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METATARSAL STRESS FRACTURES

Steven B. Weinfeld, MD, Steven L. Haddad, MD, and Mark S. Myerson, MD

Metatarsal stress fractures are commonly encountered. Defined as "spontaneous fracture of normal bone which results from the summation of stresses, any of which by themselves would be harmless,"[7] most clinicians involved in the care of the foot and ankle will frequently treat these injuries. Although commonly resulting from sporting activity, metatarsal stress fractures are by no means limited to athletes. Although these fractures occur more frequently in runners, ballet dancers, and gymnasts,[29] they also occur in military recruits,[3] patients who have undergone surgery for hallux valgus,[4, 17] and patients with rheumatoid arthritis[11] or metabolic bone disease, including neuropathic conditions.[5]

Devas[8] classified stress fractures radiologically as oblique, transverse, compression, and longitudinal types. Although the oblique type is the most common in the metatarsals, the transverse pattern frequently is seen with stress fractures of the fifth metatarsal. The compression type is usually seen in children and the elderly, and it frequently occurs at the base of the first metatarsal. The longitudinal type, which may be an extension along the length of a bone with an oblique fracture, is also seen in the metatarsals.

PATHOPHYSIOLOGY

Stress fractures may result from alternating compressive and tensile forces transmitted to the bone through ligaments, tendons, and muscles.[8]

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Many causes for metatarsal stress fractures have been proposed; the most commonly encountered is that from repetitive overloading of a particular metatarsal. Regardless of the underlying cause and whether the fracture occurs in an athlete or nonathlete, one should attempt to identify why a particular metatarsal has been subjected to this increased load. This should be examined even when other sources for the fracture may be evident (e.g., in female athletes who are at particular increased risk for developing a stress fracture due to hormonal imbalance).

Female dancers and runners have been shown to be at increased risk for stress fracture. Kadel et al[15] studied 54 dancers and found that increased training time and menstrual irregularities were associated with increased incidence of stress fracture, most of which occurred in the metatarsals. In addition to amenorrhea, intensive training was also associated with an increased incidence of stress fractures. This increased susceptibility has been shown microscopically to be secondary to a loss of trabecular bone, related to amenorrhea of more than 6 months' duration. Interestingly, estrogen replacement therapy was not shown to be effective in decreasing the incidence of stress fracture in these dancers.[15]

Clearly, the shape of the foot must in some way predispose patients to developing metatarsal stress fractures. The height of the longitudinal arch of the foot has, in fact, been implicated as contributing to the risk of metatarsal stress fracture. This was substantiated by Simkin et al,[27] who found that military recruits with a low arch height were at greater risk for stress fracture than those with a normal arch. The incidence of stress fracture of the metatarsals in this population was decreased with the addition of an orthotic support. These authors proposed that the increased cushioning provided by the orthosis was responsible for decreasing the vertical loads on the metatarsals, thereby decreasing the incidence of stress fracture.[27]

Yet, although one assumes that it is the overall shape of the foot that in some way contributes to the incidence of metatarsal stress fracture, there must be additional factors, such as the loads to which it is subjected. For example, although patients with cavus feet have demonstrably increased load under the first metatarsal head, these patients do not have an increased frequency of stress fractures of this metatarsal. This foot shape, however, is particularly prone to stress fracture of the fifth metatarsal. Conversely, hyperpronation is associated with stress fractures of the first metatarsal.[1] Excessive pronation has been demonstrated to increase the load on the medial aspect of the distal first metatarsal as well as the second metatarsal. It is possible that, with hyperpronation, an element of hypermobility of the first metatarsal is present, increasing the load on the second metatarsal. This may be verified by examining the motion of the sagittal plane of the first metatarsal and the appearance of the weightbearing radiographs of the foot.

On the lateral radiograph, the first metatarsal is elevated above the plane of the second metatarsal; on the anteroposterior view, the medial cortex of the second metatarsal is slightly hypertrophied, indicating overload.

