STRESS FRACTURES IN MILITARY RECRUITS
A PROSPECTIVE STUDY SHOWING AN UNUSUALLY HIGH INCIDENCE

C. Milgrom, M. Giladi, M. Stein, H. Kashtan, J. Y. Margulies, R. Chisin, R. Steinberg, Z. Aharonson

From the Hadassah University Hospital and the Osteoporosis Institute, Jerusalem

In a prospective study of 295 male Israeli military recruits a 31% incidence of stress fractures was found. Eighty per cent of the fractures were in the tibial or femoral shaft, while only 8% occurred in the tarsus and metatarsus. Sixty-nine per cent of the femoral stress fractures were asymptomatic, but only 8% of those in the tibia. Even asymptomatic stress fractures do, however, need to be treated. Possible explanations for the unusually high incidence of stress fractures in this study are discussed.

The incidence of stress fractures among military recruits has been reported as ranging from 12% among female Caucasian American recruits to less than 2% for their male counterparts (Brudvig, Gudger, and Obermeyer 1983). Their distribution also varies, being very different in American military trainees from that in recreational runners and joggers (Daffner, Martinez and Gehweiler 1982). Giladi et al. (1985) have already noted that the location of stress fractures in the Israeli army approximates to that in runners and joggers; their study may serve as a more relevant model for civilian stress fractures than the American Military studies.

Our impression was that the rate of stress fractures among combat soldiers in the Israeli Army far exceeded the rates reported by the American Army or those of other military services elsewhere. As part of a prospective study of stress fractures at the Osteoporosis Institute of Jerusalem, we therefore studied the incidence of stress fractures among specific units of the Israeli Army.

PATIENTS AND METHODS
In February 1983 a group of 295 male military recruits from selected combat units were evaluated for 14 weeks in a prospective study of stress fractures. All the participants in the study gave their informed consent and knew the goals of the study. Before beginning basic training, their motor skills and physical fitness were evaluated. Each recruit also had a pre-basic training screening which included an orthopaedic clinical examination as well as anteroposterior and lateral radiographs of his tibiae and feet. During their 14 weeks of training the recruits were reviewed by three army doctors in the field and by a hospital-based orthopaedic surgeon. All the recruits were encouraged to report symptoms of possible stress fractures. They had free access to the medical staff as well as mandatory examinations every three weeks during training. Soldiers with symptoms suggesting stress fractures were given three days’ rest and, if the symptoms persisted, were seen by an orthopaedic surgeon and treated appropriately.

The location of any pain was recorded and its distance from anatomical landmarks measured. Appropriate radiographs were taken, and late phase 99mTc-MDP scintigraphy of the whole body performed, as well as individual views of the feet, tibiae, knees and femora at higher resolution. A diagnosis of stress fracture was made on the basis of either positive radiographs or a positive scintigram; scintigraphic evidence was accepted even if radiographs showed no fracture, as reported in the earlier studies of Greaney et al. (1983) and Prather et al. (1977). The scintigram was considered diagnostic of a stress fracture when a focal area of increased uptake was found in the absence of other bony pathology (Prather et al. 1977). The time of fracture was considered to coincide with the earliest manifestation of pain in the affected limb.

All the soldiers were reviewed by an orthopaedic surgeon once again at the end of their basic training. They were questioned as to whether they had had any symptoms suggesting possible stress fractures and the orthopaedic examination was repeated.

RESULTS
During the 14 weeks of basic training, 171 out of 295
recruits in the study presented with symptoms suggesting the possibility of stress fractures. They were all evaluated by radiography and by scintigraphy; on this basis 91 of the 295 soldiers (31%) were diagnosed as having a total of 184 stress fractures. In 20% of cases the radiographs were positive. Figure 1 shows the number of fractures at each site: 51.2% were in the tibia (not including the tibial plateau), 29.8% in the femur (not including the femoral condyles), and only 8.7% in the feet (tarsus and metatarsus). Eighty per cent of tibial diaphyseal fractures were in the mid-shaft. There were no stress fractures in the femoral neck or in the calcaneus.

Figure 2 shows the time of onset of pain of the 184 fractures. With 12 of the fractures the time of onset could not be determined precisely, and calculations were therefore based only on the remaining 172. Sixty-one of the fractures (35%) were asymptomatic and their time of onset could not be determined. Of the 111 symptomatic fractures, the onset in 11 (10%) was before basic training, in 59 (53%) it was during weeks one to four of training, in 24 (22%) during weeks five to eight and in 17 (15%) after the eighth week of training.

The time of onset of femoral stress fractures and the number without symptoms are shown in Figure 3, while the figures for tibial stress fractures are shown in Figure 4. It can be seen that while only 8% of tibial diaphyseal stress fractures had no symptoms, 69% of femoral stress fractures were asymptomatic.
Only one scintigram showed the characteristic findings of periostitis described by Lieberman and Hemingway (1980). No cases of compartment syndrome were found.

