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Original Research Article

Epidemiology of stress fractures among athletes involved in various sports

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Abstract: Stress fracture is partial or complete fractures of bone that result from the repeated application of a stress less than that required to fracture a bone in a single loading situation. Stress fractures comprise between 0.7 and 15.6 percent of all athletic injuries. Athletes particularly at risk of stress fracture are runners and jumpers, gymnasts and dancers and in general, the bones most commonly injured are the metatarsals, fibula and tibia. The present study was done to determine the epidemiology of stress fractures among athletes involved in various sports activities. The Materials and methods in The study done including the athletes involved in the sports activities like football, runners, jumpers, gymnasts and other sports involving application of constant stress to body particularly to the lower extremities. Detailed history of all these stress fractures injuries were retrieved and arranged systemically. The study was included the record of the last 5 years of the sports injuries. All stress fractures were analyzed for incidence, frequency of stress fractures, and location of stress fractures, injury severity and incidence of re-injuries. In Results A total of 49 stress fractures were registered in 42 players, out of total 983 players of all the sports academies. The incidence of stress fractures was found to be 0.6 % of all the sports injuries. In Conclusion There is limited research assessing stress fractures injuries in athletic sports. We have shown that stress fractures are rare in athletic sports but when they occur, they cause long absences. Younger age and intensive workload appear to be risk factors. Stress fractures are a recognized complication of the chronic, intensive, weight-bearing training familiar to athletic, dance and military populations. Bones are most susceptible to stress fracture when weakened by remodeling- related porosity, a primary stage in the adaptive response of bone to changes in patterns of loading.
Keywords: Stress fracture, sport activities, Athletes

INTRODUCTION:

Stress fractures were first described by Briethaupt, a Prussian military physician in 1855. He described the clinical signs and symptoms of metatarsal fractures in military recruits after long marches, hence they are also known as ‘March fractures’. These are spontaneous fractures of a seemingly normal bone following a summation of stresses, which are singly insufficient to produce a fracture [1, 2].

The injury is usually seen in the lower extremities, but it has also been reported in the upper extremities and the ribs. The most common locations for stress fractures include the tibia, metatarsals, fibula, and navicular bones; less common locations include the femur, pelvis, and sacrum [3].

A stress fracture is caused by repetitive and submaximal loading of the bone, which eventually becomes fatigued and leads to a true fracture. The typical presentation is a complaint of increasing pain in the lower extremity during exercise or activity. The patient's history usually reveals a recent increase in either training volume or intensity[3]. A stress fracture represents the inability of the skeleton to withstand repetitive bouts of mechanical loading, which results in structural fatigue and resultant signs and symptoms of localized pain and tenderness [3].

A recent review in fact concluded that data regarding the epidemiology of stress fractures in athletes are ‘‘lacking,’’ except that stress fractures usually occur among those participating in sports with repetitive weight-bearing activity. Also, risk factors may not be the same for all athletes, so studies focusing on specific sports may provide particularly useful information for participants in that sport [4, 5]. Therefore this study was planned to know the epidemiological status of stress fracture.

MATERIALS AND METHODS:

The study done including the athletes involved in the sports activities like football, runners, jumpers, gymnasts and other sports involving application of constant stress to body particularly to the lower extremities. Approval of the ethical committee was taken before start of the study. All the records of the nearby sports clubs were analyzed for finding out the incidence of the stress fractures. Detailed history of all these stress fractures injuries were retrieved and arranged systemically. The study was included the record of the last 5 years of the sports injuries. Average age of the players was 24 years with range of 13 to 35 years.

All stress fractures were analyzed for incidence, frequency of stress fractures, and location of stress fractures, injury severity and incidence of re-injuries.

RESULTS:

Incidence and severity of stress fractures:

A total of 49 stress fractures were registered in 42 players, out of total 983 players of all the sports academies. The incidence of stress fractures was found to be 0.6 % of all the sports injuries.

