrate and restore the athlete’s electrolyte balance. Most of the time, water is sufficient.

Passive stretching will help keep the muscle from forcefully shortening (Figure 17–16). Massage, along with passive stretching, will relax the muscle involved.

Achilles Tendonitis

The Achilles tendon derives its name from Achilles, the mighty warrior of Greek mythology. His mother dipped him into the magical waters of the river Styx at birth to give him physical invulnerability. According to legend, she held him by the heel, which was not touched by the mystic waters and therefore remained his only vulnerable spot. Many years later, he was killed when an arrow struck him in the heel.

Achilles tendonitis is a painful condition caused by inflammation of the Achilles tendon. The Achilles tendon connects the gastrocnemius and soleus muscles of the posterior lower leg to the calcaneus. The gastrocnemius and soleus are strong leg muscles that attach to the foot and give us the ability to rise up on the toes, facilitating the act of walking. The Achilles tendon is vital to the ability to walk upright, so Achilles tendonitis can make walking almost impossible.

The inflammation that characterizes tendonitis reflects tearing of the tendon tissues caused by excessive stress. The problem may be
caused by a single incident of overstressing the Achilles tendon, or it may result from an accumulation of lesser stresses that produce numerous small tears over time. The injury often occurs at the point where the tendon attaches to the heel, but it may occur at any point along the length of the tendon.

Sometimes overpronation causes the arch of the foot to flatten too much and the leg to twist more than normal. This, in turn, causes the gastrocnemius and soleus muscles to stretch more than normal. The force sustained by the Achilles tendon and the calcaneus increases, resulting in inflammation and pain.

**Signs and Symptoms**

In most cases, symptoms develop gradually. Discomfort may be relatively minor at first and worsen if the patient tries to “work through” the pain. The initial discomfort is often attributed to the aches and pains that accompany fatigue. Repeated or continued overstress increases the inflammation; in severe cases, a rupture of the tendon can occur. This results in traumatic damage and severe pain that make walking virtually impossible. Other signs and symptoms of this condition include pain and crepitus (noise) upon palpation of the Achilles tendon and redness at the site of discomfort.

**Treatment**

The best treatment for Achilles tendonitis is prevention. Stretching the Achilles tendon before exercise, even at the start of the day, will help maintain flexibility. The stretching exercises shown in Figures 17–17 through 17–21 will help the athlete maintain flexibility of the Achilles tendon.

It is important to find the cause of the problem, not just treat its symptoms. Chronic Achilles tendonitis should be assessed by a sports medicine physician or podiatrist. Solving a biomechanical problem with the foot or lower leg should allow resolution of this condition.

Conservative measures used to treat Achilles tendonitis include icing the injury, anti-inflammatory medication, and physical therapy. Resting the painful Achilles tendon will minimize aggravation of the inflammation and allow healing. A slow and careful return to activity should be monitored by the certified athletic trainer and physical therapist.

**Achilles Tendon Rupture**

Achilles tendon ruptures occur within the tendon substance itself, approximately one to two inches proximal to the insertion of the tendon into the calcaneus. Causes of Achilles tendon rupture include poor conditioning and overexertion. Ruptures usually occur when a sudden, eccentric force is applied to a dorsiflexed foot. Ruptures of the Achilles tendon may also occur as the result of direct trauma. Ruptured Achilles tendons must be surgically repaired. Rehabilitation may take up to a
Figure 17-17 To stretch the Achilles tendon, the athlete positions her hips over her lower legs. Keeping her heel on the ground, she slowly squats down and slightly forward, stretching the tendon.

Figure 17-18 The athlete places the foot not to be stretched forward of the other. Both feet should be pointing straight ahead. As in Figure 17-17, the athlete slowly squats, stretching the Achilles tendon of the back leg.

Figure 17-19 This exercise is the same as Figure 17-18, except that the athlete stretches the lateral portion of the Achilles tendon by turning the back foot out about 30 to 45 degrees.

Figure 17-20 This exercise is the same as Figure 17-18, except that the athlete stretches the medial portion of the Achilles tendon by turning the foot in about 30 to 45 degrees.