It is recognized that a high-arched cavus foot is more rigid than a planus foot, which is typically associated with increased pronation. A low arch allows the foot to absorb greater energy with repetitive impact loading, creating higher stress on the metatarsals when compared with a "normal" arched foot. A foot with a high arch does not absorb as much energy, and it transfers the stress to the femur and tibia. Yet, the vertical ground reaction force on each metatarsal is clearly not the only factor that increases the likelihood of stress fracture. This relationship between a low or a high arch and stress fractures has been studied.[27] Using radiographic measurements, it was found that either a high or low arch (i.e., a significant difference in the calcaneal angle and arch height to length ratio) was associated with femoral/tibial and metatarsal stress fractures, respectively. The authors also found that the metatarsal stress fracture rate was 0 and 6%, respectively, in military recruits with and without a prefabricated semirigid orthosis.

A short first metatarsal has also been implicated as a possible cause for lesser metatarsal stress fracture because it is believed to cause increased loading of the lateral aspect of the foot, particularly the second metatarsal. Drez et al,[10] however, showed that the absolute lengths of the first and second metatarsals in a group with stress fractures did not differ from those of a control group without stress fracture. Therefore, it is not the absolute length of the metatarsal that is of importance, but the forefoot function during the toe-off phase of gait. A short metatarsal may appear to provide insufficient loadbearing of the forefoot, but the load is determined during toe-off, while the toes are dorsiflexed. Provided that with dorsiflexion of the hallux the metatarsal head is depressed, the load under the first metatarsal will increase regardless of its length.

It is, therefore, the manner in which the hallux functions that determines the distribution of forefoot load. In static and dynamic conditions of the forefoot, such as hallux valgus, hallux rigidus, and after surgery (particularly resection arthroplasty), the weightbearing function of the hallux is altered, and stress fractures of the adjacent metatarsals occur. Implant arthroplasty[17] or resection arthroplasty of the hallux[12] similarly contribute to the development of stress fractures of the lesser metatarsals because overloading of the lesser metatarsals occurs. In these procedures the flexor hallucis brevis function is compromised after resection of the base of the proximal phalanx. The first metatarsal, therefore, elevates during foot-flat and toe-off, with increased load being transferred to the lesser metatarsals.

Several mechanical and pathologic factors contribute to the cause of fifth metatarsal stress fractures. Ouzounian and Shereff[25] determined the in vitro motion of the metatarsals and found the second and third to be quite rigid whereas the fourth and fifth metatarsals were found to have 9 and 10 degrees of motion in the sagittal plane. Although the fifth metatarsal is the most mobile of the metatarsals in the sagittal plane, its motion in adduction and abduction is limited by strong ligamentous and muscular attachments. The question then arises as to why the fifth metatarsal, given its freedom of sagittal plane motion, should be so susceptible to fatigue fracture. It is common to see stress fractures of the fifth metatarsal in patients with cavus feet, genu varum, and chronic ankle instability. These patients place tremendous adduction forces on the proximal aspect of the fifth metatarsal, with its rigid ligamentous and muscular anchors acting as a fulcrum for resultant stress fracture. If the underlying pathologic alignment of the limb is not corrected, adduction forces continue to place distraction loads on the lateral cortex of the fifth metatarsal.

The vascular anatomy of the fifth metatarsal also plays a role in the difficulty in healing of this fracture. Shereff et al[26] showed the blood supply to the fifth metatarsal to consist of a single nutrient artery to the shaft, with epiphyseal and metaphyseal arteries supplying the base and tuberosity. The nutrient vessel enters the medial cortex of the metatarsal at the junction of the proximal and middle one third of shaft. The location of the diaphyseal stress fracture corresponds to this location, possibly rendering the fracture site avascular.[18]

Stress fractures of the fifth metatarsal are commonly seen in patients with neuropathic disorders, such as Charcot-Marie-Tooth (hereditary sensorimotor neuropathy) disease and diabetes. These patients with neuropathy possess a decreased protective sensation of the foot. The cavus alignment of the foot in hereditary sensorimotor neuropathy, combined with peroneal muscle weakness, places significant adduction forces on the proximal fifth metatarsal. Diabetic patients with neuroarthropathy frequently develop severe midfoot deformities, thereby altering the weightbearing loads on the metatarsals and resulting in stress fracture (Fig. 1).

