Stress fractures—a prospective study amongst recruits

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ABSTRACT

BACKGROUND

Stress fracture (SF) is the single most common cause for the lost number of manpower days during training of recruits in the Armed Forces. This prospective study was undertaken with a view to develop baseline data on incidence of SF and to identify related variables.

METHOD

A prospective study over a period of five years during 2004–2009 in which a total of 8,570 recruits were enrolled at the start of their training to find out the incidence and pattern of SFs.

RESULTS

A total of 604 (7.04%, 95% CI 6.40–7.40%) out of a total of 8,570 recruits sustained SF during the study period. The majority of fractures occurred during basic training. The factors like urban residence, vegetarianism and those without prior history of physical activity were found to be associated with SF. Tibia was the commonest bone involved.

CONCLUSION

Prevention is undoubtedly the best approach in SF and other sports injuries. Priority should be given to individuals with good sports and physical activity background during recruitment. Intensity of training should be gradually increased during first three months (12 weeks) of training.

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Key Words: recruits; stress fracture

INTRODUCTION

The problem of stress fractures (SF) amongst athletes and recruits is as old as the history of military itself. Though, it has been known since antiquity, exact understanding of its mechanism, prediction, and prevention has been not researched enough and no army can claim to have eliminated this disorder. The literature on its prevalence from India is scanty with few

isolated studies done on the subject though some intervention studies on its management are reported.^{1,2} There is a paucity of prospective studies on the incidence of SF in the Indian Army.^{3,4} This prospective study was embarked on with a view to develop baseline data on incidence of SF and to identify related variables. Stress fracture is the single most common cause for the lost number of manpower days during training of recruits in the Armed Forces. Stress fractures are among the five most common running injuries, and account for 50% of all injuries sustained by runners and military recruits.^{5,6} The incidence of SF ranges from 1.5% to 31%.^{6–9} Women are reported to be at greater risk, with one study reporting a two-fold increase of bilateral SF over men.¹⁰ Stress fractures were first described in the medical literature as March Fractures by Briethaupt in 1855 who found them in the metatarsals of the Prussian Army recruits.¹¹ There are no data available on SF amongst Indian women but there is a need for research in this direction as well due to induction of women in the defence forces. There are very few prospective studies on SF available in the literature.

Strategies designed to prevent SF are not well understood. Proposed strategies include gradual and progressive initiation of vigorous physical training,^{12,13} recovery periods with no running or marching after 2–3 weeks of training,^{14–16} use of proper running shoes,¹⁴ use of shock-absorbent insoles, use of orthotic shoe inserts, and adherence to an appropriate diet. While a number of prevention strategies have been recommended, few have been evaluated adequately.

MATERIALS AND METHOD

A prospective study was carried out to find the incidence of SF amongst recruits undergoing training at a regimental training centre located in southern India with recruits drawn from southern states. The centre has one MO posted with it. The centre is located at an altitude of 6,000 ft in the Nilgiri Hills of Tamil Nadu. Annually 800–1,200 recruits join at the training centre depending on the requirement. Over a period of five years between 2004 and 2009, a total of 8,570 recruits were enrolled into the study at the start of their training to find out the incidence and pattern of SF. Details were recorded on their demographic parameters, dietary history and relevant history on prior physical activity. Prior physical activity was considered to be present prior to training if the recruit had a history of participation in sports and games activity at inter school, zonal, state or national level in track and field events, and field sports like football, hockey, volleyball, basketball, handball,

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wrestling, boxing, etc. Dietary habits (vegetarian and non-vegetarian) were also noted. The recruits thus enrolled were followed up through their training period for occurrence of SF. Details of their training schedule were obtained. On occurrence of SF, the history of clinical features, bone involved, and site affected were noted. In case of tibial fractures intercondylar and inter malleolar distance was measured to find any relative bowleg and knock knee. The SF were graded in to four groups based on the suggested clinic-radiological classification by Agarwal et al,⁴ and further modified by us as given in Table 1. The 604 cases were managed with standard measures which included rest, immobilisation, and dietary supplementation and observed in low medical category and sick leave depending upon the classification of the SF.