Figure 17-21 Commercial devices are available to assist in stretching the Achilles tendon and calf muscles.
year before the athlete is ready to return. Figure 17–22 shows a repaired Achilles tendon.

**Special Tests**

One test certified athletic trainers use to see if the Achilles tendon is intact is the Thompson test. As shown in Figures 17–23 and 17–24, the resting calf muscles are gently squeezed. If the foot plantar flexes (points down), the Achilles tendon is intact. If the foot does not react, the Achilles tendon may be completely torn.

**Medial Tibial Stress Syndrome (Shin Splints)**

Medial tibial stress syndrome, or shin splints as it is often known, is a catchall term for pain that occurs below the knee either on the front outside part of the leg (anterior shin splints) or on the inside of the leg (medial shin splints). It is normally the result of doing too much too soon. Shin splints most often occur early in a training program or after training has been discontinued for a period of time and then resumed. It appears to be associated with repetitive activity on hard surfaces or forcible excessive use of the leg.
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muscles, especially with running and jumping activities. Figure 17–25 illustrates the area of discomfort and pain with shin splints.

Among the causes of medial tibial stress syndrome is tightness of the gastrocnemius and soleus muscles. These muscles propel the body forward, placing additional strain on the tibialis anterior muscle in the front part of the lower leg. The tibialis anterior works to lift the foot upward and also prepares the foot to strike the running surface. Running on hard or uneven surfaces places greater forces on the lower leg complex. Varying the training schedule to include running on cushioned surfaces helps to ease the stresses placed on the leg.

Worn or ill-fitting shoes increase the stress on leg muscles. Softer surfaces and shoe-cushioning materials absorb more shock, thereby transferring less force to the lower legs. How the athlete runs contributes to the overall health of the lower extremities. Athletes who run primarily on their toes put a tremendous amount of stress on the anterior portion of the leg, which may cause shin splints. Also, athletes who overpronate when running cause the muscles of the foot and leg to overwork in an attempt to stabilize the pronated foot; the repeated stress can cause the muscles to tear where they attach to the tibia. Finally, athletes who do too much too soon are also at risk.

Treatment

Immediate treatment of shin splints consists of icing immediately after practice or competition, reducing the activity level, and gentle stretching of the posterior leg muscles. Long-term treatment should include a biomechanical assessment of the lower extremities to rule out any conditions that would expose the athlete to excessive stresses on the lower leg. Physical therapy, orthotic devices, anti-inflammatory medications, and a strengthening and flexibility program to help correct muscle imbalance may be helpful in alleviating and eliminating this condition. Athletes who are out of shape, beginning a new activity, or coming back from an injury are at much greater risk. These athletes must follow a graduated conditioning schedule to avoid overuse injuries.

Stress Fractures

Pain in the lower leg can be diagnosed as shin splints but actually be caused by a stress fracture. A stress fracture is an incomplete crack in the bone—a far more serious injury than shin splints. If the repeated stress placed on a bone is greater than the body’s ability to heal it, stress fractures occur. These are microscopic fractures (deteriorations) in the bone that will eventually lead to a full fracture if left untreated. A bone scan is the definitive tool for diagnosing a stress fracture.
However, there are clues that will signal whether the athlete should get a bone scan.

**Signs and Symptoms**

If the examiner presses the fingertips along the shin and finds a definite “hot spot” of sharp, intense pain, it is a sign of a stress fracture. Shin-splint pain is more generalized. Usually, stress fractures feel better in the morning, because the bone was rested all night, whereas shin splints are worse in the morning because the soft tissue tightens overnight.

**Compartment Syndrome**

**Compartment syndrome** may develop whenever there is swelling within one or more of the four compartments of the lower leg: the *anterior compartment*, *peroneal compartment*, *deep posterior compartment*, and *superficial posterior compartment*. Swelling may be caused by contusions, fractures, crush injuries, localized infection, excessive exercise, or overstretching. Anything that can cause an inflammatory response or uncontrolled swelling may result in increased pressure within one of these compartments. Figure 17–26 shows a cross-sectional view of the lower leg, with the four compartments identified.

