PATTERNS OF STRESS RELATED INJURIES OF LOWER LIMBS IN MILITARY SETUP ON SKELETAL SCINTIGRAPHY

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ABSTRACT

Objective: To determine patterns of stress related injuries of lower limbs in military (training) setup on skeletal scintigraphy and frequencies.

Study Design: Cross sectional descriptive study.

Place and Duration of Study: Nuclear Medical Centre, Armed Forces Institute of Pathology (AFIP) Rawalpindi from Jul 2004 to Dec 2012.

Materials and Methods: Total 297 positive cases of military cadets/recruits on 3-phase skeletal scinitigraphy were included in study whereas negative cases were excluded. 99mTc-MDP (20mCi) was injected intravenously followed immediately by angioscintigraphic, blood pool imaging and delayed imaging after 2 hours. Acquisition was done on Siemens E-Cam ® and Scintronix ® Gamma Cameras. Radiotracer uptake in localized focal pattern was labeled as stress fracture, in linear pattern along the periosteum as sub-periosteal reaction or periostitis, linear uptake in poster medial distal tibial aspects as medial tibial stress syndrome or shin splints and up take at insertion sites of major lower limb muscles as activity induced enthesopathy, respectively.

Results: Stress fractures constituted 80.13% cases with bilateral middle third tibiae as the commonest site. Shin splints were present in 21.88% of cases and sub-periosteal reactive changes in 14.47% of the patients. Activity induced enthesopathy was present in 4.20% of patients with bilateral quadriceps femoris enthesopathy being more prevalent.

Conclusion: Most common overuse injuries are stress fractures followed by shin splints, sub-periosteal reactive changes and activity induced enthesopathy. Middle third of tibia is commonest site prone to stress fractures and overall right lower limb is frequently involved as compared to left in all stress induced injuries.

Keywords: Bone scan, Overuse injuries, Stress fracture.

INTRODUCTION

Approximately 50% of all the injuries pertaining to physical exertion are secondary to overuse[1]. Approximately half of these include those of lower limbs (20%), ankles (15%), and feet (15%). The stress related injuries include stress fractures, shin splints, sub-periosteal reactive changes and/or activity induced enthesopathy. The tibial stress related injuries account for up to 75% of patients with lower extremity pain[2-4].

Stress fracture is defined as a partial or complete bone fracture as a consequence of repeated stress application which is lower than that required for bone fracture in a single loading situation[5]. Shin splints, or medial tibial stress syndrome (tibial periostitis), is characterized by diffuse tenderness in distal third of the tibia posteromedially[6]. Periosteal reaction is response of cortical bone to various aetiologies such as; trauma, infection, tumour, drugs and arthritic conditions which can cause periosteal elevation from cortex resulting in various patterns of periosteal reaction[7]. Enthesopathy is pathological change at entheses (osteotendinous or osteoligamentous junctions) secondary to repetitive stress application and consequently, these sites are commonly involved in overuse injuries or enthesopathies[8]. A number of studies pertaining to stress fractures in athletes have been documented in literature in the past. These

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studies have suggested that tibia is the most commonly involved bone, followed by the metatarsal and tarsal bones. Track and long distance running, have been the most common sporting activities resulting in stress fractures.

The purpose of our study was to determine the frequencies of stress related injuries in the lower limbs and to ascertain the pattern and injury prone sites in personnel undergoing training in military institutions.

MATERIAL AND METHODS

This cross sectional descriptive study was carried out at Nuclear Medical Centre, Armed Forces Institute of Pathology (AFIP) from July 2004 to December 2012. Positive cases, on 3-phase skeletal scinitigraphy, were included in the study during the study period whereas negative cases were excluded. Total 297 positive cases comprising of military cadets/recruits were included in the study through, non-probability consecutive sampling. 99 m Tc MDP (methylene diphosphonate), 20 milli Curie (mCi) dose, was injected intravenously followed immediately by perfusion phase and by blood pool phase imaging of the involved site. Delayed images were acquired after 2 hours, anterior and right/left oblique images were obtained. Acquisition was done on Siemens ® E-cam and Scintronix ® gamma cameras.

The localized focal uptake of the Tc-99m MDP was labeled as stress fracture, whereas uptake in a linear pattern along the periosteum was labeled sub-periosteal reaction or periostitis. Linear uptake in the posteromedial distal tibial aspects indicated medial tibial stress syndrome or shin splints and radiotracer accumulation at the insertion sites of major lower limb muscles was labeled as activity induced enthesopathy.

Data analysis was carried out using SPSS version 20. For quantitative variables like age, mean and standard deviation (±SD) were calculated. For qualitative variables like gender, type of stress induced injury and site (stress fracture, shin splints, enthesopathy and sub-periosteal reaction); frequency and percentages were calculated.

RESULTS

A total of 297 positive cases (comprising of military cadets/recruits) on 3-phase skeletal scintigraphy were enrolled in this study and there were no missing values. Males were predominant in study population as compared to

Table-I: Breakdown of tibial stress fractures with frequency.