RESULTS

A total of 604 (7.04%, 95% CI 6.40–7.40%) out of a total of 8,570 recruits enrolled for undergoing training between 2004 and 2009 sustained SF during this study period. On study of distribution of SF cases according to clinicoradiological classification in grades, it was observed that two-third cases of SF belong to grade II (67.5%) and minimum (2.5%) to

grade III (Table 1). It is observed that a major proportion of SF were concentrated in the training period of basic training phase from nine weeks to 27 weeks (Table 2). Most of the SF in this prospective study involved tibia whereas, the metatarsals were least affected. As the tibia was the most common bone involved ($n=535$, 88.57%) we studied the distribution of SF according to the region involved and it was seen that upper one-third of tibia was the predominant site affected (Table 3).

The occurrence of SF in recruits from urban area is significantly more ($P=0.000$) in comparison to those from rural area. It is observed that the occurrence of SF is significantly more ($P=0.000$) in recruits who were not involved in prior physical activity in comparison to recruits having prior physical activity. It is also observed that the incidence of SF is significantly more in recruits with vegetarian dietary habit in comparison to non-vegetarians ($P=0.000$) (Table 4).

Disposal and Outcome of All Stress Fracture Cases After Hospital Management

It is observed that two-third of the cases of SF required sick leave after a brief hospitalisation. About a quarter of all cases showed good recovery only after brief hospitalisation. Average duration of hospitalisation for grade I SF was 16.3 days (varied from one week to four weeks). They were discharged from

Table 1 Distribution of stress fracture according to clinicoradiological classification.

Grades	Clinical picture (at presentation)	Radiography (at two week; plain radiograph)	SF n (%)
I	Mild pain	Periosteal reaction	163 (27)
	Tenderness		
	Walks without pain		
II	Severe pain	Hair line crack of cortex	410 (67.5)
	Tenderness		
	Walks without support		
III	Severe pain	Partial thickness involvement of cortex	13 (2.5)
	Tenderness		
	Walks with support		
IV	Severe pain	Full thickness of cortex involved	18 (3)
	Tenderness		
	Cannot walk/walks with difficulty even with support		
	Total		604 (100)

SF: stress fractures.

Table 2 Distribution of onset of stress fractures according to duration of training.

Onset of training (wk)	Phase*	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004	Total n (%)
Up to 8	'O' training phase	3	0	0	2	0	5 (0.82)
9–27	Basic training	98	58	59	88	176	479 (79.3)
28–31	Four week leave						
32–46	Advanced training	23	31	22	18	26	120 (19.86)
Total		124	89	81	108	202	604 (100)

*'O' phase training: education, WT, PT—1 mile, drill; basic training: battle physical efficiency test, drill without arms, battle obstacle course, firing, route march—12 Km; advanced training: battle physical efficiency test, route march of 20 Km, 30 Km, and 40 Km.

hospital without sick leave. Grade II SF were kept in hospital for a minimum of four weeks and sent on sick leave for 4–8 weeks depending on response to treatment. Grade III SF after four weeks of hospitalisation and sick leave of 4–12 weeks were observed in low med cat (LMC) at the regimental centre for a maximum period of 12 weeks with some light duties and subsequently upgraded to A1 (fit for continuing training activities).

A total of 21 cases (3.46%) of SF had to be invalidated out of service due to poor response to management and their inability to continue training. One case of grade II SF was observed in LMC for 12 weeks but despite this he had to be invalidated out because of inadequate response to management. Two cases of grade III SF had to be invalidated out. All 18 recruits of category IV SF could not continue their training because of persistent pain at the site of fracture in spite of satisfactory radiological osteoblastic activity (bone union). Hence, they were boarded out of service.

