

ACSM's Handbook for the Team Physician

Edited by W. Ben Kibler, MD

Medical Director

Lexington Clinic Sports Medicine Center

Lexington, Kentucky

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Rose Tree Corporate Center
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Accurate indications, adverse reactions, and dosage schedules for drugs are provided in this book, but it is possible that they may change. The reader is urged to review the package information data of the manufacturers of the medications mentioned.

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There are many books on sports medicine for the clinical practitioner in the field. This book is produced to serve a slightly different need. It is truly a handbook, a book that is readily available and can be used by the practitioner on the field. The American College of Sports Medicine has provided a resource book for teams as a part of the total program. It is designed to be the first reference for athletic-related problems as they arise in the office. It is the purpose of this book, in this format and being made available, to fill a gap between the large goals of this book are to provide information on problems that occur in teams and that it is easily accessed in a format that provides up-to-date information from people who are actually engaged in sports medicine. The College of Sports Medicine has provided a successor and enlargement of the book and as a complementary book. This continues the American College of Sports Medicine's tradition.

23

Lower Leg Injuries in Athletes

Mary Lloyd Ireland

Calf injuries are "uncommonly good." They occur often but are rarely serious. Early diagnosis is key. History and physical examination with particular attention to anatomy and injury patterns enables the practitioner to diagnose early and institute appropriate treatment.

Classification of leg pain can be by location: anterior, anterolateral, and posterior (Table 23-1). The diagnosis can also be classified by the anatomic part involved: muscle, muscle tendon junction, fascia, bone, periosteum, nerve, artery, and vein.

ALIGNMENT

Lower extremity alignment, flexibility, and muscular development and strength all play key roles in development of injury. Although the alignment of the individual cannot truly be changed, treatment is addressed toward improving flexibility, improving strength, and balancing the musculature in the anterior and posterior compartments of the calf, assessment of the foot and orthotics to improve contact forces or shock absorption. This can be accomplished with a clinical assessment of viewing the lower extremity. One can improve the surface area of contact in a cavus foot with an orthotic and the shock absorption by increasing the medial arch with a soft

Table 23-1. Differential Diagnosis Location

<i>Diagnosis</i>	<i>Workup</i>
Medial	
Medial tibial stress syndrome (MTSS) (Shin splints)	PE: Diffuse pain in medial tibia
Tendinitis/Dysfunction	
Posterior tibial	Pain posterior ankle on resistance
Flexor hallucis longus	Great toe dorsiflexion
Achilles	Pain on plantar flexion
Fracture	
Tibia stress	PE: Localized pain
Acute	Plain radiographs
Medial malleolus	Cone and Marked Possible bone scan
Tarsal Tunnel Syndrome	
Fascial Defect	
Posterior	
Strain	PE: Pain and swelling
Gastrocnemius	
Medial	
Lateral	
Rupture	PE: Palpable defect usually musculotendinous junction
Gastrocnemius	
Medial or lateral	
Proximal head	
Achilles tendon	Thomas test, palpable defect; history pop
Plantaris	History pop PE: Posterior knee pain
Compartment syndrome	Compartment Pressure Measurement
Location	
Superficial	
Deep posterior	
Timing	
Acute vs. chronic exertional (CECS)	

(continued on next page)

Table 23-1. (continued)

<i>Diagnosis</i>	<i>Workup</i>
Fracture	Radiographs
Acute	Plain
OS trigonum	Marked cone views
Posterior tibia	Bone scan
Stress	
Posterior medial tibia	
Vascular	Venogram
Vein	Plethysmograph
Deep vein thrombosis	
Superficial	
Phlebitis	
Artery	Doppler studies
Popliteal artery	Arteriogram
Entrapment	History claudication
Arterial insufficiency	
Fascial Defect	
Anterolateral	
Ankle sprain	PE: Pain dorsiflexion
High	Eversion of ankle Interosseous pain Pain compression tibia fibula
Strain/tendinitis	
Anterior tibialis	PE: Pain on dorsiflexion foot. Localized swelling
Peroneal tendons	PE: Pain on eversion
Fracture	
Fibula acute whip kick	PE: Localized tenderness Plain radiographs
Stress	PE: Localized tenderness Cone, AP radiographs Marked

(continued on next page)

Table 23-1. (continued)

<i>Diagnosis</i>	<i>Workup</i>
Compartment syndrome	
Location	Compartment pressure
Deep peroneal	
Superficial	
Timing	
Acute vs. chronic exertional (CECS)	
Subluxation	
Proximal tibiofibular joint	PE: Instability Apprehension anterior fibula forces knee flexed
Peroneal tendon distally	PE: Actively can sublux Pain on anterior subluxation maneuver behind fibula
Nerve entrapment	PE: Positive Tinel's and pain over nerve
Deep peroneal	Neurologic assessment EMG/NCV
Superficial peroneal	
Sural	
Fascial Defects	

semi-rigid or rigid orthotic made of the newer materials. There is more force transmitted through the bone and joint in an individual with a high arch, heel varus, and joints that are inflexible. Femoral anteversion, genu varum, internal tibial torsion are the factors creating miserable malalignment (Fig. 23-1A,B). This alignment would be more at risk for stress fracture and peroneal tendinitis (Fig. 23-1C,D). This runner with pes cavus reported pain in the lateral foot and ankle. Diagnosed with rigid pes cavus foot and peroneal tendinitis, treatment was custom orthotics. Flexibility and calf strengthening was also shown to her. In an individual who has pes planus, heel valgus, excessive knee valgus, is loose-jointed, and has a general external rotation valgus attitude of the lower extremity, there is risk for posterior tibialis strain and more injury to the medial side of the

calf. This soccer athlete with pes planus and forefoot pronation had posterior tibial tendinitis. She was fitted with a molded medial arch orthotic to neutralize the heel valgus and lessen tensile forces on the posterior tibialis tendon, which she wore during everyday activities (Fig. 23-2A-D).