Tibial Stress Fracture	Tibia			
	Bilateral	Right	Left	Total
Middle third	29	28	18	75 (40%)
Proximal third	20	25	21	66 (36%)
Distal third	12	17	15	44 (24%)
Total	61 (33%)	70 (38%)	54 (29%)	Grand total=185 (100%)

Table-II: Comparison with previously published studies.

Lower extremity	Ovara 1978 (n=142)	Matheson 1987 (n=330)	Mutoh 1998 (n=251)	Iwamoto 2003 (n=196)	Present study (n=297)
Pelvis	1.4 %	1.6 %	2.4 %	7.1 %	2.9%
Femur	6.3 %	7.2 %	3.2 %	1.0 %	5.9 %
Lower leg	67.6 %	55.7 %	37.8 %	49.5 %	81 %
Tibia	-	-	32.3 %	44.4 %	77.7 %
Fibula	-	-	5.6 %	5.1 %	3.3 %
Tarsal	0.7 %	25.3 %	3.6 %	1 %	2.5 %
Metatarsal	18.3%	8.8%	28.7%	9.7%	1.2%

females (98.3% vs 1.7%). Mean age was 22 years (SD=6). Stress fractures were present in 80.13% cases (total=238) followed by shin splints which comprised of 21.88% (total=65). Sub-periosteal reactive changes were found in 14.47% cases (total=43) and activity induced enthesopathy was present in 4.20% (total-10). Overview of stress related injuries is shown in fig-1.

Stress Fracture

Among the stress fractures, tibial stress fractures were the commonest comprising of 77.73% (total=185). Right tibia was more commonly involved followed by bilateral tibiae and left tibia. Tibial stress fracture details are elaborated in table-II.

Femoral stress fractures were present in 5.88%, talar 3.78%, fibular 3.36%, pelvic 2.94%, malleolar 2.52%, calcaneal 1.68%, metatarsal 1.26% and navicular 0.84%.

Out of 5.88% femoral stress fractures, the distal third of femur was involved in 4 cases followed by 3 cases of proximal third and 1 case of middle third femur. Bilateral middle and distal femoral stress fractures were noted in 2 and 1 case respectively. Among 3 cases of femoral condylar stress fractures; lateral condyles were involved in 2 and medial condyle in 1 case, respectively.

Talar stress fractures were noticed in 3.78% cases. Among the 3.36% cases of fibular stress fractures proximal third was involved in 5 and distal third in 3 cases. Pelvic stress fractures comprised of 2.94% with 4 cases involving the pubis, 2 of sacroiliac junction and 1 case of acetabulum/ischium respectively. Malleolar stress fractures were noted in 2.52% with 3 cases of medial, 2 cases of lateral and 1 case of bilateral malleolar fracture. Calcaneal stress fractures were found in 1.68% cases. Metatarsal stress fractures comprised of 1.26% with 1 case each of 1st, 2nd and 5th metatarsal respectively. Navicular stress fractures were present in 0.84% cases.

Shin Splints

Shin splints were positive in 21.88% patients out of which 66% cases involved bilateral tibiae, 19% cases right tibia and 15% cases left tibia, respectively.

Sub-periosteal Reactive Changes

Sub-periosteal reactive changes were found in 14.47% of cases with proximal halves of bilateral tibiae as the most frequent site.

Activity Induced Enthesopathy

Activity induced enthesopathy was present in 4.20% of patients with bilateral quadriceps femoris enthesopathy present in 6 cases followed by 2 cases of right quadriceps femoris enthesopathy. There was one case each involving the left iliac crest and lesser trochanter of left femur.

DISCUSSION

Physical stress induced injuries have long been a feature of military training. Risk factors include poor physical fitness or adaptation, raised body mass index, high feet arches, smoking, age >24 years and excessive running[11]. Injuries result because of repetitive/prolonged muscular action on bones causing periosteal resorption outstripping rate of remodeling

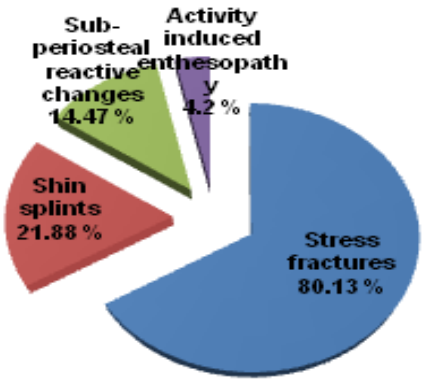


Figure-1: Frequency of stress related injuries of

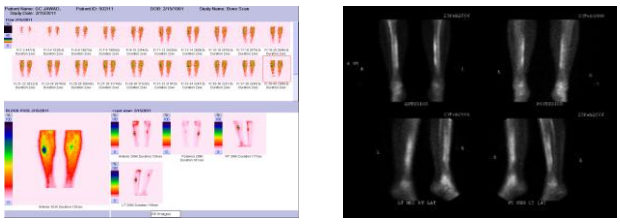
causing microfractures, cortical cracks and overt cortical fracture if the physical stress is not discontinued. These changes occur when physical stress is abruptly changed in duration, intensity and/or mode of training not catering for