DISCUSSION

Stress fracture is the single largest cause of loss of training among military recruits.¹⁷ However, the incidence of SF among military recruits vary widely from 1.3% reported among 6,677

recruits by Scully and Besterman,¹⁶ to high as 31% reported by Giladi et al among 295 recruits of the Israeli Army.¹⁷ In Indian series of 1,014 recruits published by Singh et al, the incidence was 3.65%.¹⁸ In another Indian series⁴ the total number of recruits who underwent training over five years was 12,700 out of whom 1,452 were diagnosed as cases of SF (11.4%). The SF incidence of 7.04% in our study is not on the higher side in comparison to the Indian series.

There is no classification described for SF in the literature based on clinical features and plain radiographic findings.⁴ Hence, this modified classification by Agarwal et al was used in categorising SF, planning management, and also prognostication.⁴ In a large Indian series based on similar classification by Agarwal et al it was found that the most common grade of SF was grade I.⁴ However, in our series, the common grade of SF was grade II followed by grade I. Greaney et al¹⁹ and Gracic et al²⁰ reported that 60% and 40% of SF, respectively, had occurred during the initial military training. According to Giladi et al the occurrence of SF was found maximum at 14 weeks of training.¹⁷ Sterling et al observed the maximum occurrence of SF at 15 weeks of training.¹² In this study, the maximum occurrence of SF is found between nine weeks and 27 weeks, i.e. the basic phase of training similar to the study by Giladi et al.¹⁷ The distribution of sites of SF in this study is similar to the other military studies.^{19,21} The most affected bone is tibia and the common site of tibial involvement is the upper one-third which is similar to Orava et al and Singh et al.¹⁸ The lower one-third SF of tibia is common amongst recruits having mild knock knee. In our series, it was decided to study whether the intercondylar distance (relative bow leg) made any significant difference to the site of SF. It is observed that greater the intercondylar distance more were chances of involvement of upper one-third of tibia, though not statistically significant. Similarly, the study was undertaken to correlate the significance of inter malleolar distance (relative knock knee) with the occurrence of SF at the lower one-third of tibia, again not statistically significant. Though, it is mentioned in the textbooks that bowleg and knock knee do increase the incidence of SF of tibia, no intercondylar or inter malleolar distance study has been carried out earlier in the literature.

There is marked and significant difference in the incidence of SF in recruits from urban areas (10.08%) in comparison to

Table 3 Distribution of stress fractures according to bones affected.

Bones	No. of cases (%)	Distribution of tibial involvement	
Femur	10 (1.65)		
Tibia	535 (88.57)	Site of tibia involved	No. of SF (%)
		Upper 1/3rd	382 (71.4)
		Middle 1/3rd	89 (16.63)
		Lower 1/3rd	64 (11.96)
		Total	535 (100)
Fibula	56 (9.27)	50 cases of lower 1/3 fibula, six middle 1/3 fibula	
Metatarsals	3 (0.5)	Two involved 3rd metatarsal, one case 4th metatarsal	
Total	604 (100)		

SF: stress fractures.

Table 4 Distribution of stress fractures cases according to place of residence prior to training, history of prior physical activity, and dietary habits.

Parameter	Class	SF occurred (%)	SF not occurred (%)	χ^2 test	Pvalue*
Place of residence	Urban (3,558)	362 (10.1)	3,196 (89.9)	90.77	0
	Rural (5,012)	242 (4.8)	4,770 (95.2)		
Prior physical activity	Present (1,960)	99 (5.0)	1,861 (95.0)	15.47	0
	Absent (6,610)	505 (7.6)	6,105 (92.4)		
Dietary habit	Veg (2,131)	209 (9.8)	1,922 (90.2)	32.97	0
	Non-veg (6,439)	395 (6.1)	6,044 (93.9)		

*P value significant at <0.05.