TENDINITIS/DYSFUNCTION/RUPTURE

Repetitive micro-traumatic loading such as involved in dance or running can create tendinopathies. Diagnosis by clinical examination is made by manual muscle resistive testing of the involved muscle weakness and pain on palpation, usually at the musculotendinous junction. It is unusual to be able to feel localized swelling except in the Achilles tendon. Posterior tibialis tendinitis is most commonly seen in individuals with pes planus and in sports where the shoe does not resist the heel valgus or provide adequate medial arch support. Peroneal tendinitis is more likely to occur with pes cavus when there is pain on eversion of the foot and direct palpation. Other entities to consider with lateral calf pain include peroneal tendon anterior subluxation, fibular stress fracture, and anterolateral compartment syndrome. Although less common, the anterior tibialis tendon can become inflamed, particularly with repetitive dorsiflexion maneuvers. The retinaculum and peritenon surrounding this can be locally tender. In martial arts, such as tae kwon do, contusions in the dorsum of the foot and ankle can cause pain over the transverse and cruciate crural retinaculum.

Referral to the orthopedist should be considered before ordering an MRI or other tests. If the diagnosis is made early, rapid recovery is usual. Treatment includes rest, strengthening, and nonsteroidal anti-inflammatory medication to prevent a more chronic problem. In posterior tibialis dysfunction, early diagnosis is key to maximal improvement.

Posterior Tibialis

Posterior tibialis tendon (PTT) functions to invert and plantarflex the forefoot. If functioning normally, the PTT inverts the heel when the patient goes up on the ball of his/her foot.

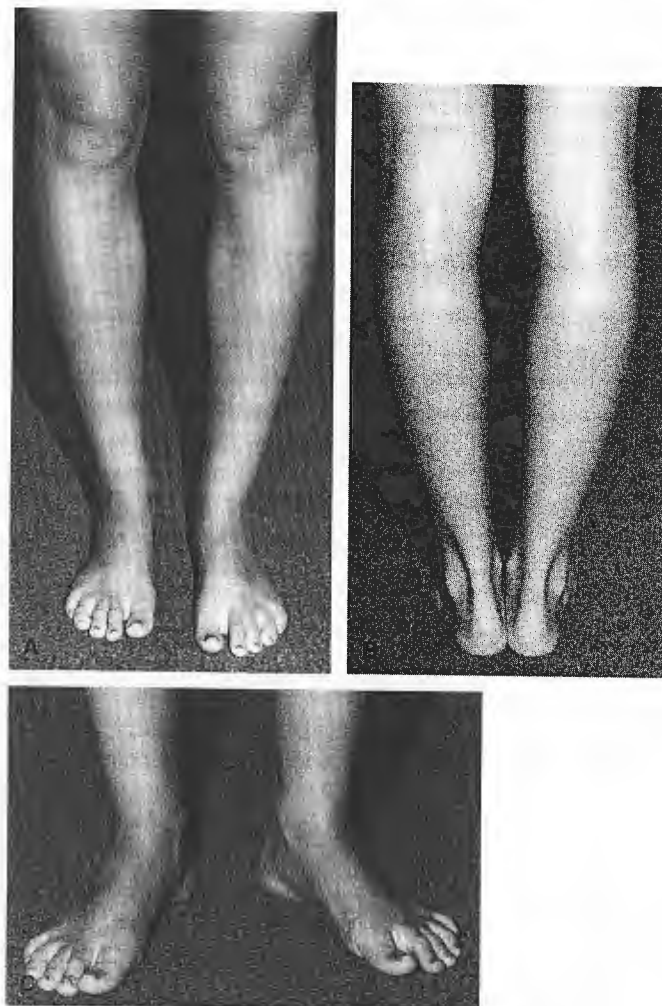


Figure 23-1. This adolescent runner exhibits miserable malalignment syndrome, shown from the front (A) and back (B). As seen on the standing views, increased femoral anteversion, patellas pointing toward each other, internal tibial torsion, heel varus factors creating miserable malalignment syndrome. Closer view of the feet demonstrate pes cavus and rigid forefoot (C). Improvement of surface area of contact and shock absorption can be done using a soft or semi-rigid orthotic of newer synthetic materials (D).



Figure 23-1 (continued)

Posterior tibialis tendon dysfunction progresses through stages of inflammation, tendon degeneration, elongation, chronic lengthening, and nonfunctional progressive pes planus. The PTT is not working if looking at the foot from behind one sees too many toes, and the patient is unable to go up on his/her toes and the foot inverts. This individual is usually older and there is asymmetry when examining both feet. Early diagnosis of PTT dysfunction should be made and nonoperative treatment of nonsteroidal anti-inflammatory medications, shoe orthotics and possible walking boot or hiking boot to reduce forces across the posterior tibialis tendon. In the early rupture, direct repair may be possible or tendon transfer is performed. However, in the more chronic severe cases with limited subtalar mobility and marked weakness, a subtalar arthrodesis may be necessary.

Other Tendons

Other tendons can avulse, although much more rarely. Achilles tendon ruptures are common. The anterior tibialis tendon is easily palpable as it inserts anteriorly. In the older athlete with inability to dorsiflex the foot and a palpable soft tissue mass anteriorly, clinically the diagnosis can be made on the clinical exam.



Figure 23-2. This male soccer athlete was having pain in the medial aspect of his foot and diagnosed as having posterior tibialis tendinitis. The forefoot pronation (A) and heel valgus seen from behind (B) showing the lack of medial arch and first toe visible of the foot, which is at risk due to being more flexible and going into excessive valgus. A semi-rigid orthotic to decrease heel valgus and by less posterior tibialis tensile forces helped return this athlete to full soccer activities as seen from beside (C) and from behind (D).

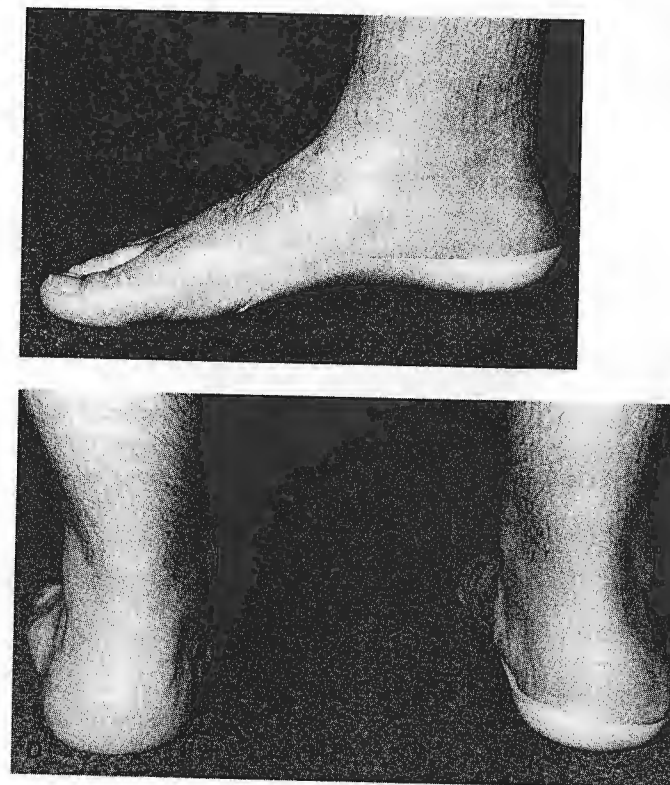


Figure 23-2 (continued)

Peroneal longus tendon rupture, although rare, can occur with ankle sprain. The level is at the distal fibula. Partial tears can exist and are treated with immobilization. MRI scan can be helpful in this diagnosis, which may be confusing. Direct repair of the tendon is best in acute rupture.