DIAGNOSIS

History

Patients sustaining stress fractures of the metatarsals generally present with insidious onset of pain in the forefoot. This is often initially misdiagnosed as a soft-tissue injury, although with a careful history

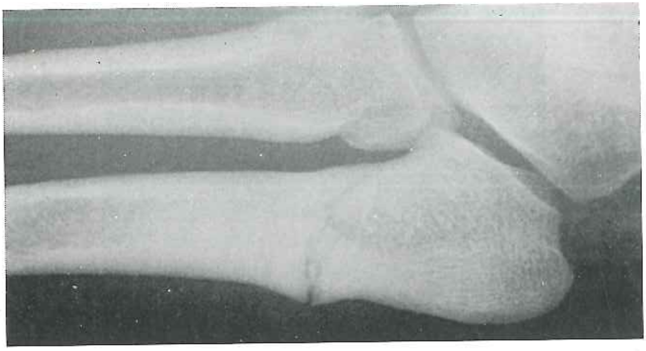

Figure 1. Radiograph of fifth metatarsal fracture in a patient with insulin-dependent diabetes with nonunion after open reduction and internal fixation.

alone, the diagnosis is usually obvious. The patient typically does not recall any specific injury, but one may elucidate the recent onset of a new activity after prolonged rest, changes in the intensity of physical activity, increased duration of a repetitive activity, or changes in footwear or surface on which an activity is performed. The characteristics of the pain change over time, increased intensity with decreased activity, and a period of dull, aching pain in the forefoot for some weeks is usually followed by a sudden change in intensity. This more focal pain eventually precludes sporting activity and begins to affect activities such as standing or walking.

Examination

Physical examination often reveals swelling and warmth in the forefoot that is usually global rather than localized to the fractured bone. It is important to confirm the metatarsal as the source of pain to prevent confusion with synovitis of the metatarsophalangeal joint or with neuritis. Tenderness is present by pushing under the affected metatarsal in a dorsal direction, which reproduces the pain, particularly if the patient is resisting the upward pressure. Pain associated with synovitis of the metatarsophalangeal joint is located more distally and is reproduced by axially loading the joint over the proximal flexion crease.

Examination of the patient with a suspected stress fracture should include a careful evaluation of the ankle and hindfoot. In general, deformity of the hindfoot or ankle will affect the more distal parts of the foot, particularly in those feet that are more rigid, because forefoot loading increases significantly. Because hindfoot varus deformity is usually associated with a midfoot cavus and forefoot equinus, the position of the hindfoot and the limitation of subtalar joint motion is quite

Figure 2. Collegiate basketball player with a healed fifth metatarsal stress fracture after screw fixation. Anteroposterior *(A)* and lateral *(B)* radiographs.

Illustration continued on opposite page

obvious; however, this is not always the case, and idiopathic hindfoot varus alone may be present. The overall function of the ankle should also be checked; a good example of this problem is presented in Figure 2. This patient was a collegiate basketball player who sustained a stress fracture of the fifth metatarsal and was treated with cannulated, percutaneous screw fixation. After initial healing and complete resolution of symptoms, he began to experience increasing discomfort with athletic

Figure 2 *(Continued).* Anteroposterior *(C)* and lateral *(D)* radiographs after refracture and bending of the screw.

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activity, and the screw was noted to be bent. A larger-diameter screw was then inserted, once again with clinical and radiographic healing. Six months later he refractured the same metatarsal while simultaneously sustaining an acute sprain of his ipsilateral ankle during the offseason while playing basketball; this occurred when landing from a jump-shot. He had previously sustained multiple ankle sprains and, recognizing the chronic nature of this condition, had always had the ankle carefully

Figure 2 *(Continued).* Anteroposterior *(E)* and lateral *(F)* radiographs after reosteosynthesis with a larger intramedullary screw. *G,* Anteroposterior stress radiograph showing varus instability of ankle.

taped, but failed to do so on this occasion. In addition to significant ankle instability, he was noted on examination to have subtle hindfoot varus and limited subtalar motion, which clearly caused increased stress to both the ankle and fifth metatarsal. The fracture was therefore treated with revision of the cannulated screw fixation with simultaneous ankle ligament repair and reconstruction.