![Figure 17–26 Compartments of the lower leg.](image)

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**Compartments of the lower leg:**

- **Anterior compartment:** Contains the tibialis anterior, extensor digitorum longus, peroneus tertius, and extensor hallucis muscles.
- **Peroneal compartment:** Contains the peroneus longus and peroneus brevis muscles.
- **Deep posterior compartment:** Contains the popliteus, flexor digitorum longus, flexor hallucis longus, and tibialis posterior muscles.
- **Superficial posterior compartment:** Contains the gastrocnemius, soleus, and plantaris muscles.
Signs and Symptoms

Depending on the cause of the condition, there may be sudden or gradual onset of symptoms in the afflicted leg. There will be swelling accompanied by point tenderness and pain in the affected muscle group. In the later stages, numbness, weakness, and inability to use the affected muscle may develop. Compartment syndrome must be diagnosed immediately or irreversible neurological, muscular, and vascular damage will occur. Any delay in treatment could result in permanent disability.

An athlete who has chronic compartment syndrome typically complains of lower leg pain and tightness that occurs only with physical activity. A physical examination may reveal weakness and mild tenderness in the muscles of the respective compartments. The most common and consistent sign of compartment syndrome is a diffuse, intense pain that is exacerbated by movement, touch, pressure, and stretching. There is palpable tenseness in the affected compartment.

Treatment

Treatment of compartment syndrome is immediate transportation to the nearest medical facility. Surgery will usually be needed.

Fractures

The tibia and fibula (the lower leg bones) are susceptible to fractures associated with athletic activity. Both bones are vulnerable because they are close to the surface, and force directly impacts the bone. There is little protective soft tissue around them.

Ten to fifteen percent of all lower-leg fractures are open fractures of the tibia, in which the bone protrudes through the skin. The tibia can be fractured by a direct blow, a twisting force, or occasionally from repetitive overuse, which produces a stress fracture. Acute tibial fractures are usually readily recognized because this is the weight-bearing bone in the lower leg, and symptoms are normally severe enough to require radiographic studies.

The fibula is normally fractured by a direct blow to the outside of the leg. The fibula is not a weight-bearing bone, but acts as a lateral stabilizer of the leg. Fractures of the fibula present tenderness at the site of the injury, local swelling, and increased pain on any manipulation of the bone. The tenderness and swelling might be mistaken for a contusion because the athlete is often able to walk.

**ADDITIONAL TESTS FOR THE FOOT, ANKLE, AND LOWER LEG**

The following are standard methods of testing the various structures of the lower extremity.
• Ankle sprains are usually the result of excessive inversion or plantar flexion. Sprains are treated with cold, compression, and elevation.
• Arch sprains result from overstretched ligaments in the arch, which then cannot support the foot or absorb shocks. Sprains are treated with cold, compression, and elevation.
• Blisters result from friction that causes the layers of the skin to separate; fluid seeps in between the layers and creates the blister. Blisters should be covered and padded.
• Turf toe is caused by hyperextension of the great toe. It is treated with ice, rest, compression, elevation, and support.
• Plantar fasciitis is a strain of the ligamentous tissues in the bottom of the foot due to chronic overuse, overstretching, and irritation. Treatment is targeted at correcting training errors, ice, and massage.
• Heel bruises occur due to repeated stress. They are treated with cold application, elevation, and padding.
• Heel spurs are a bony growth on the calcaneus that causes painful inflammation of the soft tissues. Management includes taping the arch and using shoe inserts.
• Fractures are breaks in bones. Treatment must be sought from a physician and will depend on the severity of the break.
• Contusions are injuries to the soft tissues.
• The exact cause of muscle cramps is unknown. Cramps can be relieved by passive stretching, fluid replacement, massage, rest, and ice.
• Achilles tendonitis is an inflammation of the Achilles tendon. The best treatment is prevention by stretching before beginning exercise.
• An Achilles tendon rupture is a complete tear of the tendon. This injury usually requires surgical treatment.
• Medial tibial stress syndrome (shin splints) is pain that occurs in the lower portion of the leg. Treatment consists of icing, reducing activity levels, and gentle stretching.
• Stress fractures are microscopic breaks in the bone due to repeated stress and overuse. Treatment from a physician should be sought.
• Compartment syndrome is damage to tissues resulting from swelling of one or more of the compartments in the legs. Immediate emergency treatment should be sought.
Anterior Drawer Test
This procedure tests the integrity of the anterior talofibular ligament. Figure 17–27 explains this procedure.

