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Research Article

Stress Fracture in Military Recruits: A One Year Study

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Abstract

Objectives: Stress fractures occur as a result of repeatedly making the same movement in a specific region, which can lead to fatigue and imbalance between osteoblast and osteoclast activity, thus favouring bone breakage. Stress fractures in military recruits causes long periods of absence from training and economic losses. The purpose of this prospective study was to determine the incidence and distribution of stress fracture in military recruits and present evidence-based concepts to provide with an overview of diagnosis, treatment, and rehabilitation.

Methods: 284 military recruits at a peripheral military hospital who had presented with symptoms of pain, swelling or deformity of lower limb were studied over a period of 1 year. All of them with clinical and radiological diagnosis of Stress fracture were hospitalised and treated conservatively for a week followed by 4 weeks of sick leave and thereafter observed for 6-12 weeks depending upon the severity of their symptoms wherein stress fracture rehabilitation was provided in a phased manner.

Results: 284 recruits had reported with pain, swelling, deformity of lower limb at the end of physical activity with a focal point of tenderness. The average age of the patients with Stress fracture was 20 years. The incidence of Stress fracture reached maximum during 11-20 weeks of the training schedule. Overall, the most common sites of bone injuries were the tibia (52.11%), fibula (23.59%), femur shaft (9.50%), femur neck (7.74%)and metatarsals (7.04%). Most fractures healed in an average period of 5 weeks. Most individuals returned to their full activity in an average period of 18 weeks.

Conclusion: The study provides evidence that Stress fracture among military recruits occur frequently during their training period. To prevent stress fractures, modifiable risk factors must be identified and a proactive approach should be adopted which helps recruits withstand intense physical activity.

Keywords: Military recruits, stress fracture, stress pain

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Stress fractures were first described in Prussian soldiers by Breithaupt in 18551. They were named "march fractures" and their characteristics were confirmed 40 years later with the advent of radiography.[1] Stress fractures occur due to repetitive cumulative micro trauma on the bone over a period of time. They occur as the result of repeatedly making the same movement in a specific region, which can lead to fatigue and imbalance between osteoblast and osteoclast activity, thus favouring bone breakage. These fractures are a result of repeated application of stress lower than that required to fracture the bone in a single loading situation.[2] Stress fracture injuries most often evolve with an insidious onset that typically occurs at the end of physical activity with a focal point of tenderness.[3] The activities involved in the diverse types of military training may put personnel at different injury risks. The most frequently reported cause of these fractures is repetitive weight-bearing activities such as running and marching, a recent increase in physical activity, beginning of a new activity or some other change in their routine can also result in increase of these fractures.[4]

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The medial tibial syndrome is an overuse injury at the medial tibial border caused by running exercises. The pain is elicited by exertional ischaemia. The pathogenesis is explained by increased pressure in the fascial compartment of the deep flexor muscles due to prolonged exercise.

Symptom includes pain which increases on bearing weight and swelling. Typical findings include localized tenderness, swelling and erythema. Accurate diagnosis for stress fractures is dependent on the anatomical area. Regardless, early recognition is the optimal goal to minimize the potential for micro-fractures to become macro-fractures. Stress fractures may heal completely, slowly or incompletely. Treatment strategies includes early identification of the symptoms, early diagnosis, a sufficiently long training pause and in special cases consultation of experts in the field. Surgical treatment may be needed in some cases.[4]

Besides the knowledge about the occurrence of these fractures and their effect on economy and loss of man hours, there are relatively few studies that provide actual incidence of these fractures. The present study is aimed at determining the incidence, types and site of Stress fractures in military recruits through clinical and radiological diagnosis and to present an updating article on this topic and condense the main information obtained through the most important studies published over the last few years.

Methods

It is a prospective study of Stress fractures, wherein a group of 2000 military recruits training at a military training centre was selected and those presenting with symptoms were evaluated clinically and radiologically, treated and followed up till the fracture healed. Only plain X-Rays were used as the imaging modality. All the participants in the study gave their informed consent and knew the objectives of the study. Any trainee having acute history of trauma was excluded from the study. Recruits who presented with stress pain but had no radiological evidence of stress fracture were also excluded from the study.