Peroneus brevis can detach from the tendon insertion at the base of the 5th metatarsal. This can be clinically apparent by a small avulsion fracture and on manual muscle testing inability to evert the foot.

STRAINS

The most common calf strain involves the medial head of the gastrocnemius in an activity involving plantar flexion and has been coined "tennis leg." A sudden pop is felt in the mid-calf. Controversy exists whether plantaris rupture actually occurs. A pop felt in the posterior calf when doing an explosive push-off maneuver usually involves the gastrocnemius. Lateral gastrocnemius can also be involved. If the pain is deeper, soleus strain also is considered. Other entities in the differential diagnosis include acute posterior compartment syndrome and deep vein thrombosis if there is acute onset of calf pain.

MEDIAL TIBIAL STRESS SYNDROME

This syndrome presents with diffuse medial tibial pain of differing degrees of severity. Other previous names for this are shin splints, tibial periostitis, or medial tibial syndrome. Unlike a tibial stress fracture, the pain is diffuse over the medial aspect of the tibia on direct palpation, usually the middle third. Plain radiographs may show thickening of the medial tibial cortex. Technetium bone scan will show a diffuse, less intense activity than the more intense focal uptake seen in a tibial stress fracture. This entity is secondary to repetitive loading on pronated extremity resulting in changes in attachments and inflammation of the soleus and posterior tibialis tendon and tibial periostitis. Medial tibial stress syndrome is more common in the foot with pronation, heel in valgus, and differing degrees of rigidity. The more typical foot attitude is pes planus as in Figure 23-2. Treatment is rest, strengthening of the musculature and assurance of proper medial plantar and heel support, and nonsteroidal anti-inflammatory medications.

FRACTURES

Stress fractures result from fatigue or insufficiency. Fatigue fractures are caused by repetitive muscular stresses and torque on normal

bone. The synchrony of load transmitted through bone and dynamic muscular ability to dissipate forces are disturbed. Controversy exists if the muscle fatigues first, then bone load increases or if the muscle tension and attaching forces cause the bone to fail.

Insufficiency fractures occur when the bone does not have normal elastic resistance or mineral. This can be due to many factors, including previous immobilization, age, gender, menstrual history, medical condition, certain medications, level of fitness, anatomic alignment, biomechanical factors, and previous surgeries on the lower extremities. Wolff's law describes the bone adapting to the stresses placed on it. If the elastic resistance is abnormal, weakening may occur rather than strengthening. If loading forces exceed the bone integrity, a stress fracture results.

The frequency of stress fractures in runners was reported by McBryde's series as tibia 34%, fibula 24%, metatarsals 18%, femur 14%, pelvis 6%, and other bones 4%. Fibula stress fractures are being seen at greater rates in female athletes in sports that involve landing and cutting—gymnastics and basketball. If a stress fracture is diagnosed, workup should include a detailed history of distance and intensity of training, nutritional assessment with completion of daily intakes, observation of eating by a medical staff, and menstrual history. Physical examination is also important to assess lower extremity alignment, leg length discrepancy, foot mobility, pes cavus, pes planus, and wear on the sole of the shoe.

In a repetitive sport such as running, the longer extremity is more likely to be injured and at the calf will tend to have increased valgus and pronation movements. The longer leg has an increased risk of injury. Runners who are running on the side of the road will have more problems with their downside leg.

Running on a hard surface such as concrete, or alignment problems such as tibia vara or pes cavus, increase the forces that must be absorbed by the bone. When a runner is on a banked track or running in the road that has the ability for drainage of water, a leg length discrepancy and abnormality of forces exist. The lower or then essentially longer leg must externally rotate, creating increased posteromedial knee joint forces and abnormal loading of bone.

Stress fractures are more common in female long distance runners who have irregular menstrual periods and eating disorders or poor nutrition. Barrow and Saha reviewed female long distance runners and found significant increase in stress fractures in runners with very irregular menstrual periods. Association of menstrual irregularities and eating behavior disorder was also found to be very high.

Tibia

The most common location of tibial stress fracture is the mid-distal third junction. A test for tibial stress fracture involves 3-point pressure and distraction at fracture site (Fig. 23-3). This premenarchal runner began running cross country immediately with 20 miles per week. After 2 weeks, she developed localized pain to palpation directly over the medial tibia. Marked radiographs of the left tibia/fibula show localized periosteal reaction consistent with a healing stress fracture 4 weeks after the initial symptoms (Fig. 23-4A). Bone scan was not performed because the patient clinically had a small localized area of pain. The plain radiographs showed callus and medial tibial cortical thickening. She was treated with rest, swimming exercises, and returned to running activities at 4 months. She was then postmenarchal and nutrition assessment had been done with improvement of her dietary habits. One year after the tibial stress fracture, she was playing soccer and running cross country. She was seen for bilateral calf pain, and radiographs showed the fracture healed (arrow) and no new stress fracture (marker) (Fig. 23-4B).