SF: stress fractures.

those from the rural areas (4.82%). This study yields a similar result as observed by Singh et al.¹⁸

In our study it is interesting to observe that the incidence of SF increases (5.89%) in recruits with history of no physical activity in comparison to recruits with history of physical activity (5.05%). Prior physical activity reduced the incidence of SF¹⁸ as the study is compared between technical and non-technical graduates from Indian Military Academy (IMA). Physical and sports activities before joining army training in a regimental centre significantly influenced SF in our study. Provost and Morris,²² Leebhart,²³ and Gilbert and Johnson,²⁴ amongst the American recruits noted that subjects who led a sedentary existence prior to basic training were at a higher risk to developing SF. Contradicting their results are the studies of Giladi et al¹⁷ who found no difference between SF and control group who did sustain SF regarding pre-training physical and sports activities. Our findings are similar to the study by Provost²² and Leebhart.²³ In our study there is a significant increase in the incidence of SF (9.8%) in a vegetarian recruit in comparison to non-vegetarians (6.13%). Though, it is mentioned in the textbooks that dietary/nutritional supplements with protein vitamins and calcium do help in the healing of SF, no specific study has been carried out so far to reach at a conclusion of prescribing these to prevent SF. This needs further study for further clarification.

The efficacy of thermal modalities in the treatment of SF lacks supporting research. However, we treated all low-grade SF cases (without plaster of Paris [POP] immobilisation) with short wave diathermy and got satisfactory response from the patients. Most published research (in animal models) has demonstrated inhibition of fracture healing with administration of both non-specific non-steroidal anti-inflammatory drugs (NSAIDs) and cyclooxygenase two selective NSAIDs.²⁵ However, we treated cases of SF with severe unbearable pain with non-specific NSAIDs and got satisfactory clinical response.

Out of the 604 cases of SF, a total of 21 cases were boarded out (Invaliding Medical Board) which constitutes 3.47% of those diagnosed with SF. Out of 21 cases, (invalided out), six cases were SF femur out of a total of 10 cases (60%), 11 cases were SF tibia, and four cases were SF both tibia and fibula. Out of 15 cases of SF tibia (invalided out), eight were upper one-third and four were lower one-third and were associated with relative bow leg and relative knock knees, respectively, and the remaining three cases were SF of middle one-third of tibia. Out of 21 cases of SF invalided out, 16 were having an urban back ground with history of less physical activities in comparison to five cases of SF of rural background with history of more physical activities.

CONCLUSION

Our study brings out the fact that those with prior physical activity, non-vegetarian diet, and belonging to rural area had significantly lower incidence of SF. Priority should be given to individuals with good sports and physical activity background during recruitment.

Intellectual Contributions of Authors

Study concept: Col Niranjana Das (Retd)

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CONFLICTS OF INTEREST

None identified.

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Journal scan

Havenetidis K, Paxinos T. Risk factors for musculoskeletal injuries among Greek Army officer cadets undergoing Basic Combat Training. Mil Med 2011;176:1111–1116.

Predictors of work-related injuries were assessed using data from a group of Greek Army officer cadets. The total number of ($n=253$) cadets were monitored by physicians for musculoskeletal injuries resulting through a 7-week Basic Combat Training (BCT) period. Potential predictors of musculoskeletal injuries (Cadets' entry number, body mass index [BMI], body fat percentage [BFP], gender, age, sport experience, and nationality) were modelled via univariate and multivariate logistic regressions at Human Performance-Rehabilitation Laboratory, Faculty

of Physical and Cultural Education, Hellenic Army Academy, Leoforos Vari-Koropiou Avenue, 16673 Vari, Attiki, Greece. Using odds ratio (OR) and confidence interval (CI), it was shown that older age (OR=0.73; 95% CI=0.56–0.96), female gender (OR=0.13; 95% CI=0.02–0.81), high BFP (OR=1.21; 95% CI=1.07–1.37), and Greek nationality (OR=0.22; 95% CI=0.07–0.69) were all associated with musculoskeletal injuries. These factors, except for gender, were also related to overuse injuries. The authors concluded that during BCT, adiposity expressed as BFP and not as BMI can predict the magnitude and type (acute-overuse) of musculoskeletal injuries in Greek cadets.

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