During their training, the recruits were routinely examined by the Medical Officer appointed at the training centre. All the recruits were encouraged to report symptoms of possible Stress fracture, and all symptomatic recruits were referred to the department of Surgery for further management. Appropriate radiographs of the involved limb were taken. The time of fracture was considered to coincide with the earliest manifestation of pain in the affected limb. The recruits had free access to the Regimental Medical Officer and the Nursing assistant and were always encouraged to report to the medical authorities in case of pain, swelling, erythema of any limb. All except 8 patients who required surgical intervention were treated conservatively; with initial an period of immobilization with crepe bandage, rest, ice packs and analgesics, followed by mobilisation and gradual re-induction into training programme. The duration of medical observation and pause from training was granted according to the site and grade of Stress fractures and signs of healing of the fracture on X Ray.

The Stress fractures was graded in to groups based on the suggested clinic-radiological classification by Agarwal.[5]

Grade I: Mild pain, periosteal reaction, tenderness, walks without pain.

Grade II: Severe pain, hair line crack of cortex, tenderness, and walk without support.

Grade III: Severe pain, partial thickness involvement of cortex, tenderness, walks with support.

Grade IV: Severe pain, tenderness, cannot walk/walks with difficulty even with support, full thickness of cortex involved.

Results

284 out of 2000 recruits had symptoms of Stress fractures. On evaluation by radiography 284 recruits (14.2%) were diagnosed as having Stress fractures. Out of 284 diagnosed with Stress fractures, 120 (42.25%) were Grade I, 108 (38.02%) were Grade II, 38 (13.38%) were Grade III and 18 (6.33%) were Grade IV (Fig. 1).

176 (61.97%) recruits were of the age of 19 years, 58 (20.42%) recruits were 20 years of age and 50 (17.60%) recruits were of the age of 21 years (Fig. 2).

148 (52.11%) recruits suffered stress fracture Tibia, 67 (23.59%) had stress fracture fibula, 40 (14.08%) had stress fracture involving the metatarsal, 17 (5.98%) recruits had stress fracture femoral shaft and stress fracture of femoral neck occurred in 12 (4.22%) patients (Fig. 3).

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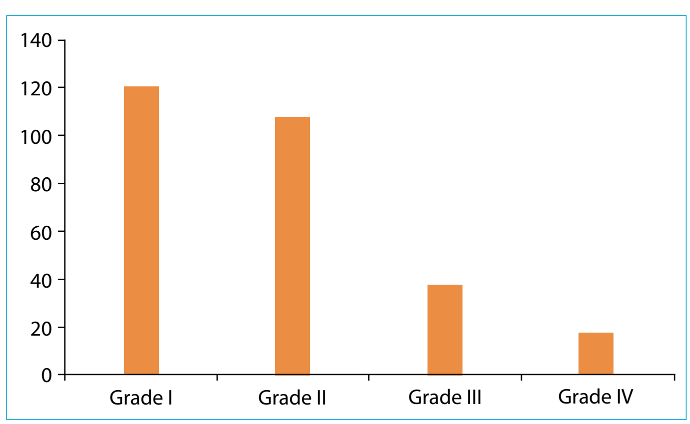

Figure 1. Percentage presentation of different grades of Stress Fracture.

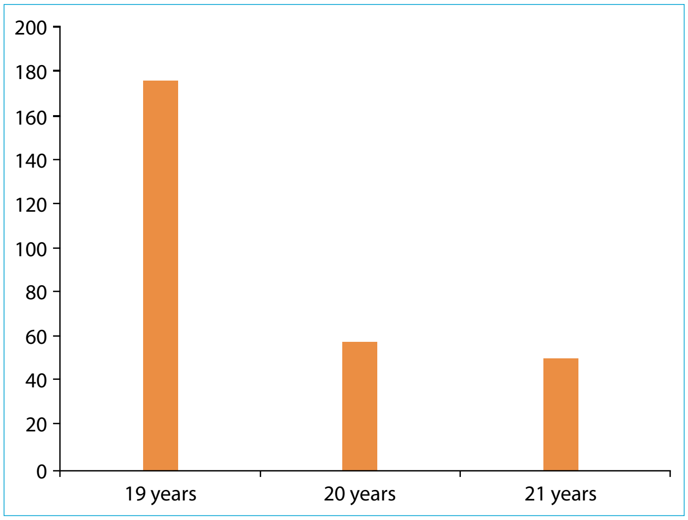

Figure 2. Age of recruits presenting with Stress Fracture.