Location of stress fractures:

All stress fractures affected the lower extremities involving the metatarsal, tibial, pelvic, foot and fibula fracture. Most common bone affected was metatarsal bone (73%). In that fifth metatarsal bone was affected. Other commonly affected bones are tibia (11%) and pelvic bone (9%). Other bones are affected in 7% cases. (Table 1)

Table 1: Incidence of stress fracture according to the site affected

Site of fracture	Percentage of injury
Metararsal bones	73%
Tibia	11%
Pelvic bone	09%
Other bones	07%

Injury severity:

Most of the stress fractures were severe causing on average absence of 26 days. Some metatarsal bone and pelvic bone caused absence of around 3 to 5 months.

Incidence of re-injuries:

Re-injuries caused 24 % of all stress fractures and whenever they present, it caused longer absences than those occurred for the first time. Incidence of re-injuries was high for the pelvic (41%) and tibial fractures (32%). While it was lower for the metatarsal fractures (17%). (Table 2)

Table 2: Site of re-injury in cases of stress fracture

Site of re-injury	Percentage
Pelvic	41%
Tibial	32%
Metatarsal	17%

Presence of more than one stress fractures:

Total of 06 players had more than one stress fracture. Four players sustained re-fractures of the fifth metatarsal bone. Another player had incidence of three stress fracture, while one player had re-fracture of the pelvic bone.

DISCUSSION:

Stress fractures are a frequent cause of injury in competitive and recreational athletes [6]. Stress fracture is usually a hairline fracture of bone caused by rapid and repeated application of a heavy load, such as constant pounding on a surface during running, route march, parade, drill and weapon training. It occurs when muscles become fatigued and are unable to absorb added shock. Eventually, the fatigued muscles transfer the overload of stress to the bone causing tiny cracks [2].

Pathophysiology of stress fracture:

The precise pathophysiology of stress fractures is unknown, and current models are based on theory. In its role of providing internal support, the skeleton is exposed to repetitive bouts of mechanical loading, which result in bone strain [3].

Strain refers to the change in length per unit length of a bone. It is a unit less value, but because it is very small it is often expressed in terms of micro strain ($\mu\varepsilon$). As with other structural materials, repetitive strain in bone is naturally associated with the generation of damage (often termed micro damage). This damage is typically of little consequence, as bone is capable of self-repair through targeted remodeling. Under certain conditions, however, imbalances can develop between damage generation and its removal. The subsequent accumulation of damage is believed to be the start of a pathology continuum that results clinically in stress reactions, stress fractures, and ultimately complete bone fractures [3].

Results from studies of female or female and male athletes are contradictory regarding the associations of stress fractures with age, lower bone mineral density or lean body mass, late age at menarche, not using oral contraceptives, low body weight, disordered eating, and low calcium and dairy product intake. Individual studies have reported leg length discrepancy, low dietary fat intake, and a history of stress fracture to be risk factors, but confirmation in other investigations is needed [5].

Studies of stress fracture in female or female and male military recruits and trainees have also produced somewhat inconsistent and tentative results. Possible risk factors include increasing age, a small thigh girth, lower aerobic fitness, no or only a small amount of lower extremity weight training in the past year, lack of menstrual cycles in past year, and, in a large prospective study, lower bone mineral density, weight loss, alcohol consumption of more than 10 drinks per week, cigarette smoking, weight bearing exercise, lower adult weight, corticosteroid use, use of depomedroxy progesterone acetate, and lack of past regular exercise [5].

The cause of stress fractures in the calcaneus involves the resumption of activity subsequent to major fractures of the lower leg. These reports include those patients that have had long periods of convalescence and non-physiologic loading to the heel. The mediating factor is thought to be disuse osteopenia with loss of secondary trabeculae. A less common but contributing factor following lower extremity fracture is the possible angulatory deviations that may be accepted as a consequence of healing. Furthermore there are some well-established metabolic states that also escalate the incidence of stress fracture in the calcaneus. Perhaps the best known one is the alteration of bone resiliency following sodium fluoride therapy for osteoporosis [7].

The actual orientation of calcaneal stress fractures usually occur at right angles to the primary trabecular pattern and often are quite removed from the direct transmission of forces. In the metatarsals, the pattern and location of most stress fractures is in the midshaft, and can easily be seen to be a result of excessive cantilever bending. Although such cantilever bending is a sub-optimal load to failure, the rate and repetition of that load are responsible for the propagation of the fatigue fracture. The protective nature of the muscles surrounding any long bone, against fracture, is well established [7].