ANTERIOR CORTEX

The fracture of the anterior tibial cortex or the dreaded black line occurs in jumping athletes who have an anterior tibial bow and repetitive flexor musculature activities involved in the sport which place tensile forces along the anterior tibial cortex. This basketball athlete had localized pain and firmness in the midanterior tibial cortex with pain localized over area on palpation. He had 6 weeks of pain and had started intensive plyometrics. The figures show the

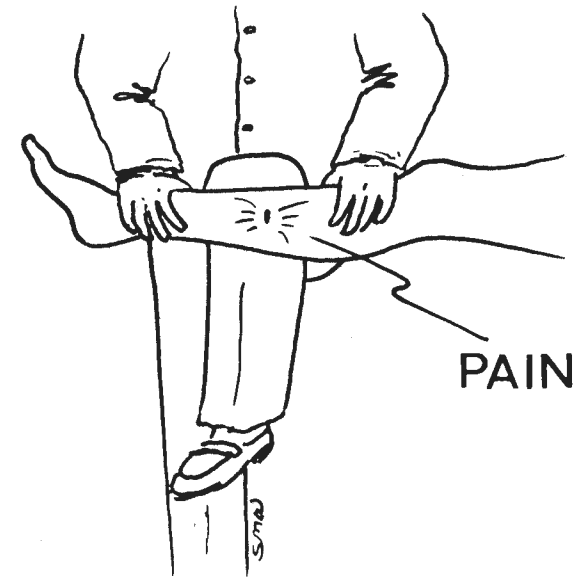


Figure 23-3. Easy clinical test to diagnose tibial stress fracture is shown diagrammatically using 3 point pressure techniques and distraction (Courtesy of Peter Jokl, M.D., Chief, Section of Sports Medicine, Yale Sports Medicine Center, Department of Orthopaedics and Rehabilitation).

dreaded black line in a very thick cortex and alignment, which showed an anterior tibial bow (Fig. 23-5). Treatment for this fracture was rest, water conditioning, and return to activities at 6 weeks when the fracture clinically was no longer tender. This fracture can be very bothersome with delayed nonunions and may require surgery.

MEDIAL MALLEOLUS STRESS FRACTURE

This fracture is seen in jumping sports. This basketball athlete sustained a second medial malleolus fracture after the initial one was healed with casting. The acute reinjury films show radiolucency of the medial malleolus just at the corner of the tibial plafond (Fig. 23-6A). Aggressive treatment with internal fixation without exposing

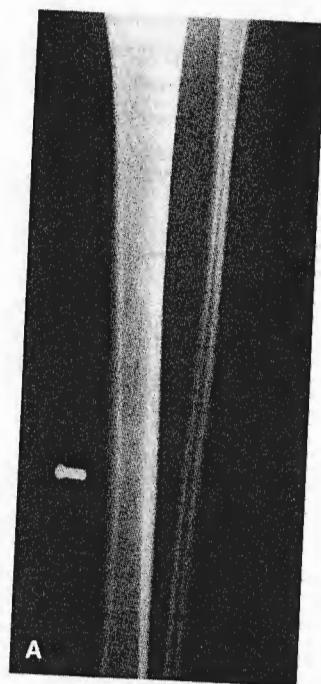


Figure 23-4. This cross-country runner developed localized pain medial aspect of her tibia. Marked AP view of the left tibiofibula shows periosteal reaction consistent with a tibial stress fracture (A). She returned a year later with diffuse pain in both medial tibias and was playing soccer and running. Marked AP views of both tibiofibula show the healed stress fracture with cortical thickening of the mid-distal third junction, tibial stress fracture location (B). She was felt to have medial tibial stress syndrome and no new stress fracture.

the nonunion was done, since this was the second stress fracture (Fig. 23-6B). Clinical and radiographic union occurred at 6 weeks postop (Fig. 23-6C).

Fibula

STRESS FRACTURE

In sports that involve repetitive axial loading and twisting such as gymnastics, a fibula stress fracture is frequently seen. Overly developed musculature for plantar flexion, tibia varus, heel varus, less shock absorption through the foot create tensile forces on the fibula resulting in the stress fracture.

This gymnast had pain over the lateral compartment, which was localized. Radiographs of AP view with marker at level of pain show



Figure 23-4 (continued)

a very thickened fibula cortex with very little medullary canal (Fig. 23-7A). No bone reaction or radiolucent line can be seen. A bone scan showed intense increase in activity (Fig. 23-7B). Bone scan was ordered to better counsel the athlete on timing of treatment. Fibular stress fractures are treated with a change of training activities that reduce the amount of repetitive loading. Continuation of the sport is usually possible. No operative intervention is necessary. Recurrence of the fracture is rare.

ACUTE WHIP KICK TYPE

Fractures of the fibula are common in contact sports such as football. When the runner is tackled, forces of helmet and body torquing will result in a short oblique fracture, usually about 14 cm from the most



Figure 23-5. Cone lateral view of the tibia shows the dreaded black line or anterior tibial cortex stress fracture. This is typically seen in athletes with anterior tibial bow and can be difficult to heal and can require intermedullary rodding for late or nonunion.

proximal aspect of the fibula. This football running back was tackled and sustained a direct blow with shoulder pads in the lateral leg. Fracture orientation and location is classic (Fig. 23-8A). The fracture heals quickly as shown in AP view at 4 weeks post injury (Fig. 23-8B). Return to sport is based on pain and can be as early as a couple of weeks.

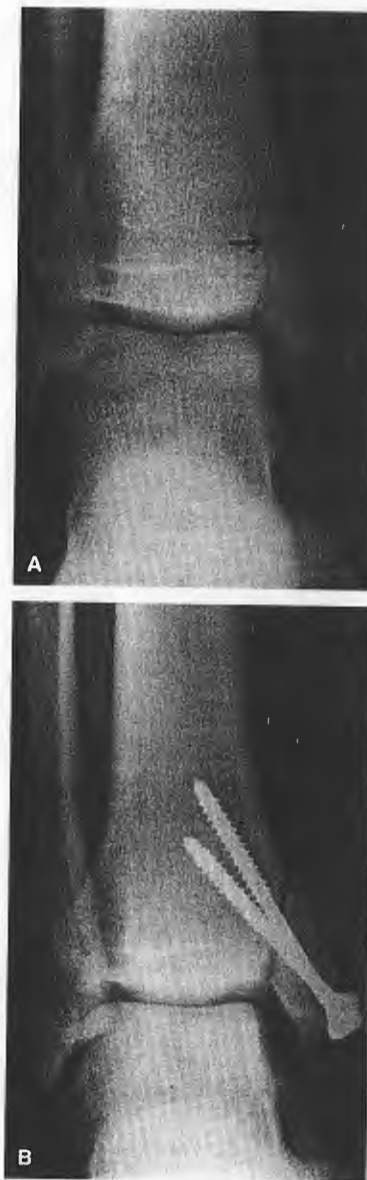


Figure 23-6. Medial malleolus stress fracture is seen with lucency going obliquely in the medial malleolus at the tibial plafond level. There is no significant periosteal reaction due to the cancellous bone and intra-articular nature of this fracture (A). Fixation was done as this was the second medial malleolar stress fracture with two cancellous screws placed without the fracture being taken down (B). Healing was complete at 6 weeks postop as shown (C).