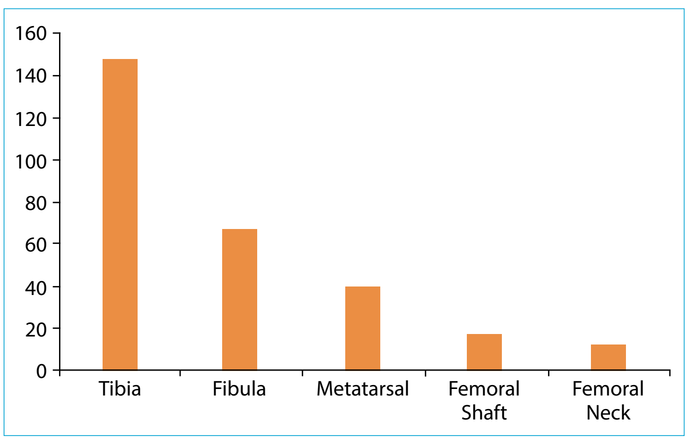

Figure 3. Percentage of bones involved in Stress fracture cases.

Right lower limb and 108 (38.02%) patients had stress fracture of the left lower limb.

The incidence of Stress fractures was more during their initial training, 99 (34.85%) recruits presented with stress fracture between 1-10 weeks of training, 116 (40.84%) reported between 11-20 weeks of training, 49 (17.25%) reported between 21-30 weeks of training and 20 (7.04%) recruits reported between 31-40 weeks of military training (Fig. 4).

Out the 148 tibial stress fractures, 41 (27.70%) involved the proximal third, 86 (58.10%) involved the middle third and 21 (14.18%) involved the distal third of Tibial shaft. 39 (58.20%) Stress fractures involving fibula involved the proximal 1/3rd and 28 (41.79%) involved the distal third of Fibula. Second metatarsal was most commonly involved in 18 cases (45%) followed by 3rd metartarsal in 12 (30%) cases and 10 cases involved the 4th metatarsal (25 %).

All the fractures were treated conservatively except 8 (2.81%) fractures (3 fractures tibial shaft, 3 fractures femoral

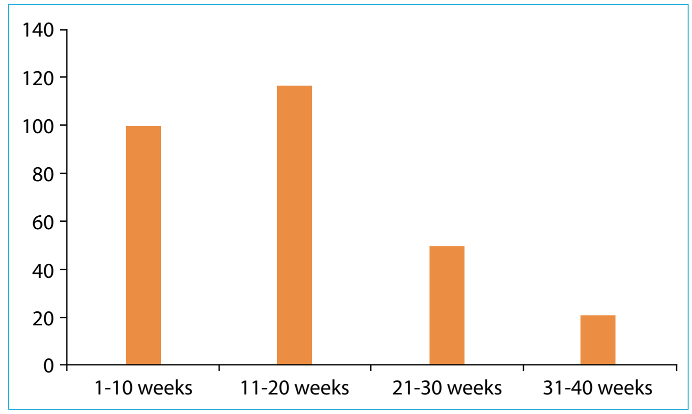

Figure 4. Presentation of Stress Fracture during the course of training.

shaft and 2 fractures neck femur) that were operated upon. All fractures healed well in an average period of 5-7 weeks which included 1 week of hospitalisation and 4-6 weeks of sick leave. 269 (94.71%) recruits returned to full activity and resumed training in an average period of 18 weeks. 15 (5.28%) recruits had persistent symptoms and radiological evidence of fractures and could not continue with their training for medical reasons.

Discussion

Stress fractures in military recruits is an overgrowing concern all over the world. Data about the actual incidence from Indian military and precisely at what point in training they occur is limited. The present study was performed to provide answers to these questions, and the controlled circumstances of military training imparted to recruits at military training centre provided a suitable group to study.

Runners, soldiers and dancers are the main victims of stress fractures.[6] Stress fractures are mostly commonly diagnosed in the tibia, followed by the metatarsals (especially the second and third metatarsals) and by the fibula.[7] In the military population, the incidence of stress fractures among females is greater than among men.[8] The incidence of SFs among military recruits has been reported to be around 5% amongst the US military recruits.[9] However, in India two studies by Agrawal PK and Dash N et al.,[5] reported high incidence of 11.4% and 7.04% in two different military training centres. Apparently, the 14.2% incidence of SFs in our study far exceeds this figure or those reported from any previous study.