Similarly, damage accumulation and stress fracture may also result from purely cyclic overloading, which occurs when remodeling is given insufficient time to repair damage and additional loading cycles enable damage to accumulate. Therefore, factors that increase the number of loading cycles may also contribute to the development of a stress fracture [3]. It has been suggested that the cause of the female athlete triad (disordered eating, menstrual dysfunction and osteoporosis) might be an energy deficit due to low energy intake in combination with high energy expenditure in training and matches [8].

Radiographic Findings:

Radiographic findings typically are often quire subtle and non-diagnostic, particularly in the early stages of the entity. As with any stress fracture, positive radiographic findings are confirmatory and are present because of the reparative or healing process. Patients with symptoms may have totally normal radiographs, yet have established stress fractures that have not healed enough to exhibit a visible change in the bone density. This so called lag period must be considered in those patients in whom the history and physical findings indicate stress fracture, yet the radiographs do not [7].

Radiography is the method of choice to establish the diagnosis of stress fracture. Fracture lines, lucency, periosteal thickening or early callus in normal bone help in establishing a diagnosis of stress fracture. However, only 50% of stress fractures will be visualized on initial plain radiograph. Other imaging options include repeating the radiographs after 2-3 weeks, radionuclide bone scanning and magnetic resonance imaging or computed tomography. The technetium-99 diphosphonate 3-phase bone scan remains the “gold standard” as it is extremely sensitive for stress fracture. The bone scan reveals increased uptake by osteoblasts in new bone formation at the site as early as 6-72 hours after the injury [9].

Many theories have been proposed to explain the aetiology of stress fractures. These include repetitive stress, rapid changes of load or changes of surface, and negative catabolism due to dieting[8].

Risk Factors for Stress Fractures As with most overuse conditions, the development of a stress fracture is likely due to a range of factors, with the relative contribution of each factor varying among individuals. These factors can be grouped into two categories, extrinsic and intrinsic. Extrinsic risk factors are factors in the environment or external to the individual that influence the likelihood of sustaining an injury. In terms of stress fractures, these include the type of activity or sport, as well as factors involving training, equipment, and the environment [3].

Intrinsic risk factors refer to characteristics within individuals themselves and how the body responds to mechanical loading and the damage that it may generate. The contribution of intrinsic risk factors is indicated by the fact that not all individuals exposed to an equivalent loading regimen will develop a stress fracture. Intrinsic risk factors include skeletal, muscle, joint, and biomechanical factors, as well as physical fitness and gender [3].

The principal factor in causation of stress fracture is rigorous and sustained physical activity over a relatively short period of time in an unaccustomed cadet. The proactive approach for preventing stress fractures is to start at a lower level of activity and gradually progress to full-scale basic training. Training program should also include muscle endurance training to help the cadets withstand intense physical activity. Proper footwear and appropriate running surface also contribute to the prevention of injuries. While complete elimination of stress fractures is impractical, an objective approach to minimize loss of training hours should be the goal of all training establishments [2].

The treatment of most stress fractures is relatively straightforward and includes decreased activity and immobilization; however, patients with some stress fractures, such as displaced femoral neck stress fractures and fifth metatarsal base stress fractures, are more likely to have complications such as nonunion [3].

The initial phase of management focuses on pain control with ice, non-steroidal anti-inflammatory medication, and relative rest. Ice application for 15-20 minutes four times per day serves the dual purpose of analgesia and reduction of soft tissue swelling [2].

CONCLUSION:

There is limited research assessing stress fractures injuries in athletic sports. We have shown that stress fractures are rare in athletic sports but when they occur, they cause long absences. Younger age and intensive workload appear to be risk factors.

Stress fractures are a recognized complication of the chronic, intensive, weight-bearing training familiar to athletic, dance and military populations. Bones are most susceptible to stress fracture when weakened by remodeling- related porosity, a primary stage in the adaptive response of bone to changes in patterns of loading. Prevention is the most appropriate management approach, best achieved through graduated training increments. The goal of stress fracture treatment is to facilitate the natural progression of bone remodeling by reducing loads on the injured site to the greatest extent. Thus, rest from pain-provoking activities remains the most effective, if often prolonged, intervention approach at this time.

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