Research Article

Study of stress fracture contributing factors and its association with bone mineral density in recruit trainee in one of the training center of Central India

Brajesh Dadarya[1], Sameer Gupta[2]

[1]Department of Orthopaedics, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India.
[2]Department of Orthopaedics, Gajra Raja Medical College, Gwalior, Madhya Pradesh, India.
Correspondence to: Brajesh Dadarya, E-mail: dr_brajeshd@yahoo.co.in

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Abstract

Background: 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. There are various factors of stress fracture such as training error, over training, and anatomical factors. This study was aimed to understand the contributing factors of stress fracture in military recruits and its association with bone mineral density.

Objectives: This study is aimed to evaluate: (1) various factors contributing to the development of stress fractures and (2) association of bone mineral density and the incidence of stress fractures.

Materials and Methods: The study was conducted in 580 recruits at one of the paramilitary training centers of central India for 2 years. Diagnosis of stress fracture was made by careful history and physical examination. Bone mineral density is measured and data were analyzed and evaluated by standard statistical methods.

Results: In maximum number of cases, the precipitating cause was running (in 44% cases). FPET was responsible for a large number of cases (38%). No association was established between the calcaneal bone mineral density level and the occurrence of stress fractures. The recruits who were using good-quality sport shoes showed least incidences of stress fracture and who were using PT shoes showed the highest incidences.

Conclusion: It can be concluded that to reduce the morbidity in trainees, the proper care of type of shoes can reduce the incidence of stress fracture. Proper rest time between the training sessions can also improve the condition. More sensitive modalities can be used to diagnose the case at an early intervention period. However, more studies are required to elaborate the contributing factors.

KEY WORDS: stress fracture, contributing factors, bone mineral density, recruit trainee

Introduction

Mechanical loading during physical activity produces strains within bones. It is thought that these forces provide the stimulus for the adaptation of bone. An accepted tenet of bone biology is that under normal circumstances there is a close relationship between the structure of bone and its particular function.[1] 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. 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 results in bone strain.[2]

Stress fractures are common overuse injuries seen in athletes and military recruits. The pathogenesis is

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multifactorial and usually involves repetitive sub-maximal stresses. Intrinsic factors, such as hormonal imbalances, may also contribute to the onset of stress fractures, especially in women. An abrupt increase in the duration, intensity, or frequency of physical activity without adequate periods of rest may lead to an escalation in osteoclast activity. During periods of intense exercise, bone formation lags behind bone resorption.[3]

Stress fractures continue to be a significant clinical problem that causes substantial morbidity and time lost from participation. In order to prevent stress fractures, an appreciation of their risk factors is required. A study by Warden et al. described various potential extrinsic and intrinsic risk factors for stress fractures, based on the available literature, and suggested, as with most overuse conditions, that the development of a stress fracture probably requires a combination of factors.[4]

Studies by Brukner et al. reviewed 180 cases of sport person and evaluated the sites of stress fractures in male and female and the relation with types of sport.[5] In another study by Milgrom et al. on female runners evaluated biochemical stress factors for stress fractures in tibial bone.[6]

Stress fractures continue to be a significant clinical problem that causes substantial morbidity and time lost. In order to prevent stress fractures, an appreciation of their risk factors is required. In this work, a detailed study of stress fracture among military personnel at a training center was carried out to find various factors contributing to the development of stress fractures and association of bone mineral density and the incidence of stress fractures.

Material and Methods

This study was an observational study. All the trainees were registered for study at the time of joining the training and they were observed for the development of symptoms of stress fracture. All 580 recruits taking training at Military Training Centre, B.S.F. Tekanpur were included in the study. A "Case" of stress fracture was defined as "a trainee with a history of localized pain of insidious onset with training which worsens with progressive activity and is relieved by rest".

If stress fracture is present on more than two anatomical locations, it is considered as one case. All the recruits who were taking training during study period were considered as population at risk. They were observed and evaluated at regular intervals for signs and symptoms of stress fracture and showed positive signs and symptoms of stress fracture. Also the data of military hospital were checked at regular intervals to find out cases who had consulted in the hospital. Bone mineral density assessment was done when possible. Approval for all procedures was obtained from the human subjects. All the subjects had given their informed consent before the study. Data were analyzed with the suitable statistical methods.

Results

Patients were carefully evaluated on the basis of their history and symptoms. Total 116 cases of stress fracture were found. All the precipitating factors under the study were evaluated and are shown in Table 1. In the maximum number of cases, the precipitating cause was running (in 44% cases). FPET was responsible for a large number of cases (38%) although trainees had to perform FPET only once in a week.

No association was established between the calcaneal bone mineral density level and the occurrence of stress fractures (Table 2). In same study, types of footwear and their association with stress fractures were also evaluated. The results are shown in Table 3. The recruits who were using good-quality sport shoes showed least incidence of stress fracture and those who were using PT shoes showed the highest incidence.