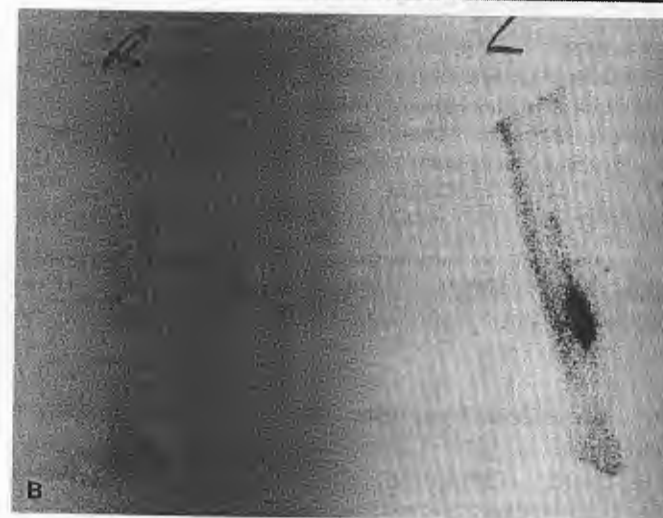


Figure 23-6 (continued)

Pathologic Fracture

Particularly in adolescents, careful scrutiny of the radiographs should be done to rule out any other reasons for fracture such as an underlying tumor. This soccer athlete sustained a pathologic fracture through an underlying nonossifying fibroma of the distal tibia. The fracture occurred when his foot was planted as he was going for the ball in a noncontact mechanism. He had no previous knowledge of the cyst or pain in the tibia. The long oblique comminuted fracture is shown (Fig. 23-9A). He was treated in a long leg cast (Fig. 23-9B). After 8 weeks of cast immobilization, the fracture had completely healed. Follow-up radiographs at 6 months postop show the fracture completely healed, and the cyst was smaller on AP (Fig. 23-9C) and lateral (Fig. 23-9D) views. The fracture itself and bone response reduce the size of the cyst. Careful attention should be

Figure 23-7. Marked AP view of the tibiofibula show the cortical thickening diffusely of the fibula without much medullary canal (A). Stress fracture was clinically diagnosed by the localized pain and the nature of her sport of repetitive axial loading in gymnastics. A bone scan (B) was performed to document the diagnosis since there was no periosteal reaction on plain radiograph.



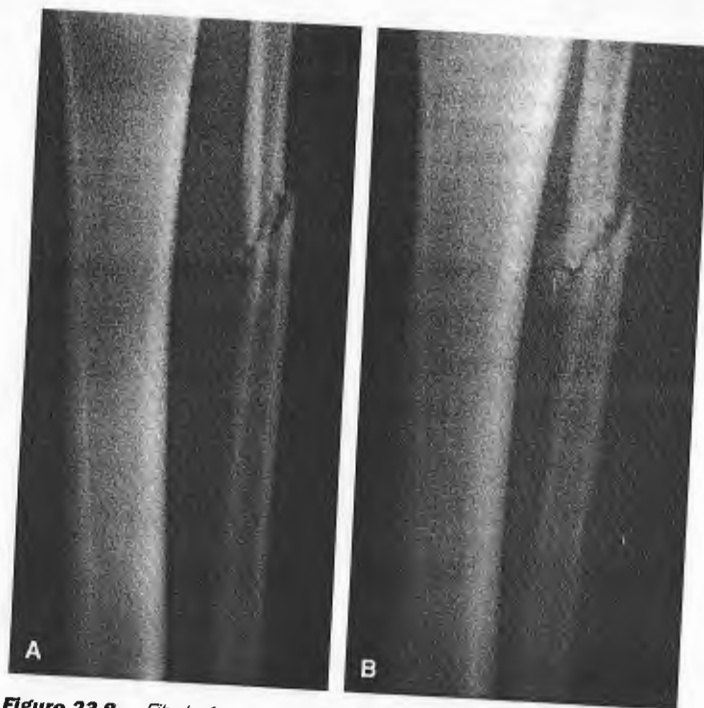


Figure 23-8. Fibula fracture occurred in a football athlete, short, oblique typical location for a whiplash-type injury 14 cm below the tip of the fibula. Acute fracture is shown in A and healing occurred at four weeks (B). This fracture is stable and is treated symptomatically, with return to sport as soon as running comfortably is possible.

paid to the fibula for tumors such as Ewing's sarcoma. In skeletally immature individuals, careful inspection of the epiphyseal plate and sometimes ordering comparison AP views is suggested.

Tibiofibula Synostosis Ectopic Bone Formation

With high interosseous ligamentous sprains ectopic bone can form in the interosseous membrane. This football athlete had prolonged pain following a high ankle sprain. Initial radiographs were negative. Radiographs at 3 months following his injury showed a fibular synos-



Figure 23-9. This soccer athlete planted his foot going for a ball and felt acute pain in his ankle. Films reviewed a pathologic fracture through a nonossifying fibroma of the distal tibia (A), AP view and lateral view (B). He was treated in a long leg cast and healing occurred at eight weeks. Views shown six months postop, AP (C), and lateral (D) show cyst to be consolidating and filling in and fracture completely healed.

tosis/ectopic bone with a radiolucency (arrow)(Fig. 23-10A). Bone scan showed intense increase in activity (Fig. 23-10B). Follow-up film at 1 year post injury at which time the patient was nonsymptomatic showed consolidation of the bone (Fig. 23-10C). The ectopic bone will usually become asymptomatic. One should proceed with caution with any surgical exploration as this may cause increase in symptoms and recurrent bone will develop if the bone scan shows increased activity when surgery is performed. A conservative watchful approach is best.



