Stress fractures in the foot and ankle of athletes

Fratura por estresse no pé e tornozelo de atletas

Authors: Asano LYJ, Duarte Jr. A, Silva APS

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The Guidelines Project, an initiative of the Brazilian Medical Association, aims to combine information from the medical field in order to standardize procedures to assist the reasoning and decision-making of doctors.
The information provided through this project must be assessed and criticized by the physician responsible for the conduct that will be adopted, depending on the conditions and the clinical status of each patient.

Description of the evidence collection method

To develop this guideline, the Medline electronic database (1966 to 2012) was consulted via PubMed, as a primary base. The search for evidence came from actual clinical scenarios and used keywords (MeSH terms) grouped in the following syntax: "Stress fractures", "Foot", "Ankle", "Athletes", "Professional", "Military recruit", "Immobilization", "Physiotherapy", "Rest", "Rehabilitation", "Conventional treatment", "Surgery treatment". The articles were selected by orthopedic specialists after critical evaluation of the strength of scientific evidence, and publications of greatest strength were used for recommendation. The guidelines were drawn from group discussion. The entire text was reviewed by a group specializing in evidence-based clinical guidelines.

Grade of recommendation and strength of evidence

A. Experimental or observational studies of higher consistency.
B. Experimental or observational studies of lower consistency.
C. Case reports (non-controlled studies).
D. Opinions without critical evaluation, based on consensus, physiological studies, or animal models.

Objective

The target audience of this guideline includes orthopedists, physiatrists and sports doctors in order to guide the diagnosis and treatment of athletes with stress fractures in the foot and ankle.

Conflict of interest

No conflict of interest informed.

Introduction

Stress fractures were described for the first time in 1855 by Breihaupt among soldiers reporting plantar pain and edema following long marches.[1] For athletes, the first clinical description was given by Devas in 1958, based solely on the results of simple X-rays.[2] Stress injuries are common among athletes and military recruits, accounting for approximately 10% of all orthopedic injuries.[3]

It is defined as a solution for partial or complete continuity of a bone as a result of excessive or repeated loads, at submaximal intensity, resulting in greater reabsorption faced with an insufficient formation of bone tissue.[1]

Although stress fractures may affect all types of bone tissue, they are more common in bones that support bodyweight, especially those in the lower limbs (tibia, 49%; tarsal bones, 25%; metatarsals, 9%).[3] Studies on runners reveal a higher incidence of stress fractures in the tibia, followed by the metatarsals, fibula, femur and navicular bone.[4,5]

The locations of stress fractures vary from sport to sport. Runners may develop a stress fracture of the medial malleolus, the distal end of the fibula, calcaneus, lesser metatarsal, and medial sesamoid bone. Classical ballet, aerobic gymnastics, tennis and volleyball athletes mainly present stress fractures in the navicular and sesamoid bones. Basketball athletes have a prominence of the medial malleolus, navicular bone and metatarsal stress fractures, while for footballers lesser metatarsal fractures are more common.[6,7,8]

From a biomechanical point of view, fatigue fractures are the result of specific, cyclical and repetitive muscle action until exhaustion, with load transfer to the bone exceeding its adaptation capacity.[8,10] The shear and compression forces stimulate bone transformation according to Wolff's law, that is, the compression forces promote osteoblast activity and bone deposition leading to a strengthening of bone structures, adapting to the applied load, while shear forces lead to the reverse process of bone resorption by stimulating osteoclast activity. As a result, the majority of stress fractures are located in the areas of shear stress.[4,5,8]

When should we suspect a stress fracture in the foot?

Suspected injury is based on the details from the medical history, general physical examination and orthopedic physical examination. It is important to establish the relationship between the start of painful symptoms and physical activity, generally performed repetitively, abrupt changes in the amount of training and the presence of risk factors (**D**).[8,11,12]

Initially, pain emerges at the end of the exercises and intensifies over some weeks; it may occur during the entire activity, and be constant during walking. Pain worsens and transforms training into suffering. Training becomes increasingly painful and difficult to continue. Even after some days of rest, returning to activities too early leads to recurrence of the pain (**D**).[4-6,8]

Recommendation

Stress fractures in the feet of athletes should be suspected in the presence of insidious pain associated with increased exercise intensity.

Which complementary exams should be requested for the diagnosis?