Plantar Fascia Test
The certified athletic trainer presses under the foot to locate plantar fascia pain. Figure 17–28 shows this test.

Talar Tilt Test
This procedure tests the integrity of the calcaneofibular ligament. Figure 17–29 shows this test.

Tinel’s Sign
Tarsal tunnel syndrome is an entrapment of the tibial nerve as it runs through the inside aspect of the foot and ankle. Pain, numbness, burning, and electric-shock sensations may be felt along the course of the tibial nerve, which includes the inside of the ankle, the heel, the arch, and the bottom of

Figure 17–27 The certified athletic trainer stabilizes the top of the ankle with one hand and pulls up from the heel with the other hand. If there is forward movement of the foot, the anterior talofibular ligament may be torn.

Figure 17–28 The certified athletic trainer tries to locate plantar fascia pain at the medial calcaneus. Pressing in the area of the injury will help determine how much of the plantar fascia is affected.

Figure 17–29 The calcaneofibular ligament is located laterally and stabilizes the ankle against direct inversion. With the patient sitting in a comfortable position, place the ankle in a neutral position (90 degrees, directly between dorsiflexion and plantar flexion). Grasp the calcaneus with one hand and the tibia-fibula with the other and apply a direct inversion stress. The test is positive if the talus tilts out from the lateral malleolus. Compare to the opposite ankle.
foot. Symptoms usually worse with increased activity, such as walking or exercise. Prolonged standing in one place may also be an aggravating factor. Figure 17–30 illustrates the Tinel’s sign method of testing the tibial nerve.

CONCLUSION

Injuries to the lower extremity are common in athletics. A solid understanding of the anatomy of the foot, ankle, and lower leg will help the examiner assess any injuries that occur. The examiner must also understand the different biomechanical forces applied to this area of the body during athletic participation. Proper conditioning, equipment, and training are essential to the overall health of the athlete. The body generates great forces during running and jumping activities, all of which are translated to the foot and ankle. When an injury does occur, the informed athlete takes the necessary steps to heal the injury and correct any use or biomechanical problem that might have contributed to the injury in the first place.

1. Describe the basic anatomy of the foot and ankle.
2. How many bones are located in the foot and ankle?
3. What bones make up the talocrural and subtalar joints?
4. What demands are placed on the lower extremity during athletic participation?
5. Where is the peroneal nerve located?
6. What type of ankle sprain is most common? Why?
7. List and explain the common injuries to the foot and ankle.
8. Why do athletes get muscle cramps? What can be done to prevent them?
9. How did the Achilles tendon get its name?
10. What would cause the Achilles tendon to rupture?
11. Describe the signs, symptoms, and treatment for medial tibial stress syndrome.
12. What is the pathology of a stress fracture?
13. Explain the different compartments of the lower leg.
14. Take a close look at Figure 17–26 on page 363. This diagram is which leg—right or left? Why?
1. Write a research paper on one aspect of the lower extremity.
2. Research how different athletic shoes change the biomechanics of the foot.
3. Take a trip to your local sporting-goods store. Report on how many different types of athletic shoes are available for different foot conditions.
4. Make a chart listing injuries of the various structures of the lower extremity, injury causes, and treatments.

- Visit the website of the American Podiatric Medical Association at http://www.apma.org. What additional information can you find on the injuries discussed in this chapter?
- Visit the website http://www.sportsinjuryclinic.net and look for information on the injuries discussed in this chapter. Are any of these injuries common in a particular sport?