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# Stress Fractures of the Tibia after Jogging

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#### Abstract

Stress fractures of the tibia seldom occur and the diagnosis is easily overlooked. Radiological signs may be subtle and the majority of cases will heal after a sufficient period of immobilization. The following description of two cases and subsequent review of the literature provide helpful information for the clinician to recognize, diagnose and treat stress fractures of the tibia.

**Keywords:** Fractures; Stress; Tibia; Radiography

## Introduction

A stress fracture is bone fracture which can be partial or complete and results from repeated application of stress the bone. This stress is lower than the stress required to completely fracture the bone in one instance. Healthy athletes, especially runners and military personnel generally sustain these injuries. Stress fractures account for up to 20% of sports related injuries. The site most commonly affected is the 2nd metatarsal bone. Stress fractures of the tibia seldom occur and the diagnosis is often overlooked as we would like to illustrate with the following two cases of patients with stress fractures of the tibia. A description of the cases is followed by a review of the literature on pathofysiology, presentation, diagnostic work-up and management of stress fractures of the tibia.

## Case 1

A forty-nine year old male patient presented himself to the emergency room with the complaint of pain in the right leg after jogging. The pain occurred a week ago and started after jogging. Beforehand there were no complaints at all (e.g. shin splints). The pain was described as an ongoing sensation during jogging which got so severe after a while that he discontinued jogging. The pain was located at the anterior 2/3 distal part of the shin of the right tibia. The patient had full function of his leg and was able to go to work the whole week. Upon examination we saw painful, red, tender mass located at the anterior 2/3 distal part of the right tibia. His body temperature was 37.6°C (99.7°F) and he had no calf tenderness. Pulsations of the dorsal and posterior tibial artery were intact. There were no wounds visible upon examination. In his history, the patient sustained a distal fibula fracture in the past which was managed conservatively. We examined the old x-rays and saw no difference in the healed fibula fracture. We treated the patient with antibiotics under the working diagnose of having superficial skin infection.



**Figure 1:** Anterior-posterior x-ray showing irregularity at the bone cortex without any disruption of the distal tibia and early callus formation. The white arrow shows callus formation



**Figure 2:** Lateral x-ray showing a horizontal fissure of the distal 2/3 of the tibia without any periostal reaction

After 5 days the redness had not subsided and we made an X-ray of his lower leg. On the X-ray we say a fissure of the tibia without any periostal involvement correlating with the site of the redness (Figure 1 and 2). We also saw early callus formation (see arrows in Figure 1). The distal fibula showed signs of union of the aforementioned fibula fracture. A subsequent MRI (Figure 3) was performed and showed oedema of the bone marrow around the fracture line and callus formation and no signs of a pathological fracture. The old fibula fracture showed no signs of a refracture. The bone cortex was undisrupted. The patient was diagnosed as having a stress fracture of the tibia and received a circular polymer resin cast for 6 weeks with excellent results. A Bone mineral density (BMD) of the proximal femur and lumbar spine as measured by DXA showed normal values.



**Figure 3:** The lateral MRI also shows the fracture line with periostal callus formation.

# Case 2

A fifty-nine year old female who works at our hospital mentioned that she had been having pain in her left knee during our routine rotations. She told us that she had been suffering from osteoarthrosis of the left knee and underwent a medial meniscectomy 8 years ago. Beforehand there were no complaints of shin splints. She also mentioned that she started an exercise regime 8 weeks ago, which included jogging. The pain started immediately after one jogging session. The patient thought that is was related to her athrosis of her knee and temporarily stopped her exercise regime. She had been having this pain for last 6 weeks and did not go to a physician. During physical examination of the knee we found no abnormalities. Provocation tests (i.e. drawers test, Lachman and Mcmurrays test) where negative. An X-ray of her left knee (Figure 4) showed osteoarthrosis of medial knee compartment and a translucent patchy spot in proximal tibia. The MRI (not shown) revealed showed oedema of the bone marrow around the fracture line and callus formation and no signs of a pathological fracture. This patient was managed conservatively with an above the knee circular polymer resin cast for 6 weeks. During clinical examination after 6 weeks the patient still complained of axial compression pain and the X-ray showed union and callus formation. The patient received a new cast for an additional 6 weeks. After six weeks the patient was symptom free. A Bone mineral density (BMD) of the proximal femur and lumbar spine as measured by DXA showed normal values.



Figure 4: Anterior-posterior x-ray of left knee showing ostoearthrosis of medial knee compartment. Translucent patchy spot of proximal tibia

# Discussion

Stress fractures where first described in the mid-19th century in a young German soldier who complained of swelling and pain in his foot after marching [1]. In 1897 with the advent of the Rontgen ray it was shown that these symptoms were caused by a fracture of the second metatarsal bone [2]. The present two cases illustrate that a stress fracture of the tibia does not immediately come to mind when a patient presents with discrete pain in the leg to an emergency room.

# Pathophysiology and risk factors

Biomechanically, the occurrence of stress fractures of the tibia, appear to be most related to loading rates. Loading rate is one of the factors associated with its fatigue limit. The fatigue limit of a tissue is related to the type of load applied, its peak magnitude, loading rate, and the total dose. The type of load consists of a combination of compression and bending [2,3]. Most studies of stress injuries describe some change in the training regimen as the causative factor for the injury.3 For instance, it has been documented that there is an increased tibial stress fracture rate in runners with an increasing distance beyond approximately 32 km/wk [4]. Also important is any change in the training program, including a sudden increase in mileage, pace, volume, or cross-training activity without adequate time for physiologic adaptation. Hard training surfaces also is an important risk factor [5].