After the medical history and clinical exam, plain radiography, bone scintigraphy, computerized tomography and magnetic resonance imaging have been used to aid the diagnosis (**D**).[8,11] Despite its low sensitivity, simple radiography is recommended to start the investigation (**D**).[12] In more advanced cases, cortical or medullary fracture lines, regional osteopenia, sclerosis and callus formation may be noted. Unfortunately, radiographs are initially negative in 70% of stress fractures and might not show evidence of injury for 2 to 4 weeks after the start of symptoms (**C**)[13] (**B**).[14]

Rupture of the bone cortex can be demonstrated through computerized tomography and evidence of periostitis can also be detected in this manner. The sensitivity of computerized tomography is higher than radiography; however, compared with bone scintigraphy and magnetic resonance injury, the sensitivity for revealing stress fractures is low, resulting in a higher rate of false negatives (**C**).[16] Owing to the high rate of false negatives using radiographs at the start of the course of stress fractures, additional diagnostic imaging is often necessary. Bone scintigraphy has traditionally been the test of choice in this situation, but has been supplanted by magnetic resonance imaging (**B**).[17,18] Despite its sensitivity, bone scintigraphy is not specific and may produce false positive results in 13 to 24% of cases (**C**).[13]

Magnetic resonance imaging has numerous practical advantages over scintigraphy. It provides precise anatomical resolution, can differentiate a stress reaction from a stress fracture, as well as being a noninvasive, multiplanar exam that does not require radiation. It is more sensitive and specific, provides greater information and is capable of detecting pre-radiographic bone changes. The disadvantages include the higher cost, contraindications relating to claustrophobic patients and those with metal implants or surgical materials (**C**).[13]

Follow-up using computerized tomography or magnetic resonance imaging may also be useful to monitor healing of the stress fractures and determining if there is a delay in healing that could require surgical intervention (**D**).[6]

Recommendation

In cases of suspected stress fractures, plain radiography of the site of pain should be requested, with diagnosis in the majority of cases via more sensitive and specific imaging exams (magnetic resonance imaging).

What are the factors that favor stress fractures?

Various factors contribute to the pathogenesis of the disease, which may be classified into 2 sub-types: intrinsic and extrinsic. In general, extrinsic factors are related to the type and rhythm of training, the use of unsuitable footwear and sports equipment, precarious physical conditioning, the training location, environmental temperature and insufficient recovery time of previous injuries. Intrinsic factors include age, sex, race, bone density and structure, hormonal, menstrual, metabolic and nutritional balance, sleep pattern and collagen diseases (**D**)[4,5,8](**C**).[19,20]

Prospective and retrospective studies show a higher incidence among Caucasians. When compared to American black and Hispanic individuals, white individuals are more susceptible to stress fractures (**D**).[22] The same occurs with age: older individuals present a higher incidence of such fractures (**B**).[7] Stress fractures are less common in children than adolescents and adults (**D**).[23] In relation to sex, some studies have shown that military women have an incidence 5 to 10 times higher than men (**B**).[7]

With regard to genetic factors, studies on identical twin military recruits submitted to the same treatment in quantity, duration and intensity reveal fatigue fractures in the metatarsal bones in both (**B**).[7]

In relation to biomechanical factors, a high longitudinal arch of the foot, difference in the length of the lower limbs and a marked varus foot associated with multiple stress fractures have been observed (**B**)[15,21] (**C**).[19,20,24]

Cavovarus feet have recently been gaining more attention as being a significant risk factor for various conditions of overuse, especially stress fractures. This shape of foot is known for being relatively rigid, with weak capacity for attenuating shock (**C**).[25,26] Supination and pronation of the feet are associated with a significant increase in the risk of stress injuries (**B**).[27]

Recommendation

In cases of suspected stress fractures, intrinsic and extrinsic factors that favor the occurrence of injury should be investigated. The investigation of these risk factors aids diagnosis and treatment.

What is the differential diagnosis?

The main diseases that should be discarded are those resulting from repetitive and excessive effort and that affect the soft tissues that surround the area of bone affected, such as muscle injuries, bursitis, tendinopathy, splints, infections, cancer and compartment syndrome (**C**)[28](**B**).[29]

Does female athlete triad affect stress fractures?

Female athletes are more likely to developing stress fractures (**C**).[19] The growing increase of this pathology among female athletes is related to factors that characterize female athlete triad: eating disorders, menstrual disturbances and low bone density (**D**).[4,5,8] Greater prevalence of eating disorders (such as bulimia, anorexia nervosa, ingestion of laxatives and diuretics) has been found among female athletes (**D**).[30] Irregularities in the menstrual cycle (hypoestrogenism) correlate with early bone loss, reduced mineralization of the osteoid and, consequently, the prevalence of stress fractures in women (**D**).[22]

How should stress fractures be treated?