DISCUSSION

Although many recreational runners and joggers may see an orthopaedic surgeon because of pain which seems consistent with a stress fracture, two questions are important: how many of these patients do, in fact, have such fractures? and precisely at what point in training do they occur? Recreational runners are too diverse a group to provide accurate answers to these questions, and the controlled circumstances of military service provide a better group for study.

According to studies of American service men, the incidence of stress fractures among recruits is less than 2%; Brudvig, Gudger and Obermeyer (1983) reported an incidence of 1.3% among 6677 recruits at Fort Bliss, Texas. The 31% incidence of stress fractures in our study far exceeds this figure or those reported from any previous study. What can be the reasons for this marked discrepancy?

One possible explanation is that our study was prospective and also included a scrupulous follow-up of all soldiers until the completion of basic training. Most other military studies have been retrospective: they calculated the incidence by dividing the number of soldiers found to have stress fractures at morning sick call by the total basic training population for the period studied (Brudvig, Gudger and Obermeyer 1983); there was no assessment of the group that did not present at sick call.

Secondly, our soldiers, their commanders and their medical staff, were all made acutely aware of the existence of stress fractures. The recruits themselves signed a form consenting to the study and knew its goals before they began basic training; their officers received pre-training lectures about stress fractures and cooperated with the research team. The medical staff were familiar with stress fractures and had a high index of suspicion; they interviewed and examined all the soldiers every three weeks and thus reached soldiers who otherwise might not have attended a clinic. Consequently a far larger number of fractures was detected than in previous basic training periods at the same military base.

Another difference from previous studies was the use of bone scans in every patient suspected of having a stress fracture. Even if a stress fracture was seen on the radiographs, scintigraphy also was performed. In this way many stress fractures at other sites were detected. We agree with Greaney et al. (1983) that “in the appropriate clinical setting, a scintigraphic abnormality is diagnostic of a stress fracture even if radiographs are normal” (see Figs 5 and 6).

A fourth factor that might explain the high incidence of stress fractures in our study is the type of basic training performed by the recruits. It may be that some of the specific exercises of their training programme have played a part in the incidence and distribution of the stress fractures. It is also possible that our recruits constituted a population at risk. Whereas being Caucasian and/or female have been identified as risk factors in the American army (Protzman and Griffis 1977; Brudvig, Gudger and Obermeyer 1983) a previous study of the Israeli army (Giladi et al. 1985) indicates that other risk factors may exist with us, and we have undertaken to study this hypothesis.

In this present study the anatomical distribution of stress fractures was similar to that previously reported among Israeli recruits (Giladi et al. 1985). The same relatively low incidence of stress fractures of the tarsus and metatarsus was found, the same high incidence of femoral and tibial fractures, and also the fact that, in a significant number of recruits, symptoms began before basic training. More of our stress fractures occurred late in training than was reported in the American studies: only 33% occurred during the first two weeks of training in comparison with the 64% in their study (Greaney et al. 1983).

The high incidence of femoral stress fractures which were asymptomatic (69%) in contrast to the 8% of asymptomatic tibial stress fractures is important: without the protection of pain these femoral stress fractures may become displaced. The report by Luchini, Sarokhan and Micheli (1983) of two marathon runners who sustained displaced femoral stress fractures during races, though they had no symptoms beforehand, illustrates this danger. Similarly, femoral pain felt by a jogger or
recruit only briefly may be due to a stress fracture which
is at risk of becoming displaced.

This study has shown that, in evaluating a recruit or
runner with exertional bone pain, the surgeon must
maintain a high index of suspicion of a stress fracture.
Fifty-three per cent of the recruits in our study with pain
after exertion were found to have stress fractures.

The 31% incidence of stress fractures we report here
is extremely high and the true incidence may be even
higher. The 124 soldiers whose bones were not scanned
may have had asymptomatic stress fractures which were
not diagnosed but which healed spontaneously. In any
case it seems clear that, in a population subjected to
strenuous physical training, the incidence of stress frac-
tures can reach very high proportions.

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REFERENCES

Brudvig TJS, Gudger TD, Obermeyer L. Stress fractures in 295 trainees:
a one-year study of incidence as related to age, sex and race. Milit

Daffner RH, Martinez S, Gehweiler JA. Stress fractures in runners.
JAMA 1982; 247: 1039 41.

Devas MB. Stress fractures of the tibia in athletes or “shin soreness”.

Giladi M, Ahronson Z, Stein M, Danon YL, Milgrom C. Unusual distri-
192: 142-6.

Greaney RB, Gerber FH, Laughlin RL, et al. Distribution and natural
146: 339-46.

Lieberman CM, Hemingway DL. Scintigraphy of shin splints. Clin Nucl

Luchini MA, Sarokhan AJ, Micheli LJ. Acute displaced femoral-shaft
fractures in long-distance runners: two case reports. J Bone Joint

Prather JL, Nusynowitz ML, Snowdy HA, Hughes AD, McCartney
WH, Bagg RJ. Scintigraphic findings in stress fractures. J Bone

Protzman RR, Griffis CG. Stress fractures in men and women under-