Figure 23-9. (continued)

PROXIMAL TIBIOFIBULAR INJURIES

Proximal tibiofibular joint sprains, subluxations, and dislocations, although unusual, occur. Injuries involving this joint are not well appreciated or reported. The mechanism is foot in plantar flexion and inversion, knee flexed and leg adducted. Initial management if strained involves anterior pad on the fibular head to decrease chances of anterior subluxation. Symptoms can recur with recurrent anterolateral dislocations. Operative intervention to stabilize this obliquely oriented joint may be unsuccessful. This football athlete anteriorly subluxed the proximal tib-fib joint clinically. Radiographs show (Fig. 23-11) an oblique joint with no fracture or subluxation. Variations of the slope of the lateral tibial metaphysis and proximal

Figure 23-10. Football athlete with prolonged pain in the interosseous membrane. Football athlete had prolonged pain following high ankle sprain. His initial radiographs were negative. At 3 months, radiographs showed a tibiofibular synostosis as seen on cone AP view (A). Bone scan showed intense increase in activity in this area indicative of continued bone formation in the interosseous membrane (B). Follow up at 1 year following his injury shows consolidation of the ectopic bone (C) and the athlete is asymptomatic. Care should be taken to not aggressively treat these lesions surgically while bone formation is present or there will be reformation of bone and continued pain.





Figure 23-10. (continued)

aspect of the tibia are common. The more horizontal tibia and less elongated fibular head are inherently more stable. This cheerleader was noted to have asymptomatic instability during pre-season physicals (Fig. 23-12). This joint is best examined with the knee flexed and compared with the opposite side.

FASCIAL DEFECTS

With increased pressure in a compartment the muscle may bulge through the fascia. This is a cosmetic problem, not functional. No surgical repair is indicated. If symptomatic, treatment is a compressive calf sleeve and ice.



Figure 23-11. Proximal tibiofibular joint injuries occur more often than thought. This football athlete anteriorly subluxed his proximal fibula anteriorly. Radiographs of an oblique view show no fracture and the joint was re-reduced. Variations in contour of the lateral tibial plateau and proximal fibula influence the joint stability.



Figure 23-12. Identification of variations of the proximal tib-fib joint can be helpful. This cheerleader was noted to have asymptomatic anterior subluxability of her proximal tibiofibular joint. Examination of this joint is best done in 90 degree knee flexion as examiner is anteriorly subluxing the fibular head.

COMPARTMENT SYNDROME

Compartment syndromes are secondary to acute direct trauma or chronic exertional compartment syndrome (CECS). Compartment syndrome is defined as a condition in which increased pressure within a limited space compromises the circulation and function of the tissue. There are four compartments in the leg: anterior, lateral, superficial posterior, and deep posterior (Fig. 23-13). The compartments have investing fascia around the muscle that can compress the muscle, artery, and nerve. The compartments and their nerve supply are anterior (deep peroneal), lateral (superficial peroneal), superficial (posterior sural), and deep posterior (tibial). Acute compartment syndrome is usually associated with severe trauma of a direct blow or a tibial fracture. CECS occurs during activities, usually in runners who report dull aching or pain in the area of the involved compartment and paresthesias in the foot. CECS involves the deep posterior and anterior compartment in the majority of cases. Clinical evaluation involves the seven Ps: pain, pressure, pain with passive

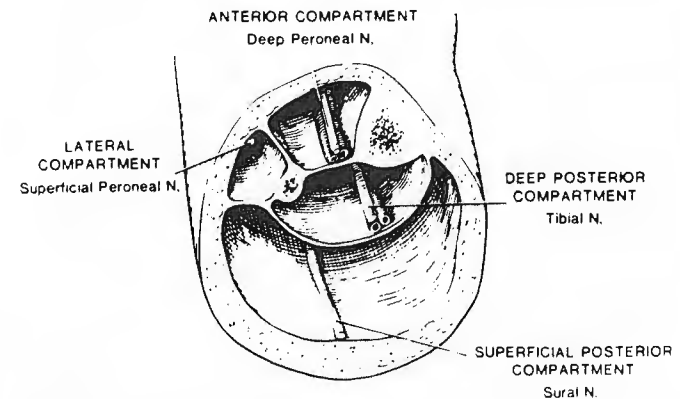


Figure 23-13. The nerve running in each of the four calf compartments is shown. Deep peroneal nerve in the anterior compartment, superficial peroneal nerve in the lateral compartment, tibial nerve in the deep posterior compartment and sural nerve in the superficial posterior compartment. Knowledge of the contents of each compartment enable the examiner to correctly diagnose compartment syndrome.

Table 23-2. Anatomy Calf Compartments

Region	Muscle	Artery	Nerve
Anterior	Tibialis anterior Extensor digitorum longus, extensor hallucis longus Peroneus tertius	Anterior tibial	Deep peroneal
Lateral	Peroneus longus Peroneus brevis	Peroneal	Deep peroneal Superficial peroneal
Superficial posterior	Gastrocnemius-Soleus Plantaris		Sural
Deep posterior	Tibialis posterior, flexor hallucis longus Flexor digitorum longus	Tibial	Tibial

stretch, paresis or paralysis, paresthesia, pulselessness, and power. The diagnosis is made by measurement of the intracompartmental pressures. The contents of the specific compartments are summarized in Table 23-2. Measurements of intracompartmental pressures before and after exercise are performed. Post exercise compartment pressures above 30 mm Hg is believed to be significant. If acceptable to the patient, treatment for CECS is modification of activities, stopping before symptoms develop. However, the management of a documented compartment syndrome is surgical with release of that specific compartment. The superficial and deep posterior compartments are released through a single incision off of the medial tibia, and the anterior and lateral compartments are released using an incision just anterolaterally. This athlete developed a bilateral foot drop and lateral calf pain a certain distance into her run. The difference in her resting and post exercise pressures was 40 mm Hg. She underwent anterior and anterolateral fasciotomies. Operative exposure of the anterolateral calf shows fascial investment (Fig. 23-

14A), scissors performing release (Fig. 23-14B), and healthy muscle under no further pressure (Fig. 23-14C).

Nerve Entrapment

The three most common nerves to be entrapped by fascia are the deep peroneal nerve, superficial peroneal nerve, and sural nerve (Fig. 23-15). The common peroneal nerve can be entrapped by peroneus longus origin. This has been reported in runners in activities that involve plantar flexion inversion force at the ankle, causing the nerve to be under pressure due to the repetitive muscular contracture and sharp fibrous edge of the peroneus longus. The common peroneal nerve can also have pressure applied from osteochondroma or bony lesion of the proximal fibula, proximal tib-fib dislocation, knee injuries, and localized lateral meniscal cyst. Detailed physical exam is necessary.