principle of transition' phenomenon[12]. Subclinical tissue damage may remain hidden before patient experiences pain. An indicator of possible musculoskeletal overuse injury is walking or running more than 32 km per week[13]. Intrinsic factor (muscle imbalance/weakness, instability, inflexibility, and mal-alignments)[14] and extrinsic factors (poor technique/footwear/equipment, exercise on hard surfaces and inappropriate changes in the duration/frequency of activity)[12] both play a role in overuse injuries.

Our study had 80.13% stress fractures being the most common stress induced injury. Tibia was the commonest site comprising of 77.73% stress fractures. Bilateral middle third tibia was most frequently involved followed by right middle third and right proximal third tibia respectively. Overall right tibia was more frequently involved as compared to left. In military cadets/recruits, lack of proper prior conditioning/training increases the overall risk of developing stress related injuries in contrast to conditioned personnel in whom osseous system has adapted over a period of time[15]. Other related factors are age; adults being more prone to stress related injuries than adolescents and gender; females being more susceptible than males[16]. Track & field activities and particularly running causes stress related injuries usually stress fractures of tibia, metatarsal and tarsal bones[17]. Physical activities comprising of frequent jumping involve the tibia and tarsal bones[18]. High ground reaction forces encountered in running and jumping should be countered with good quality shoes and judicious selection of training surfaces[19]. Stress fracture has a distinct focal appearance on delayed images of 3 phase scintigraphy with increased blood flow and tracer pooling[9].

Medial tibial stress syndrome also known as tibial periostitis or the shin splints is a clinical entity which comprises of diffuse tenderness in distal posteromedial aspect of the tibia/tibiae[20]. Mild cases have exertional pain whereas in more severe cases rest pain is present. Shin splints comprise of 12% to 18% of running injuries and occur in 4% of all military cadets/recruits undergoing basic training[21]. In this study 21.88% cases had shin splints correlating well with previously published studies. It is important to differentiate shin splints from stress fracture/exertional compartment syndrome (although these are different entities they may coexist), since their management varies[22]. 3 phase bone scan, the imaging modality of choice, exhibits a characteristic vertical linear area of increased activity along the tibial periosteum which differs from the more focal fusiform increased radiotracer accumulation as in stress fractures[10,23]. Treatment of shin splints constitutes of rest, correcting any recent transition in training and NSAIDS/other anti-inflammatory modalities. Bad quality shoe ware, gradient running, uneven surfaces should be avoided. Any muscular imbalance should be corrected by strengthening and flexibility. Posterior fasciotomy has been mentioned in severe limitations of physical activity, recurrence, or showing no response to available therapy[24].

Periosteal reaction occurs when cortical bone responds to one of many possible insults. Two types of periosteal reactions have been described namely nonaggressive (thin, solid, thick irregular, septated) and aggressive (laminated/onionskin, spiculated, perpendicular/hair-on-end, sunburst, disorganized, codman triangle). The stress related injuries result in a subtle solid type periosteal reaction in the region of pain or trauma[7].



(a) (b)

Figure-2: Bilateral tibial stress fractures (a) and shin splints (b).

Periosteal reaction was present in 14.47% of cases in this study.

Enthesopathy is pathological change at entheses (osteotendinous or osteoligamentous junctions). These are sites of stress concentration and commonly susceptible to overuse injuries ie enthesopathies depicting increased radiotracer accumulation at the site of bony attachments of tendons and ligaments[8]. Inflammatory changes at these sites might be the first or only sign of this disease. It is most commonly encountered at tibial tuberosity, patella, pelvis, achilles tendon, plantar fascia, femoral trochanter, humeral tuberosity, olecranon process and the spine. Differentiating enthesopathy from a bone stress reaction is of important because of marked differences in their management. Initial management for musculotendinous injuries includes strengthening, stretching exercises and in some cases a local corticosteroid injection. Whereas protected weightbearing is advised for bony stress injuries[25].

Stress related injury sites showed some variation, although our results generally showed fair correlation with those of previously published studies, as shown in table-II. There was a propensity of tibial stress fractures in our study which was primarily due to the fact that the target population underwent strenuous track and field activities in general and long distance running in partciular with full combat load. The limitation in comparing our study with the previously published studies is difference in type and degree of strenuous physical activities undertaken by subject population.

CONCLUSION

Most common stress induced injuries are stress fractures, shin splints, sub-periosteal reactive changes and activity induced enthesopathy respectively (in descending order). Middle third of tibia is the commonest site prone to stress fracture and overall right lower limb is more frequently involved as compared to left in all stress induced injuries.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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