Idiopathic forefoot pain, often termed metatarsalgia, is a common complaint among running athletes. Whereas several causes are often included in the differential diagnosis, Freiberg’s infraction is rarely considered. The signs and symptoms present with Freiberg’s infraction however, can mimic those present with more common forefoot injuries. The article presents the case of a female Division-I college soccer player who developed and was successfully treated for bilateral Freiberg’s infraction. Her initial complaint of unilateral forefoot pain, induced only by vigorous running, progressed to intolerable bilateral forefoot pain with light exercise. Conservative treatment was unsuccessful, and therefore surgery was required to enable her continued athletic participation. As with all weight-bearing joints, clinicians need to be aware of the potential for progressive degenerative changes at the metatarsal heads and the steps used in the evaluation and subsequent treatment of Freiberg’s infraction. 

**Key Words:** Freiberg’s infraction, avascular necrosis, sclerosis, osteochondrosis, metatarsal head

Freiberg’s infraction is not commonly considered when athletes present with atraumatic forefoot pain. Freiberg’s infraction is osteochondrosis with associated flattening, fragmentation, and sclerosis of the metatarsal head. Although classically associated with the second metatarsal, Freiberg’s infraction has been reported at the third, fourth, and first metatarsal heads, as well. When a final diagnosis of Freiberg’s infraction is made, conservative treatments, similar to those implemented with other forefoot injuries, are attempted to alleviate pain and restore function. If conservative efforts fail, however, surgical intervention is necessary. Our purpose is to present the case of a female intercollegiate soccer player who underwent surgical debridement for bilateral Freiberg’s infraction and successfully returned to competition.

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Case Report

During her sophomore season, a 20-year-old female intercollegiate soccer player experienced a burning, localized pain in her left forefoot, specifically over the second and third metatarsal heads. She denied trauma, prior injury, or bilateral symptoms. Her pain was persistent during running and pivoting but was relieved with rest. She denied numbness or tingling and had no ankle pain. Her examination by the team physician revealed localized swelling at the third metatarsal head and pain with passive and active range of motion at the third metatarsophalangeal (MTP) joint. Distal metatarsal compression produced pain. Her distal neurovascular examination and ankle range of motion were normal. Radiographs revealed a crescent sign and collapse of her third left metatarsal head and deformation of the second right metatarsal head (Figure 1), consistent with Freiberg’s disease.

Figure 1  Plantar-view radiographs of the left and right forefeet. Note the deformity, flattening, and fragmentation of the third metatarsal head of the left foot and the second metatarsal head of the right foot.
After consulting the team orthopedist, she chose conservative treatment over season-ending surgery. She was treated with prescription nonsteroidal anti-inflammatory medications, cold-water immersion, ultrasound, massage, and heel-cord stretching. Although she was able play in games, she eliminated excessive running or sprinting during practice, relying on pool running for conditioning.

Although she displayed normal foot contact while walking, her running gait consisted exclusively of forefoot contact during foot strike, midsupport, and takeoff. To reduce forefoot contact forces, neutral orthotics with a metatarsal arch pad were prescribed. Attempts to alter her running style by encouraging heel strike were unsuccessful.

Although still symptomatic, she completed her sophomore season. She improved once the season ended and her activity level decreased. As she began off-season conditioning, however, her symptoms returned. Kicking and jogging were now intolerable. In addition, she developed similar pain and stiffness in her right forefoot, with a bilateral decrease in forefoot motion.

Follow-up radiographs revealed progressive deformity of the third left and second right metatarsal heads, with flattening of the articular surfaces, subchondral sclerosis, and early marginal spurring consistent with Freiberg’s infraction. As is also consistent with Freiberg’s disease, an MRI revealed joint effusion and flattening of the third left and second right MTP joints, with focal low-signal intensity seen in the subchondral region of third left and second right metatarsal heads. No acute fracture or free fragment was seen with either imaging technique. Because of the condition’s progression and severity, the athlete elected surgery.