Radiographs

Initial radiographs may not reveal the fracture. Cortical hypertrophy usually commences by 2 weeks and the fracture becomes apparent by 3 weeks, often 5 to 6 weeks after the initial stress fracture.[9] Standard radiographs may not reveal evidence of the fracture until at least a 50% decrease in bone density has occurred, which occasionally delays diagnosis.[13] Although technetium (99mTc-MDP) scintigraphy[2] reliably confirms the diagnosis of the stress fracture, this test should not be relied upon to make the diagnosis. Nonetheless, should early definitive diagnosis be warranted or necessary (particularly for the competitive athlete), the bone scan is quite reliable, as the initial osteoclastic resorption is followed by increased vascularity, creating an area of focal, increased uptake. Such metabolic alterations within bone may be observed as early as 24 hours after injury.[19] Although sensitive, this test is not specific, and it must be combined with the appropriate clinical history to confirm a stress fracture. Recently, MR imaging has been used to diagnose stress fractures of the metatarsals, but the expense of this technique (when compared with that of a bone scan) makes its clinical value questionable. Ultimately, repeat radiographs at 3-week intervals should reveal the fracture.

SPECIFIC METATARSAL FRACTURES

First Metatarsal

Stress fractures of the first metatarsal, which always occur proximally at the junction of the metaphysis and diaphysis are rare, occurring in approximately 10% of all metatarsal stress fractures (Figs. 3*A* and 3*B*).[20] Radiographic diagnosis is not always apparent because one third of these first metatarsal stress fractures heal with less obvious intramedullary callus whereas the remainder demonstrate periosteal and intramedullary callus on radiographs.[20]

These stress fractures are treated with restricted weightbearing in a wooden-soled surgical shoe bearing the majority of weight on the heel over a 4-week period. If the fracture is displaced dorsally, the treatment remains nonoperative, but casting the foot with dorsally applied pressure on the distal first metatarsal is necessary to prevent dorsal malunion and lateral metatarsalgia. Rarely, surgery is required to correct a malunion of a first metatarsal stress fracture to reestablish a more normal weightbearing pattern (Figs. 3*C*–*F*). Rehabilitation after fracture healing is similar to that for stress fractures of the middle metatarsals.

Figure 3. Anteroposterior *(A)* and lateral *(B)* radiographs of a patient with a first metatarsal stress fracture that healed with a dorsal malunion.

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The Middle Metatarsals

Stress fractures of the second, third, and fourth metatarsals account for 90% of metatarsal injuries.[9] Coined the *march fracture,* they are frequently sustained by military recruits during the first few weeks of basic training. This is presumably due to a radical increase in activity, coupled

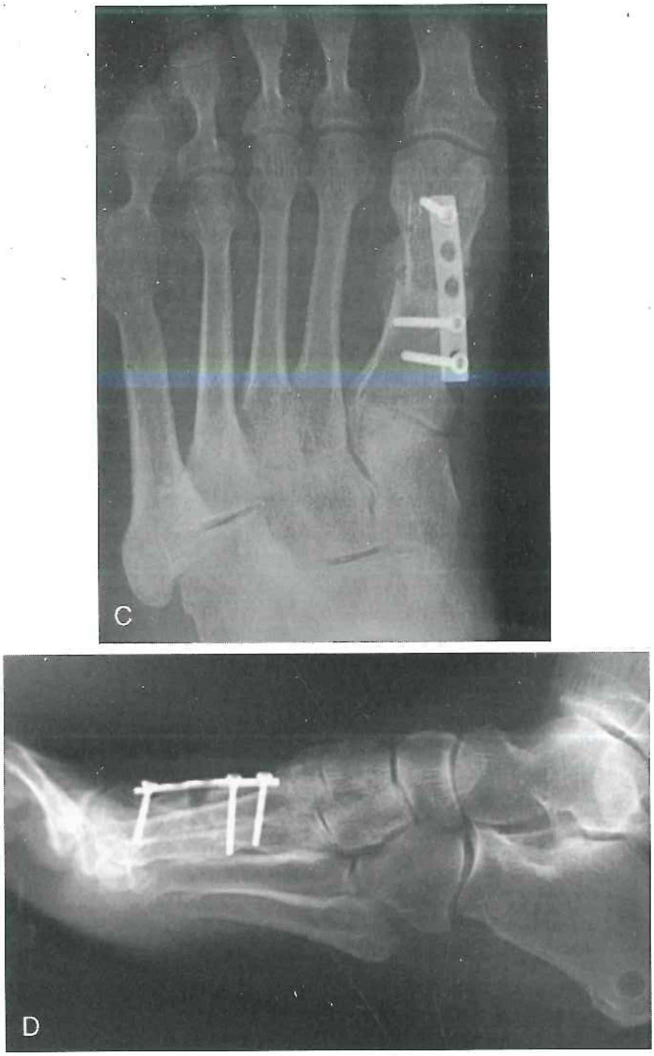

Figure 3 *(Continued).* Anteroposterior *(C)* and lateral *(D)* radiographs after plantarflexion osteotomy of the first metatarsal stabilized with plate and screws.