Table 1. Precipitating cause

Activity	No. of cases	Percentage
FPET*	44	38%
Running	51	44%
Marching	21	18%

*Field physical efficiency test

Table 2. Association with bone mineral density

BMD Level	% Cases	% Control
<−1	25	24
−1 to +1	45	42
>+1	37	34

Table 3. Type of footwear and its relation with stress fracture

Type of shoe	Physical activity	Rank of trainee	Total no. of personnel examined	No. of stress fracture case	Incidence
Canvas PT shoes	PT + Running	RCT	205	30	14.65%
Good-quality sports shoes	PT + Running	SI + AC	375	21	5.6%
Leather shoes (ammunition boots)	March + FPET	RCT	205	25	12.20%
		SI + AC	375	40	10.66%

Discussion

Stress fractures result from excessive, repetitive, submaximal loads on bones that cause an imbalance between bone resorption and formation. An abrupt increase in the duration, intensity, or frequency of physical activity without adequate periods of rest may lead to an escalation in osteoclast activity. During periods of intense exercise, bone formation lags behind bone resorption. The etiology of stress fractures is multifactorial. The rate of occurrence depends on the bone composition, vascular supply, surrounding muscle attachments, systemic factors, and type of athletic activity.[3]

Stress fracture is fairly common condition encountered in military training centers. This is due to the large number of young males exposed to unaccustomed vigorous training conditions. In this study, an effort has been done to understand any relation between type of activity and occurrence of stress fracture. It was also observed that types of shoes also affect the incidence of stress fracture. No association was established between the calcaneal bone mineral density level and the occurrence of stress fractures.

A study by Milgrom et al. reported that axial compression strains, tension strains, compression strain rates, and tension strain rates were higher during overground running than during treadmill running. These may be the additional factors that can be affected by the type of the activity and types of shoes.[6] Another study by Milgrom et al. also reported that there is no significant relation between peak compression strain and calculated drop jump energy, indicating that subjects were able to dissipate part of the potential energy of successively higher drop jumps by increasing the range of motion of their knee and ankle joints and not transmitting the energy to their tibia. No statistically significant differences were found between the principal strains during running and drop jumping, but compression and tension strain rates were significantly higher during running.[7]

In this study, we observed that trainees were wearing heavy ammunition boots for marching and FPET. These were ankle-high boots with thick leather sole. It is obvious as leather shoes cannot provide as much cushion as rubber soles.

In this study, we noticed there was a significant difference in shoes of recruit constables and officers, provided for PT and running. The shoes provided to the recruit constables were ordinary canvas PT shoes with thin rubber sole and without any shock absorbing cushion. These shoes were not capable of reducing the incoming shock waves generated due to the heel strike. Whereas the shoes provided to the officers were of good-quality sports shoes with shock-absorbing soles, which reduce the incoming shock waves.

In this study, we found that 14.65% of the recruit constables during training developed stress fracture while they were running with ordinary canvas PT shoes, whereas at the same time only 5.6% of the sub-inspectors and assistant commandants developed stress fracture while running with good-quality sports shoes. There was not much difference in the incidence of stress fracture among recruit constables and officer groups during FPET and marching, when both the groups were wearing similar leather shoes (incidence was 12.20% in the recruit constable and 10.70% in the officers).

Dressendorfer et al. in their study showed that unaccustomed prolonged exercise has been shown to reduce the aerobic performance of muscles by reducing the oxygen-carrying capacity of the blood. They also showed that sudden and large increase in training activity can cause muscular tissue damage.[8] A low level of physical conditioning and poor muscular development at the commencement of a training regime are considered by many to be risk factors for developing lower extremity injuries including stress fractures.[9]

Voloshin et al. suggested that shock wave that generates by the heel strike propagates through the body to the skull and is attenuated along the way. Wearing shoes with better shock-absorbing properties reduces the incoming shock wave at any particular site and subsequently reduces the possibility of stress fracture.[10]

Though every effort has been made to observe and evaluate factors related to stress fractures and their association with bone mineral density and types of footwear, still there are some limitations of this study. First, this study is training based and may differ according to types of training, so results cannot be implemented on all the training types. Second, the diagnosis of stress fracture is based on clinical and physical examination and personal history, but the use of more sensitive modalities for diagnosis may create different results. It is observed that more studies are required including all types of training program with larger cohort using more sensitive diagnostic modalities.

Conclusion

This study is conducted on trainee recruits in one of the training centres of paramedical force of central India. Results were analyzed and evaluated after 2 years of observation during training period. It is observed that stress fracture is a common complication in trainee recruits and is associated with types of training and pattern. It is also associated with the types of shoes used by the trainees. No association was established between the calcaneal bone mineral density level and the occurrence of stress fractures. It can be concluded that to reduce the morbidity in trainees, the proper care of type of shoes can reduce the incidence of stress fracture. Proper rest time between the training sessions can also improve the condition. More sensitive modalities can be used to diagnose the case at an early intervention period. However, more studies are required to elaborate the contributing factors.

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