In the spring, she underwent surgery on both feet, 1 month apart. The procedure on the third left metatarsal included an excisional arthroplasty and debridement of osteophytes in the dorsal half of the MTP joint. At the time of surgery, the capsule was noted to contain a large amount of gelatinous fluid with the development of a pseudoganglion. Small rice bodies in the joint were also removed. Two large, loose joint fragments attached by soft tissue to the periosteum but freely mobile within the joint were also debrided. The remaining dorsal 40% of the articular surface was completely free and peeled away from the bone and was nonsalvageable. The subchondral bone surface in this area was curetted to form a stable base and provide a more congruent joint surface (Figure 2). A K-wire was used to drill holes through the end of the sclerotic metatarsal head to ensure reinstitution of vascular supply and promote fibrocartilaginous ingrowth. Bleeding through these holes was easily seen postdrilling. The volar 30% of the joint had a normal subchondral structure and articular surface. The athlete’s postoperative range of motion was significantly improved, and the articular surface appeared symmetric with that of the fourth ray (Figure 2, left). The right second metatarsal head had similar findings, and an almost identical procedure was performed on it (Figure 2, right).
Postoperative care included weight bearing as tolerated and a rigid-soled postoperative shoe. Aggressive rehabilitation began 2 weeks after each surgery and included active and passive MTP range of motion, massage to prevent adhesions, joint mobilization to promote normal forefoot motion, and thermal modalities. Over the next 3 months, as healing progressed, the athlete continued progressive exercise using pain as her guide.

Three and a half months after surgery, she returned without limitations to begin her junior season. Throughout the season, however, she experienced bilateral pain, swelling, and stiffness. Conservative pain control included metatarsal pads fixed in orthotics, prescription NSAIDS, range-of-motion exercises, and thermal modalities.

Despite the continued discomfort, the athlete completed the season. She reduced her postseason activity, however, reducing her symptoms. The following spring, she participated in normal off-season workouts and successfully returned to complete her senior season without pain. She is currently 3 years postoperative and denies experiencing any significant pain.

Figure 2 Six-month postoperative plantar-view radiographs of the left and right forefeet. Note the more congruent joint surface (compared with preoperative views) of the subchondral bone of the third metatarsal head of the left foot and the second metatarsal head of the right foot.
in her feet, although she continues to wear orthotics. She continues to exercise regularly without foot pain. Currently she is coaching soccer but no longer playing competitively.

Discussion

Freiberg’s infraction in the general or athletic population is not considered a common disorder, although we found no specific epidemiological data as to its incidence. It has been reported in both men and women of various ages, although the disorder is most common in adolescent females between 10 and 15 years of age and young athletes who perform on their toes in events such as sprinting, jumping, and dancing. Bilateral occurrence is rare, being reported in only 6% of cases to 10% of cases. In a summary of 88 surgical cases of Freiberg’s infraction, Gauthier and Elbaz reported that 68% involved the second metatarsal head, 27% involved the third, and 3% involved the fourth. They reported no cases of multiple lesions unilaterally.

Although Freiberg’s infraction was initially described as aseptic necrosis of the metatarsal heads, there appears to be debate as to the true etiology of the disease. Infraction implies that an incomplete fracture is present, and in adolescent cases this is true. It is generally accepted that in adolescents, the growing epiphysis is in some way affected, and the condition is therefore appropriately defined as avascular necrosis or osteochondrosis. This has been supported through scintigraphic imaging of adolescents displaying active revascularization surrounding the epiphysis before any significant radiographic findings. This is a common indicator of avascular necrosis.

Gauthier and Elbaz classified the anatomic evolution of the disease in 5 specific stages: (0) subchondral fatigue fracture with normal X rays, (1) osteonecrosis without deformity, (2) osteonecrosis with crushing deformity, (3) cartilaginous tearing, and (4) degeneration of the MTP joint. In addition, Viladot and Viladot described the progression of the disease, beginning with mechanical compression and subsequent spasm of the arteries supplying the metatarsal head. The spasm results in ischemia of the epiphysis, and continued compression causes arterial occlusion and necrosis. The necrotic epiphyseal bone will be resorbed and remodeled under the mechanical load. Devoid of adequate blood supply, however, the bone will subsequently collapse, resulting in arthrosis of the MTP joint. Similar to Osgood–Schlatter and Legg–Perthes disease, insult to the epiphysis adequately explains the adolescent manifestation of Freiberg’s disease.

Kehr suggests that the symptoms of inflammation might resolve initially during adolescence but reappear later in life. The onset in adults, however, might also be linked to impingement of the osteochondral cartilage, in addition to a compromised blood supply that occurs after growth. Young et al suggest that in skeletally mature adults, shearing forces during
the toe-off phase are responsible for the pathogenesis of Freiberg’s infraction, as opposed to vascular disruption. Based on cadaver examinations, they explain that during toe-off, the phalanges produce a shearing force at the dorsal aspect of the metatarsal heads, causing separation between the mineralized and nonmineralized articular cartilage at the metatarsal head. This leads to the formation of osteochondritis dissecans and eventually degeneration within the MTP joint.