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with repetitive impact on the metatarsals exceeding the critical load necessary for fracture. March fractures occur more distally in the metatarsal shafts, occurring more frequently in the second than in the third or fourth metatarsal (Fig. 4).[23]

Perhaps one of the more frustrating aspects of forefoot surgery, particularly after correction of hallux valgus, is inadvertent dorsal malunion of a first metatarsal osteotomy, leading to overload of the second

Figure 3 *(Continued).* Anteroposterior *(E)* and lateral *(F)* radiographs of healed plantarflexion osteotomy after removal of hardware.

or third metatarsal. This increased load may present clinically with pain and callosity under the metatarsal head or, if the stress is transferred more proximally, arthritis of the metatarsocuneiform articulation may ensue. As noted previously, if a critical load is exceeded, a stress fracture results. Prevention is clearly through judicious and careful initial operative correction of the first metatarsal malalignment; however, the occurrence of stress fracture after forefoot surgery may also be prevented because these patients often present with prodromal symptoms of fore-

Figure 4. Anteroposterior radiograph showing healing second metatarsal stress fracture.

foot pain. In this setting, the second and third metatarsal should be unloaded using careful orthotic support. A more rigid orthosis is used with a metatarsal pad proximal to the second metatarsal head and a support of the medial aspect of the orthosis under the hallux, termed a *Morton's extension.* If symptoms do not subside with these measures, then a rigid 1/16-inch medial steel shank may be added to the sole of the shoe to increase the loadbearing function of the first metatarsal.

Often some form of rest, with activity modification and a stiff, wooden-soled type shoe, are sufficient treatment for these stress fractures. Occasionally, the authors use a below-the-knee walking cast or a removable walking boot if the forefoot is severely painful. Four weeks of rest is often sufficient, with a gradual return to activity, including sports. Appropriate conditioning of the foot to repetitive stress should be considered to prevent recurrence of the injury. Patients begin with nongravity exercises, such as swimming and pool running, and in 2 to 3 weeks, biking and the use of a stairmaster is added. When sufficient callus is present, a return to running (gradually increasing distances) is allowed.

Because the incidence of metatarsal stress fractures in military personnel is quite high, several clinicians have attempted to decrease the incidence of these injuries. Greaney et al[13] evaluated a group of 250 military recruits and determined that metatarsal stress was increased by performing training exercises on asphalt with a strong heel snap to mark the cadence while marching. The implementation of a program to encourage marching on grass in tennis shoes and eliminating the heel snap produced a significant decline in the number of stress fractures seen in such recruits. Milgrom et al[22] found that having military recruits use modified basketball shoes with a viscoelastic insole during basic training completely eliminated stress fractures. This shoe did, however, have drawbacks when compared with a standard military boot, including decreased durability and increased water absorption during wet weather.

The running athlete is particularly prone to metatarsal stress fracture. Transducer studies[14] confirm that during running, shear force and bending strain are greatest under the second metatarsal head; bending strain is 6.9 times higher under the second than the first metatarsal, verifying the higher incidence of stress fractures in this location. Long-distance runners have also been shown to subject the middle metatarsals to damaging stresses. Sullivan et al[29] found a 16% incidence of stress fractures in the second and third metatarsals among a group of 51 runners. The authors found that stress fractures occurred most often in runners training more than 20 miles per week and in those that ran on hard surfaces, and that they usually became symptomatic within 3 months of a training modification. Pes planus was associated with metatarsal stress fractures in 19 of the 51 runners. The study found that resolution of symptoms required a minimum of 6 weeks (mean, 7 weeks) of enforced rest (i.e., without running). During this rest period, aerobic conditioning and flexibility were maintained through nonimpact methods, such as swimming and pool running. Thereafter, runners were permitted a slow return to running (with gradual mileage increases to preinjury level) in the absence of signs of pain or symptoms of tenderness.