The deep peroneal nerve is most commonly entrapped as it travels between the extensor digitorum longus and extensor hallucis longus, approximately 5 cm above the ankle joint just below the extensor retinaculum (Fig. 23-15). This entrapment is described as anterior tarsal tunnel syndrome. Symptoms include positive Tinel's sign and pain in the first web space. Initial treatment is suggestions on changing of shoes, making sure there is no direct pressure on the anterior part of the ankle or repetitive stresses involving plantar flexion inversion.

Superficial peroneal nerve is most commonly entrapped as it exits from the fascia 10 cm proximal to the lateral malleolus. Styf described a test for superficial peroneal nerve entrapment as positive Tinel's sign at level of exit from the deep fascia, pain on passive ankle plantar flexion inversion, and tenderness on palpation with resistive ankle dorsiflexion and eversion.

The sural nerve emerges between the two heads of the gastrocnemius in the mid-calf of the leg. Entrapment may occur at any level of the lateral calf commonly as the branches exit a couple of centimeters above the ankle. Suspicion of entrapment is made based on positive Tinel's sign directly over the sural nerve course (Fig. 23-15).

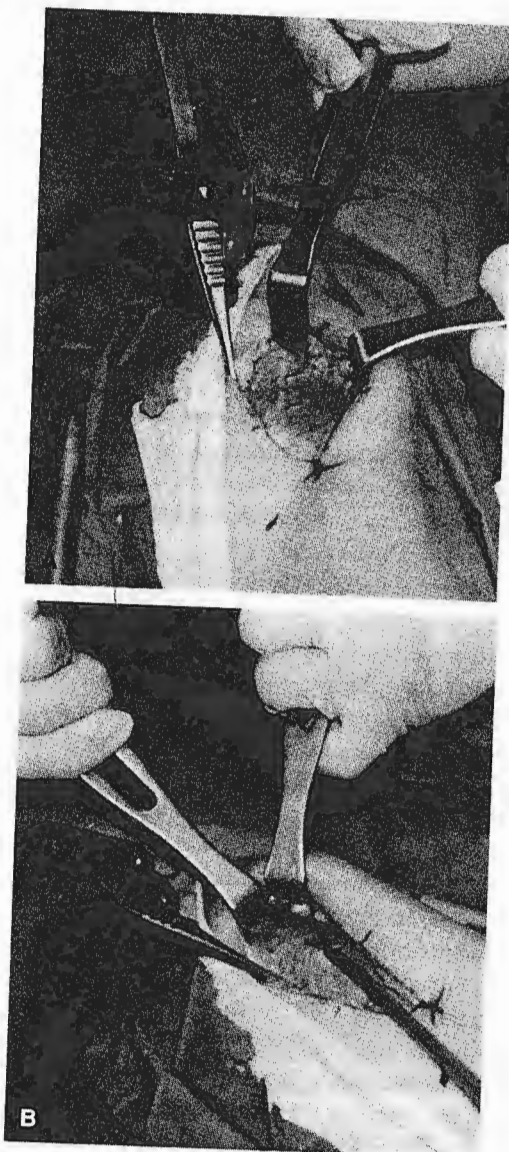


Figure 23-14. (continued)



Figure 23-14. (Continued). This athlete developed bilateral footdrop when she would run a set distance. Her compartment pressures shouldn't be a difference of 40 mg. mercury before and after exercise. Release of the anterior and anterolateral compartments was done through an 8 cm incision in the mid-third lateral to the anterior aspect of the tibia. Exposure before fascial release is shown (A), release using Metzenbaum scissors of the anterior compartment (B), and post release showing the normal appearance of the muscle following fascial release (C).

Other conditions associated of sural nerve entrapment are recurrent ankle sprains, ganglion of the peroneal sheath or ankle, and Achilles' tendinitis. Nerve entrapments are unusual but should be considered in the differential diagnosis, particularly of localized pain in the anterolateral aspect of the leg.

Consideration of lumbar spine involvement with radiculopathy should always be done and is more common than these localized nerve entrapment syndromes. Systemic conditions of diabetes, alcohol, and double crush syndrome should also be considered.

Tarsal Tunnel Syndrome

High tarsal tunnel syndrome refers to pressure on the posterior tibialis nerve as it emerges at the musculotendinous junction of the calf. Electromyelograms and nerve conduction velocities should be

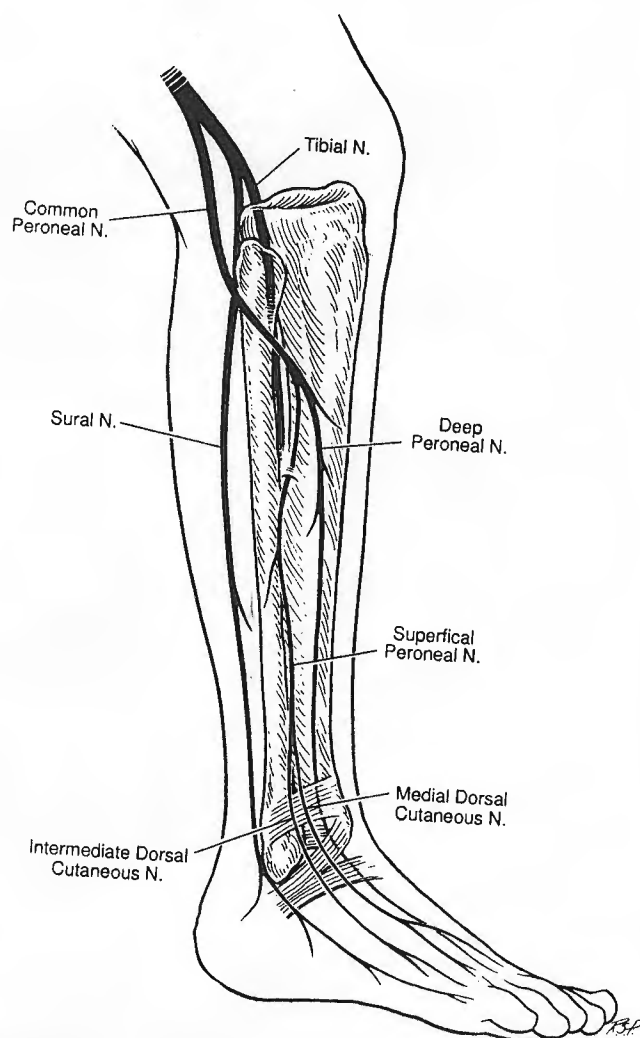


Figure 23-15. Diagrammatically, the nerves which are entrapped in the calf are the deep and superficial peroneal nerve from the common peroneal nerve and the sural nerve and posterior tibial nerve from the tibial nerve. The deep peroneal nerve is most commonly entrapped about 5 cms above the ankle joint as it emerges from the extensor retinaculum, also called anterior tarsal tunnel syndrome. The superficial peroneal nerve is entrapped

(continued)

performed. With high tarsal tendon syndrome, there is pain and a positive Tinel's over the nerve merging at the musculotendinous junction of the gastrocnemius. Initial management is to immobilize the foot and reduce eversion, plantar flexion forces, and anti-inflammatory medications.