Regardless of the true nature of the pathology, the cause is consistently linked to abnormal mechanical conditions at the affected metatarsal head. Gauthier and Elbaz reported that the lesions were only present on the metatarsals bearing the most weight. Furthermore, they recounted that 50% of their cases were attributed to hallux valgus, 30% demonstrated excessive length of the affected metatarsal, and 6% were associated with rapid weight gain. This concept (unusual loading) was supported by Bayliss and Klenerman, who reported the cases of 3 adults who, after unrelated forefoot surgery, developed avascular necrosis in the lesser metatarsal heads as a result of altered forefoot mechanics. Freiberg’s infraction has also been linked with other anomalies that can alter weight distribution, such as Morton’s toe. The high occurrence in women has been linked to wearing high-heeled shoes, which creates additional forces at the MTP joints and allows for greater MTP dorsiflexion during toe-off.

In the case of our soccer player, we think that her running gait, which consisted of forefoot and toe contact only, was a causative factor. Analysis of her running gait revealed that it was devoid of any heel strike bilaterally. Whereas this is common during sprinting, it is unusual to maintain this pattern during an endurance event such as soccer.

The initial symptom of Freiberg’s infraction is typically localized pain over the affected MTP joint during standing, walking, running, or sprinting that ceases with rest. High-heeled or pointed shoes might also produce pain. The athlete might complain of stiffness, and active and passive range of motion will be limited. Dorsal effusion and signs of synovitis are often present, as well. In the advanced stages of the disease, crepitus, locking, palpable osteoarthritic defects, hypertrophy of the joint surface, and extension contractures might be present. These symptoms might resolve and then reappear later in life with an increase in activity or alteration in loading. Although seldom reported symptomatically, evaluation of the contralateral side might enable early detection and preventive intervention before significant structural changes occur.

Imaging techniques can include simple radiographs including AP, lateral, and oblique views. These views will often reveal flattening, fragmentation, and a crescent sign with longstanding involvement of the metatarsal head. Occasionally, the plain-view X rays might only reveal a widened joint space resulting from chronic synovitis. When plain-view X rays do not reveal any significant findings, additional supplemental imaging techniques including bone scan and MRI can be helpful. With the progression of MRI techniques, however, bone scanning is becoming obsolete.
Normal X rays in the presence of pain might indicate that nonsurgical treatments will be effective. This can include techniques such as those recommended by Canale, including a short-leg walking cast with toe extension for approximately 6–12 weeks along with complete cessation of all painful activity. Ary suggested the use of a donut pad surrounding the metatarsal head and timely steroid injections. Rigid forefoot orthotics that prevent dorsiflexion of the toes can reduce shear forces at the MP joint and can therefore be helpful in diminishing pain.

In individuals with longstanding disease or progression of deformity, surgical intervention is often necessary. Techniques including excisional arthroplasty, internal fixation of the metatarsal-head fragment, and core decompression can be considered.

When fragment fixation is selected, the metatarsal head, articular surface, and underlying subchondral bone must be suitable to allow appropriate purchase of the fixation device in order to completely stabilize the metatarsal head to the metatarsal shaft.

In most cases, however, clinical findings at the time of surgery do not allow fixation, because bone fragmentation has often occurred in the articular fragments. In these instances, drilling the remaining sclerotic distal metatarsal is necessary in order to reinstitute vascular supply to this surface so that a fibrocartilaginous cap can be developed. Clearly, this is not as functional as articular cartilage, but it will facilitate improved MTP function.

Overall, the goals in treatment and surgery are to minimize discomfort and improve function. High-demand athletes will clearly stretch the limits of surgical technique because of stress that is applied to the metatarsophalangeal joints during running and jumping activities. This injury often ultimately leads to complete cessation of sporting activity and the untimely discontinuation of an athlete’s sport or career.

This case represents a successful outcome for a female intercollegiate soccer player with Freiberg’s disease. Her case was unique not only because Freiberg’s infraction is rarely presented as an athletic injury but also because her symptoms manifested beyond adolescence and occurred bilaterally. Conservative treatment was unsuccessful so surgery was necessary. Although it is impossible to establish a causal relationship, she might have developed Freiberg’s infraction as a result of her “toes only” running style. This disorder can be misinterpreted as more common stress-related persistent foot injuries, even though the signs and symptoms are specific to the metatarsal heads.

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References