As noted previously, operative procedures on the first metatarsophalangeal joint have been associated with the subsequent development of lesser metatarsal stress fractures.[12, 17] The suspected mechanism was similar to that noted previously, and altered weightbearing placed a rocking stress on the heads of the lesser metatarsals. Although both studies suggest that a shortened first metatarsal is responsible for stress fractures of the middle metatarsals, this alone is not sufficient to create increased impact loads responsible for second metatarsal stress fractures. It is likely that increased activity on the lesser metatarsals weakened by disuse osteoporosis, as well as dysfunction of the hallux, contribute substantially to the stress on these metatarsals.

Ballet dancers may sustain a different type of second metatarsal stress fracture than the distal metatarsal stress fractures discussed previously.[21] These are located on the plantar and medial surfaces of the proximal metatarsal, almost immediately adjacent to the medial cuneiform. Dancing *en pointe* severely and repetitively hyperplantarflexes the second metatarsal base, which is locked into position by its articulation with the cuneiforms. This injury is not seen in male dancers, who dance with a *demi-pointe* technique. Although rare, this injury may be visualized radiographically by internal as well as external oblique radiographs, in addition to more standard anteroposterior and lateral views. Early recognition and aggressive nonoperative management with casting or ankle-foot orthoses for at least 8 weeks will usually result in healing of this most difficult fracture, although surgery may be necessary if delayed union or nonunion occurs.

Fifth Metatarsal

Although fracture of the proximal fifth metatarsal is common, it is important to distinguish the acute, or Jones, fracture from the stress fracture (Fig. 5). Confusion abounds in the literature because the term "Jones fracture" is used to describe several different types of fracture occurring in this location. Torg et al[30] defined the diaphyseal stress fracture as a pathologic fracture of the proximal 1.5 cm of the fifth metatarsal shaft whereas a Jones fracture represents an acute injury in the same location. The problem arises when an acute fracture in this region is preceded by a history of pain or other prodromal symptoms on the lateral side of the foot. This lack of precision may account for the mixed results reported in several series reviewing treatment of these injuries.

Torg et al[30] proposed a classification system for stress fractures of the proximal portion of the fifth metatarsal, which the authors find helpful. Type I fractures are acute, with no history of lateral foot pain prior to the injury. On radiograph, a well-delineated fracture line without intramedullary sclerosis and minimal cortical hypertrophy are seen. Type II fractures have a history of previous injury or fracture, with radiographs exhibiting a widened fracture line and radiolucency, with some evidence of intramedullary sclerosis. This type may resemble a nonunion. Type III fractures have a history of repetitive trauma with a wide fracture line and complete obliteration of the medullary canal. Type III fractures closely resemble nonunions.

Stewart[28] reported a significant incidence of delayed- and nonunion with nonoperative treatment of fractures of the proximal aspect of the fifth metatarsal. Dameron[6] reported on 20 patients with stress fractures of the fifth metatarsal, and showed a prolonged healing time in many patients, including 5 patients who required a bone graft to obtain union. Other series by DeLee et al,[7] Kavanaugh et al,[16] and Torg et al[30] have confirmed the refractory healing of these stress fractures, and these

Figure 5. Anteroposterior *(A)* and lateral *(B)* radiographs of a fifth metatarsal stress fracture with moderate intramedullary sclerosis.

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authors recommend surgical treatment in athletes and those with delayed- or nonunion.

There are two basic operative approaches to treatment of stress fracture of the proximal fifth metatarsal: early bone grafting[8] or intramedullary screw fixation.[7, 16] In 1984, Torg et al[30] reported on 46 fractures of the base of the fifth metatarsal distal to the tuberosity. Of the 25 acute fractures, 15 were treated in short-leg, nonweightbearing casts, and all but one united by 7 weeks. Of the 10 treated with weightbearing methods, only 4 went on to union. In their study, 12 patients developed delayed union; 10 were treated in a non-weightbearing cast, and 1 was

Figure 5 *(Continued).* Anteroposterior *(C)* and lateral *(D)* radiographs showing healed fifth metatarsal stress fracture after intramedullary screw fixation.

treated with bone grafting.[30] Twenty of their patients were treated with inlay corticocancellous bone grafting; union occurred in all but one. The conclusions of this study were that acute fractures should be treated with immobilization in a non-weightbearing cast, whereas delayed or nonunion was most effectively treated with curettage and bone grafting.