The treatment of stress fractures varies according to some of the fracture's characteristics, such as location, type, and evolution time. A general plan can be established divided into two phases: phase I, or modified rest, is characterized by pain control through the use of anti-inflammatory drugs, physiotherapy methods for analgesia and kinesiotherapy, weight-bearing permitted in daily activities and maintenance of aerobic fitness without causing abnormal stress responses in the affected segment. Activities such as cycling, swimming or running in water are alternatives for maintaining the athlete's physical conditioning.

Phase II begins from the moment in which the athlete no longer presents complaints of pain, which generally occurs within 10 to 14 days from the start of symptoms. A gradual return to the sport is allowed based on the correction of intrinsic and extrinsic factors (**D**).[3]

Most stress fractures can be treated conservatively. This implies immobilization in a boot, without sustaining the foot until the symptoms have disappeared, generally around 6 to 8 weeks. Impact activities are avoided, but low impact workouts such as swimming, cycling, and elliptical machines can be continued to maintain aerobic fitness. Frequent physical exams are useful to identify the resolution of symptoms. Nutritional considerations are important as dietary deficiencies may contribute to the development of stress fractures. Recent data recommends early surgical treatment of fractures with a high risk of stress to elite athletes owing to the high risk of dislocation and non-consolidation. Early surgical treatment is also associated with a quicker return to the sport (**B**)[15](**C**)[49,50](**D**).[31]

Electrical stimulation has also been used for the treatment of stress fractures with satisfactory results (**C**).[32]

Recommendation

The treatment of stress fractures in the feet and ankles of athletes is, in most cases, conservative, through the use of analgesic methods, relative rest, not bearing weight, immobilization of the limb, maintaining physical condition with low impact exercise and correcting risk factors.

What are the indications for surgical treatment?

Despite greater awareness about this injury, the treatment of stress fractures in the foot and ankle continue to be a particularly problematic issue, including the navicular bone, fifth metatarsal and medial malleolus. These injuries are often not diagnosed and may occur at a higher frequency than that actually observed. For example, the navicular bone has a risk of delayed healing because of the poor areas of blood supply, and stress fractures of the medial malleolus have a high rate of dislocation and lack of consolidation. These injuries frequently require surgical stabilization (**D**).[8,33]

Stress fractures in the navicular bone are often difficult to diagnose. If untreated, they can result in osteoarthritis and delayed consolidation (**C**)[34-36](**B**).[37] A large number of stress fractures in the navicular bone may show differences in the outcomes of surgical and nonsurgical treatments for various types of injuries. Given that the published data reveals a high occurrence of delayed consolidation, importance should be given to immediate surgical treatment, especially when the fracture extends to the navicular body or up to the second cortex of the navicular bone (**B**).[38] Surgical

treatment consists in percutaneous screw fixation with or without exposure of the fracture site. Generally, bone graphs are reserved for chronic fractures and delayed consolidation and nonunions (**C**).[36] Partially threaded solid or cannulated compression screws measuring 4 mm are used (**D**).[31]

A stress fracture in the fifth metatarsal diaphysis is defined as a stress fracture of the proximal zone of the bone immediately distal to the anatomical area of the Jones fracture (**C**)[41] (**B**).[42] These fractures frequently occur in athletes and are included in the 'high risk' group owing to the difficulty of obtaining consolidation and the high rate of nonunion and refracture. These fractures may have a prolonged healing time of 21 months, and nonunion may developed in up to 25% of patients treated conservatively (**C**).[41,44] Therefore, many authors currently favor surgical intervention for this fracture, especially in athletes (**D**)[8,31,43] (**C**).[44] Compared to conservative treatment, surgical treatment offers a quicker healing time, a shorter time for returning to full sports activity, and a lower rate of complications (**C**).[40]

Various surgical treatment methods (bone grafts (**C**),[24,41] tension bands (**D**)[23] and intramedullary screws) have been proposed. Fixation with intramedullary screws is the method recommended for the treatment of stress fractures by the majority of authors in the literature (**C**)[44,47] (**B**).[45,46] The hybrid technique (fixation with intramedullary screws associated with autogenous cancellous bone graft) seems to be a reasonable treatment for primary intramedullary fixation (**C**)[24](**D**).[39] A recent systematic review (**B**)[59] concluded that intramedullary fixation with screws promotes successful union in all types of Jones fractures when compared to non-surgical treatments.