The significant higher incidence of Stress fracture has been attributed to training with maximum stress on running, jumping, parade on hard ground, and gymnastics.[10] It can be also due to sudden increase in amount and intensity of physical activity along with repeated impact due to running on hard surface, improper technique and equipment.[11]

Pathophysiology: Six to eight weeks after a sudden and non-gradual increase in the intensity of an athlete's or new patient's physical activity, this cyclical and repetitive physiological overloading may lead to the appearance of micro-fractures and may not allow the bone tissue to have sufficient time to undergo remodelling and adapt to the new condition, and thus to repair the microlesion.[12] The load applied is considered to be insufficient to cause an acute fracture, but the combination of overloading, repetitive movements and inadequate recovery time make this a chronic injury.[13] Furthermore, rigid pes cavus, discrepancy of the lower limbs, short tibia, genu valgum, increased Q angle, body mass index lower than 21 kg/m^2 and short stature should also be taken into consideration in analysing the risk factors for stress fractures.[14]

Diagnosis: Simple radiography (X-ray) is the initial imaging examination because of its ease of access and low cost.[2] Radiographs lack the ability to determine acute stress fractures since it may take 3 weeks for cortical irregularities and periosteal reactions to become evident.[15] Computer tomography scans have been identified as useful in the diagnosis of stress fractures but lack the sensitivity of MRIs to provide concurrent evaluation of soft tissue.[15] Computed tomography (CT) is used mainly when there is a contraindication against using magnetic resonance imaging.[16] Nuclear medicine using triple-phase scintigraphy (technetium-99 m) presents significant sensitivity (74–100%) to bone remodelling and shows imaging alterations three to five days after the start of symptoms.[6] Magnetic resonance imaging (MRI) is the most sensitive and specific imaging examination for diagnosing stress fractures. It is recommended by the American College of Radiology as the preferred examination in the absence of radiographic alterations.[6] Regardless of stress fracture location, MRI is currently the gold standard, largely due to the instrument's ability to display both soft tissue and bone edema.[17] One of the earliest signs of stress fracture is bony edema, which is not easily visible on standard radiographic imaging (Table 1).[18]

Modifying risk factors: The management of risk factors such as biomechanical stresses, nutrition, and overtraining may be the key to long term and successful treatment.[21] Terrain and equipment may contribute to risk factors and, therefore, treatment considerations. Runners who change terrain or run hilly landscapes are more likely to incur stress fractures.[22] Current literature indicates that high levels of calcium (1.500–2.000 mg) and vitamin D supplementation (800–1000 IU) may be a component of stress fracture prevention; however, the literature is conflicting.[3] Bisphosphonates have been commonly used to treat stress fractures, yet some concerns exist with the potential for abnormal long term bone deposition and a lack of Food and Drug Administration approval for this intervention.[23]

Treatment: Analgesics are used for pain relief6. Immobilization is only rarely used for treating stress fractures because of its deleterious effects on muscles, tendons, ligaments and joints.[24]

Complications: The main complications occur in cases of high-risk stress fractures. Inappropriate management may cause progression of the fracture to a complete and displaced fracture line and thus give rise to delayed consolidation, avascular necrosis and pseudarthrosis.[6]

Table 1. Low and high risk stress fracture classification and Fredericson tibial MRI classification.[19, 20]

Low risk classification	High risk classification	Fredericson classification for tibial stress fractures
• Heal with conservative treatment • Nonsurgical management • Compression stress fractures • Typically includes o Femoral shaft o Medial tibia o Fibula o Calcaneus o 1st–4th metatarsals	• Risk for complete fracture • Risk for non-union • Delayed union • Typically requires surgical intervention • Requires non-weight bearing or assisted weight bearing • Tension stress fractures • Typically includes o 5th metatarsal o Anterior tibia o Tarsal navicular o Femoral neck o Patella o 1st metatarsal sesamoid	• Grade 1: periosteal oedema only • Grade 2: bone marrow oedema visible on T2-weighted images • Grade 3: bone marrow oedema visible on both T1-weighted and T2-weighted images • Grade 4: intra-cortical signal abnormalities

Conclusion

Stress fracture is at the endpoint of a continuum of a bone's reaction to stress that ranges from early remodelling to a cortical fracture. Normal levels of stress facilitate normal bone remodelling. When activity levels change or increase, the level of bone remodelling also increases. This study proves that there is a high incidence of Stress fracture in military recruits that remains unreported otherwise. The possibility that some cadets do not report pain and continue strenuous exercise for fear of losing their term despite symptoms and the fear of physical instructors further add to the problem and add to the delay in seeking medical attention. The Medical Officer must therefore have a high index of suspicion for Stress fractures. The cornerstone in avoiding Stress fracture is prevention. Education of trainees, trainers and instructors, modification in training procedures, use of better equipment can reduce occurrence of these fractures. Early reporting to hospital and treatment is also necessary as it can help in early return to full activity.

Disclosures

Ethics Committee Approval: The study was approved by the Local Ethics Committee.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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