Should fifth metatarsal stress fractures in athletes be treated any differently from those occurring in nonathletes? Although nonsurgical methods of treatment may suffice for the nonathlete, the incidence of complications (including nonunion and delayed union) makes this method of treatment less appealing for the high-performance or professional athlete. The authors are firm advocates of surgical treatment for competitive athletes, based not only on the potential morbidity of nonsurgical methods of treatment, but also the far more rapid recovery and return to full function when surgical treatment is used. The series by Kavanaugh et al[16] showed that none of the fifth metatarsal fractures in football or basketball players healed with cast immobilization whereas a 100% union rate was achieved with surgical treatment. DeLee et al[7] also reported successful outcomes in 10 athletes treated with percutaneous screw fixation, with clinical healing evident at 3 to 6 weeks. Mindrebo et al[24] recently reported clinical results of nine Division I collegiate athletes treated for Torg type I fractures of the fifth metatarsal. These patients were allowed full weightbearing 7 to 10 days after surgery in a boot brace, with progression to bicycling, swimming, and a stair machine at 2 to 3 weeks. The average return to running was 5.5 weeks after surgery, with return to full competition at an average of 8.5 weeks.

The surgical technique for intramedullary screw fixation begins with an incision on the lateral border of the foot 3.5 cm proximal to the base of the fifth metatarsal. A guide pin is then inserted into the base of the fifth metatarsal across the fracture site. The foot is positioned on a stack of towels to allow proper insertion of the guide pin, as the pin must enter the bone parallel to the shaft of the metatarsal. By adducting the forefoot, the insertion of the guide pin is facilitated. With some of the newer cannulated screw systems, it is not necessary to drill over the guide pin because self-tapping screws are used; however, a drill should be used to débride the intramedullary sclerosis and reestablish the intramedullary blood supply around the fracture site. The appropriately sized screw system should be selected based on the diameter of the isthmus of the metatarsal diaphysis, and should be determined preoperatively from the radiograph. Although 4.5-mm screws are commonly used, the authors occasionally use up to a 5.5- or 6.8-mm screw. Care must be taken, however, to prevent unbending of the metatarsal's natural curvature with the screw, as this may lead to increased load on the fourth metatarsal. It has been the authors' experience that even in the type III fractures, autogenous bone grafting is not necessary if the canal is drilled before screw insertion. For athletes, the authors prefer to leave the screw in place until they have completed their career, as experience has shown an increased refracture rate after screw removal. The postoperative protocol consists of immediate weightbearing in a brace with return to running activities in 6 weeks.

The authors' current recommendations for the treatment of fifth metatarsal stress fractures are as follows: for type I fractures in a nonathlete, a short-leg, nonweightbearing cast is applied until radiographic evidence of healing is present, usually 6 to 8 weeks. For the high-performance athlete with a type I fracture, a cannulated, partially threaded cancellous screw is inserted under fluoroscopic imaging. The type II fracture is similarly treated with an intramedullary screw, whereas the type III fractures, or nonunions, are treated with drilling of the canal and internal fixation. If concomitant ankle instability is present, ligamentous reconstruction is undertaken along with fixation of the fracture. Complications after intramedullary screw fixation include screw head prominence, metatarsalgia, sural nerve injury, and peroneus brevis disruption.

DISCUSSION

Metatarsal stress fractures result from increases in load due to altered mechanics of the foot. These injuries are most frequently seen in athletes; however, they may occur in patients with diminished function of the first metatarsophalangeal joint, neuropathic conditions, metabolic disorders, and varus alignment of the hindfoot. Diagnosis of metatarsal stress fracture is facilitated by a careful history and physical examination, along with selected use of imaging techniques. Radiographic changes are not usually evident until 2 to 4 weeks after the onset of symptoms.

Treatment of metatarsal stress fractures consists of a wooden postoperative shoe or short-leg, weightbearing cast for 4 weeks until symptoms have resolved. Surgery is recommended for fifth metatarsal stress fractures in athletes and in the nonathlete with a Torg type II or III injury. The surgical treatment consists of insertion of a partially threaded cancellous screw with overdrilling of the fracture site to stimulate healing. Malalignment or instability of the foot or ankle must be addressed at the time of surgical treatment.

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