The treatment of stress fractures in the medial malleolus, and the distal end of the fibula depends on several factors. The presence of a fracture line, deviated fracture and athletic participation in the season may influence treatment decisions (**D**).[48] There are numerous reports of surgical intervention for the treatment of stress fractures in the medial malleolus. The presence of a fracture line detectable via radiography, especially in high level athletes, or deviation of the fracture is reported as an indication for surgical intervention. Surgical treatment consists in closed or open reduction and internal fixation with screws (**B**)[15](**C**).[58] The present authors believe there are no reports in the literature of surgical fixation of distal fibular stress fractures.

Recommendation

Surgical treatment is indicated in cases where the fracture occurs in the shear zone, the location most disposed to delayed consolidation, nonunion or refractures.

How can stress fractures in athletes be prevented?

The best manner of treating stress fractures is prevention. The attending physician is responsible for knowing their athlete well, seeking to detect concurrent intrinsic and extrinsic factors for the injuries caused by microtrauma from repetition, and correcting them (**D**).[11]

The prevention of injuries and prognosis are of particular importance to competitive athletes as the objective is not only to start participating again, but to compete at a high level, preventing long term consequences. Injury prevention strategies and programs are a vital part of the education and training of athletes at all levels (**C**).[51]

It is important to educate athletes that continuous pain lasting 3 weeks is a warning sign for the body, and that early diagnosis leads to quicker recovery (**B**).[52]

Changes in footwear and the surface for practicing training may help to reduce the number and severity of injuries in relation to the feet and ankles of athletes (**D**).[33]

Worn footwear may have a role in increased injury rates. Use of light and flexible shoes with less support of the midfoot may places the athlete at risk, as these may offer less protection against potentially harmful forces in the foot (**A**).[53]

A Cochrane review in 1999 declared that 'the use of shock absorbing inserts in footwear probably reduces the incidence of stress fractures in military personnel' (**A**).[54] Another Cochrane review found evidence that custom-made orthoses for feet were effective in the treatment of cavus foot pain (**A**).[55]

Running shoes with neutral insoles have recently demonstrated a statistically significant reduction in plantar pressure in athletes with cavus feet (**A**).[56]

In relation to refracture, it is well known that returning to sport early is an important risk, therefore athletes should be warned about the complication (**C**).[47,57] In high level athletes, computerized tomography or magnetic resonance imaging should be considered before returning to training in order to avoid refracture (**C**).[57]

Recommendation

The prevention of stress fractures in athletes is based on a suitable physician/patient relationship in order to identify the characteristics of the athlete, correct risk factors and guide them in relation to symptoms and the importance of correct treatment to avoid new fractures.

When can the patient return to sport?

The decision to return to sport is based on the location of the injury and its corresponding potential for healing

and risk of significant complication (**D**).[60] It is useful to divide stress injuries into high and low grades. This simplification provides an approximate assessment of the healing time, with high reliability (**C**)[35] (**D**).[8,9]

Healing time is defined as the time required to return to full activity without any symptoms. This time was significantly greater in scintigraphy with high grade stress injuries compared with low grade ones. This grading of stress injury provided by scintigraphy was a significant indicator for the time until full recovery (**B**).[29]

Low risk stress fractures generally heal when the athlete is limited to activities without pain, over a period of 4 to 8 weeks. This healing period is an ideal time to assess the modifiable risk factors that could decrease the change of injuries recurring. A gradual increase in activity (daily life activities) should begin after the athlete is free from pain and the site is not injured (**D**).[61] In a study by Arendt and Griffith (**D**),[62] returning to full activity from initial stress injuries (3.3 to 5.5 weeks) was significantly quicker than for more serious injuries (11.4 to 14.3 weeks).

For stress fractures in the navicular bone, the time for returning to sports activities and condition for returning to competitions is around 4 months (**B**).[38] Khan et al. (**B**)[37] reported on the time to returning to full activity among 55 patients with stress fractures of the navicular bone treated conservatively. The treatment of 6 weeks without bearing weight enabled 86% of the patients to return to full activity in an average period of 5.6 months after injury.

Considerations related to returning to training for athletes with high risk stress fractures are more difficult than in low risk fractures. In general, returning should only be recommended after suitable treatment and when the injury has completely healed, given that high risk fractures have the most frequent complications, such as delayed consolidation and refracture (**D**).[8,60]

Recommendation

Returning to practicing sports should be conducted gradually after consolidation of the fracture, which depends on the grade and location of the fracture, with greater rest time required for high risk fractures.

Other guidelines at www.projetodiretrizes.org.br

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