Tarsal tunnel syndrome is entrapment of the posterior tibial nerve in the tarsal tunnel, which is bordered by the medial malleolus flexor retinaculum. Structures of the eponym, Tom, Dick, and Nervous Harry equals posterior tibialis tendon, flexor digitorum longus, posterior tibialis nerve and flexor hallucis longus. Symptoms are usually burning dysesthesias in the plantar aspect of the foot worsened by activities of repetitive load. Workup includes EMG and nerve conduction analysis. Conservative treatment consists of nonsteroidal anti-inflammatory medications, steroid injections, and reduction of hindfoot valgus. Surgical release and exploration should be considered if other forms of management are not successful.

VASCULAR

Deep Vein Thrombosis

Deep vein thrombosis is unusual but can occur in the young athlete. Reports of calf pain, which increase with exercise, increased calf circumference, pain on palpation of the calf, and increasing pain

Figure 23-15. (continued) as it emerges from the fascia about 12 cms above the tip of the lateral malleolus. It can also be entrapped in a subcutaneous position about 7 cms above the lateral malleolus as it branches into the intermediate and medial dorsal cutaneous nerves. The sural nerve can be entrapped as it emerges from the fascia between two heads of the gastrocnemius or soleus mid-third of the leg or 2 cms of the ankle as it gives off branches, providing sensation in the dorsal lateral aspect of the foot. Entrapment of the sural nerve is most common at these two levels. Posterior tibialis nerve is entrapped in a high or low level. For posterior tibialis entrapment syndrome, EMG nerve conduction velocity should be done to document the level of entrapment. High tarsal tunnel syndrome as the nerve emerges at the musculotendinous junctions of the calf occurs. Tarsal tunnel syndrome with compression occurs at the ankle level.

with any change in the intensity or type of sport should clue one in to possible deep vein thrombosis. If clinical signs exist, a venogram should be performed. This 33-year-old volleyball athlete came in for increased size of the calf but no pain. He had 2 cm increased calf circumference. Due to increased volleyball activity and a 3-month history of increased calf swelling, a venogram was performed. Venogram (Fig. 23-16A,B) shows occlusion of the deep vein system. He was hospitalized, placed at bedrest, and heparinized. He was

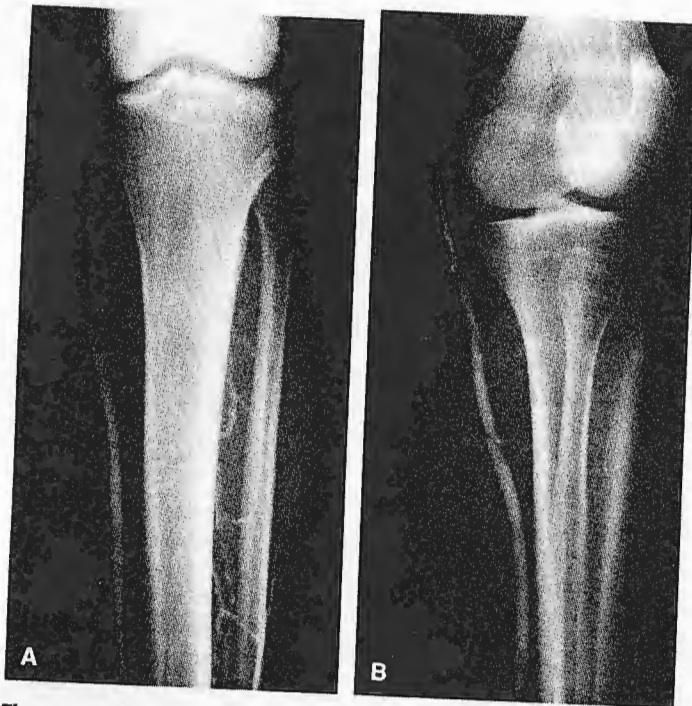


Figure 23-16. Volleyball athlete was seen for calf pain and swelling. Although his calf was nontender due to the 2 cm difference in calf circumference, he underwent venogram for suspicion of deep vein thrombosis. Venogram confirmed (A, B) that the deep vein system was occluded, superficial venous system was open. He was anticoagulated and had an uneventful return to full activities.

placed on Coumadin and wore thigh-high compression hose for 6 months.

Popliteal Artery Entrapment

Although unusual, claudication can occur and if the individual has pain in his or her calf during a certain point of activity and it responds to rest, diagnosis of claudication should be considered. The popliteal artery can have anomalies that cause extrinsic pressure at the gastrocnemius and popliteus musculature. Femoral artery involvement must also be considered. Arteriography is indicated if there are true signs and symptoms of claudication. Surgical exploration of the popliteal fossa is the necessary treatment.

CONCLUSIONS

Assessment of leg injuries makes more sense if classified in the categories of muscle strain, compartment syndrome, nerve entrapment problems, vascular abnormalities, medial tibial stress syndrome, and fractures. Appropriate management can be instituted early if correct diagnosis is made. Diagnosis is usually easily possible by detailed history and physical examination, paying particular attention to location of pain posterior, anterior, anterolateral and localization on examination based on tenderness or reproduction of the complaint by observing the functioning of the involved muscle tendon unit. Stress fractures are common and diagnosed clinically, confirmed by plain radiographs and if examination is not classic by technetium bone scan.

Assessment of the nature of the patient's sport, proper biomechanics of sport, alignment, shoe use, and foot attitude is necessary to prevent recurrent injury.

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