Giladi et al. [6], analyzed 300 military recruits, and found 2 independent variables in the anatomy considered major risk factors for stress fracture. These include a narrow width of the tibia and increased exorotation at the hip joint. A study performed by Bennell et al. [7] reported that female running athletes with stress fractures had a smaller calf circumference and less lean muscle mass in the lower limb. This correlates with Garrett [8]. who have shown that one of the major role of the calf muscles is energy absorption. A cross-sectional study comparing 23 running athletes with a history of tibial stress fracture and 23 who have never sustained a stress fracture found that the stress fracture group had a significantly smaller tibial cross-sectional on computed tomography than the non-stress fracture group [9]. In contrast a study by Cleek [5]. Reported that the repetitive loading history of runners in a single plane leads to an asymmetric cross-sectional geometry of the tibia. In contrast, soccer players who load in multiple directions were found to have much more symmetric bone geometry.

Most studies report that stress fractures occur more often in females compared to males [10]. This has also been reported in the military where female cadets undergoing similar training programs have an increased risk of stress fractures, ranging from 1.2 to 10 times [3,11] In athletes, the results are less obvious. Female athletes generally develop menstrual irregularity and disordered eating pattern resulting in osteoporosis which increases the risk of developing stress fractures. This contributes to findings that most studies report that females are at an increased risk for stress fractures [12,13] Some studies have reported an increase in risk for female athletes ranging from 1.5 to 3.5 times [14,15] In contrast, another large study has failed to show difference in the risk of stress fractures between female and male athletes sex [16].

## Presentation

The typical history of a stress fracture is that of localized pain. The pain is not present at the start but occurs toward the end of the physical activity. This pattern is generally opposite to that of many soft tissue injuries that have pain the morning after the training. Generally, the pain occurs earlier during the physical activity and lasts longer and will be present throughout the training. The pain subsequently persists into daily ambulation. A careful history is critical and often reveals a change in the training program. The physical examination typically reveals local tenderness over the involved bone. Other examinations for the clinical detection of stress fracture such as the hop test are helpful. However these are not as reliable as direct palpation. Risk factors that can be detected on physical examination should be looked for. These risk factors include various alignment of the lower extremity, leg length discrepancies, femoral neck exorotation, muscle weakness and calf circumference [17].

## Diagnostic work-up

Radiographic signs are usually seen after 2 to 8 weeks of symptoms, and in the early stages of these injuries. Unfortunately, the sensitivity of these radiographic signs may be as low as 10%. Radiography findings can correlate with the MRI signs of the fracture line or callus, but the early phases of bone stress injuries verified with MRI cannot reliably be seen with radiographs [18]. The most common sign in early stress fractures is a region of focal periosteal bone formation. A cortical area of decreased density may also be seen and usually is an early sign of a stress fracture [19]. Focal hyperemia and edema with early resorption of calcium deposits are possibly responsible for this initial graving of the cortex. Other radiological abnormalities may include signs of osteopenia, endosteal reaction, an ill-defined bony cortex, and, in severe cases a complete fracture. Radionuclide scanning is a more sensitive but less specific method for imaging bony stress injuries and can provide the diagnosis as early as 2 to 8 days after the onset of symptoms [20].

Computed tomography scan is useful in differentiating conditions that mimic stress fractures on bone scan, such as osteoid osteoma, osteomyelitis, and various malignancies. It is also helpful in detecting fracture lines as evidence of stress fractures and often can differentiate between stress fracture and stress reaction [21]. Magnetic resonance imaging with fat suppression makes it possible to grade the progressive stages of stress fracture severity [18,22-33]. Magnetic resonance imaging is associated with a high sensitivity for pathology. A magnetic resonance imaging examination can precisely define the location and extent of bony injury with the added benefit of lack of ionizing radiation exposure. Overuse of this diagnostic modality is illustrated by a study by

Bergman [25]. In which 21 runners without symptoms were followedup with MRI and nine (43%) of them showed abnormalities indicating stress injuries. After 12 months, none of the asymptomatic runners developed a frank bone stress injury. These results show the importance of correlating MRI findings with the clinical findings.

## Management

Management depends on the extent of the fracture. Minimal stress reaction without a fracture line can be managed with the temporary cessation of running activities to allow for bony repair. This can range from a few days for a minor stress fracture to 12 weeks for a severe stress fracture. If the pain persists with daily activities, a tibial brace can be used to immobilize distal and mid-tibial injuries [26-34]. The medial tibial plateau as seen in the present case report is an unusual site of stress fracture [27,28]. Use of a long-leg non weight-bearing immobilization may be necessary, especially with a cortical discontinuity. Stress fractures of the anterior cortex of the mid-tibia as seen in this case report are also unique and require a different treatment regimen. These occur on the tension side of bone in a region of reduced perfusion and are prone to delayed union or even worse to progression to complete fracture. These patients also require treatment with no weight-bearing immobilization for 6 to 8 weeks. Finally, surgical placement of an intramedullary fixation is indicated after 3 to 6 months of fails conservative management [29,30]. The Short Musculoskeletal Function Assessment Questionnaire (SMFA) can be used to objectively measure outcome [31].

## Conclusions

The tibia is an uncommon site for stress fractures. However, the diagnosis should be considered in patients who present with localized pain over the tibia that is related to the duration and intensity of physical activity. Long distance running, an alteration in training program and hard training surfaces may contribute to a high index of suspicion. Early radiological signs, i.e. focal periosteal bone formation and 'gray' cortex sign may be subtle in nature. In patients with a typical history and/or presentation and no signs on conventional X-ray the diagnostic work-up should include a CT-scan and/or a MRI. In most cases (non) weight bearing immobilization will lead to uneventful recovery. Delay in diagnosis and treatment should be avoided, since this can result in progression to a complete fracture or a non-union, especially on the anterior cortex of the mid-tibia.

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