The Correlation between Cumulative March Training and Stress Fractures in Soldiers

*Michael Giladi, M.D.**
*Charles Milgrom, M.D.***
*Yehuda Danon, M.D.**
*Zeev Aharonson, M.D.**

The hypothesis that the incidence of stress fractures is proportional to the amount of physical training stress was studied. Recruits were divided into two groups which did the same basic training except for marching. Group 1 increased its marching more gradually and marched 35 per cent less than group 2. The incidence of stress fractures in both groups was the same, but group 1 sustained its fractures somewhat later in training. This suggests that a population at risk to stress fractures existed for which lower training levels did not lessen morbidity, but only delayed the onset of stress fractures.

MILITARY MEDICINE, 150, 11:600, 1985

Stress fractures were first described in 1855 by Breithaupt[1] among recruits in the Prussian army. Since then, most published works on stress fractures have been in the military because this population allows for the study of large, uniform and statistically significant training groups. Until now extrinsic factors such as marching style and running on asphalt surfaces have been identified as effecting stress fracture incidence.[2] The only intrinsic factor identified has been the recruit's pre-army long distance running history.[3]

Most American authors have attributed the onset of the majority of military stress fractures to the first 2 and 3 weeks of training,[3,4] when the training demands placed on the soldier are quite small. No study has been published which clearly defines the stress needed to produce stress fractures.

The purpose of this study was to test the hypothesis that the incidence of stress fractures is proportional to the amount of cumulative physical training stresses.

Materials and Methods

A uniform group of infantry basic trainees was divided into 16 squads and followed for the first 11 weeks of training. All of the squads followed the same training, including runs and gymnastics, except for their march training. Group 1 consisting of ten squads, marched a cumulative distance of 110 km during the training and increased its marching distance more gradually than group 2. Group 2 consisting of six squads did 168 km cumulative marching. No parade marches were done; rather marches consisted of field marches, with about 20 kilogram pack, both with and without forced cadence, as well as stretcher marches. Records were taken of all marches during basic training and the distances summed up weekly. Any soldier with a pain consistent with a stress fracture was X-rayed and bone scanned using Tc^{99} MDP late phase scanning. Whole body imaging as well as spot films were done. The diagnosis of a stress fracture was made if there was a positive X-ray and/or a bone scan showing a focal lesion, using the criteria of Prather *et al*[5] and Greaney *et al.*[2] The time of the occurrence of a stress fracture was defined as the date of onset of pain.

Results

Table 1 shows that there was no statistically significant difference between the incidence of stress fractures in groups 1 and 2 (Chi^2, df = 1, $p > 0.1$). The distribution as to anatomical sites was also the same with 72 per cent in the tibia, 25 per cent in the femur and 2 per cent in the metatarsus.

Figure 1 shows the distribution of stress fractures with regard to time of occurrence and cumulative distance marched. During the first through the fourth weeks, group 1 marched a total of 27 km; in this same period, fractures occurred (judging from the appearance of pain) in five of the 39 soldiers with stress fractures in this group (13 per cent). During the same period, group 2 marched a total of 64 km and nine of its 23 soldiers with stress fractures sustained their fractures (39 per cent). Peak morbidity in both groups was in the fifth through eighth weeks: 26 cases in group 1 (67 per cent) and 14 in group 2 (61 per cent). Marches during this period totaled 77 and 51 km respectively. In the ninth–eleventh weeks, group 1 marched only a little (a total of 6 km); yet fractures occurred in eight out of 39 cases (20 per cent). In this same period, group 2 marched 53 km without sustaining even a single stress fracture.

TABLE I

INCIDENCE OF STRESS FRACTURES

	Cumulative Km Marched	No. of Soldiers with Stress Fx.	Total No. of Stress Fx.	Squads in Training	Soldiers with stress Fx./Squad
Group 1	110	39	63	10	3.9
Group 2	168	23	39	6	3.8

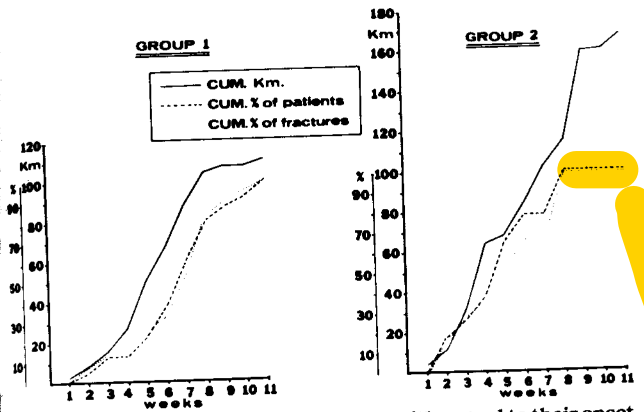

Fig. 1. Distribution of stress fractures with regard to their onset and their correlation with cumulative efforts.

Discussion

The goals of producing a top quality combat soldier and minimizing stress fractures in military trainees may be dimetrically opposed. The intense exertion of training forces on bone triggers an osteonization process which begins with increased bone reabsorption followed by bone replacement. Since bone replacement is a relatively slow process, bone becomes temporarily weaker and prone to stress fractures.[6] Eventually the process ends, yielding a newly formed bone whose stress resistance exceeds that of the bone prior to training. A theoretically logical way to lower the incidence of stress fractures is to lower training levels. This study indicates however that in spite of a 35 per cent lower cumulative marching and more gradual training, group 1 sustained the same incidence of stress fractures as group 2. Only the distribution of their occurrence in time changed. In group 2 stress fractures occurred earlier during training and none occurred in the last 53 km of marching.

The observation that group 1 and group 2 sustained the same incidence of stress fractures in spite of different training levels indicates that the incidence of stress fractures was not proportional to the amount of physical training stresses. Furthermore, in spite of continued intensive march training, group 2 sustained no further stress fractures after the eighth week of training. On the other hand group 1, while doing a very low level of training after the eighth week, sustained 20 per cent of its fractures. This phenomenon may be explained by a population at risk to stress fractures. For this vulnerable population even lower training levels did not lessen the morbidity, but only delayed the onset of stress fractures. We hypothesize that the group at risk was of the same proportion in group 1 and group 2 and therefore the incidence of stress fractures was the same. The population at risk manifested itself earlier in group 2 where training was more intense.

*Israel Defence Forces, Medical Corps, Israel Military P.O.B. 02149.
**Department of Orthopaedic Surgery, Hadassah University Hospital, Jerusalem, Israel.
Reprint requests to: C. Milgrom, M.D. Dept. of Orthopaedic Surgery, Hadassah University Hospital P.O.B. 12000 91120 Jerusalem, Israel.

References

[1] Breithaupt, M. D.: Fur patholgoie des menschlichen fusses. Med Zeitung 24:169–171, 1855
[2] Greaney, R. B., Gerber, F. H., Laughlin, R. L., *et al*: Distribution and Natural history of stress fractures in U. S. marine recruits. Radiology 146:339–346, 1983
[3] Meurman, K. O. A. and Elfving, S: Stress fractures in soldiers: a multifocal bone disorder. Radiology 134:483–487, 1980
[4] Gilbert, R. S. and Johnson, H. A.: Stress fractures in military recruits—a review of twelve years' experience. Milit Med 131:716–721, 1966
[5] Prather, J. L., Nusynowitz, M. L., Snowdy, H., *et al*: Scintigraphic findings in stress fractures. J Bone Joint Surg 59A:867–874, 1977
[6] Sweet, E. D. and Allma, R. M.: RPC of the month from the AFIP. Radiology 99:687–693, 1971