Stress Fractures in 51 Runners

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A prospective study was initiated in 1976 to investigate runners who are at risk for incurring stress fractures and how these fractures can be prevented. Fifty-one runners incurred 57 stress fractures. Tibial fractures were most common (25), followed by fibula (12) and metatarsal (8). Seven runners had previously sustained stress fractures, and six developed two stress fractures simultaneously. Five women over 30 years old had pelvic stress fractures. Stress fracture development was positively correlated with the presence of pes planus, weekly training distances greater than 20 miles, hard training surfaces, and training regimen modifications. The incidence did not correlate with generalized musculoskeletal laxity or tightness. Forty-four of 51 patients had initially positive roentgenograms. Five of five bone scans were positive. The average duration of rest before running was resumed was 7.4 weeks.

Stress fractures resulting from physical exercise have been recognized since 1855, when Breithaupt documented foot pain and swelling in a group of Prussian foot soldiers. Since then, this condition has been extensively described in populations of military recruits and athletes.[1,8,14,17] More recently, stress fractures have been recognized as a problem in rheumatoid patients and in the arthritic population following total joint arthroplasty.[20,24] The broadest research has been reported by Michael Devas.[9] Many sources emphasize running as an etiologic factor.[2,3,5–7,10,11,15] In an attempt to rate the anatomic training factors associated with the onset of injury, the authors present a prospective study of a group of runners who sustained stress fractures.

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METHODS

A prospective study was initiated in 1976 to document all cases of stress fractures and follow their progress through recovery. A uniform method was employed for recording the patients' history, physical examination, radiologic findings, and treatments. From 1976 through 1981, 51 patients who sustained stress fractures as a result of running were followed. The majority of these individuals were high school track or cross-country team members, but competitive and recreational runners of all ages were included.

RESULTS

DEMOGRAPHICS

Fifty-one runners were studied. There were 36 men ranging in age from 14–42 years (mean; 18 years, 2 months) and 15 women ranging in age from 17–47 years (mean; 23 years, 8 months). The runners were classified by training distance according to the method of Brody.[4] This data appears in Table 1. Only five of the injured runners were classified as joggers, running less than 20 miles per week. This may indicate a threshold training distance below which stress fracture is unlikely to occur.

HISTORY

The history obtained from these runners detailed previous injuries and training tech-

niques. Seven of the 51 runners had previously sustained stress fractures that had been treated elsewhere. No other pattern of prior injury or past medical history emerged as significant. Twenty runners ran mainly on hard concrete and asphalt surface, seven on a wooden indoor surface, eight on a cinder track, and two on grass. Thirty-one runners had modified their training in some way prior to injury; eight had not. Injury generally occurred within 12 weeks of these changes. The most common training change was an increase in the number of miles run, which was reported in 21 runners. Twenty-one runners who developed stress fractures had been at their current training distance less than three months, seven less than one year, and four longer than one year. Other training changes included running surface in nine runners, shoes in five, speed in two, and gait in two runners.

Physical Examination

All 51 runners presented for treatment because of pain at the fracture site. When first examined, 23 patients displayed a limp, 45 had tenderness on palpation of the fracture site, and swelling was noted in 28. Neither erythema in the skin nor muscle atrophy near the fracture site was noted in any patient.

The patients were also examined for general musculoskeletal system laxity. Specific areas of examination were elbow extension, thumb–forearm extension, metacarpophalangeal joint extension, floor-touch with fingers or palms, hip range of motion, hamstring tightness, knee alignment and extension, heel cord tightness, and plantar arch configuration. From this data an overall patient profile was obtained. Each patient was classified as either lax or tight in a single category; 18 patients had lax thumb–forearm extension, 12 had tight heel cords, and 19 had pes planus. However, of the 40 patients with adequate data for an overall profile, three were lax, 30 were normal, and seven were tight. Overall tightness or specific tightness in one area did not correlate with any particular type of stress fracture.

TABLE 1. Training Distance in Injured Runners

Classification[4]	*Distance (miles/wk)*	*Number of Runners*
Jogger	3–20	5
Sports runner	20–40	12
Long-distance runner	40–70	11
Marathoner	70–100	13

Radiologic Findings

Forty-four of the 51 patients had initially positive roentgenograms, demonstrating either stress reactions, a localized area or cortical thickening involving both periosteal and endosteal reaction, or the actual fracture. Of the seven patients with initially negative roentgenographic findings, the fracture was radiographically evident within four to 12 weeks in four patients. The remaining three patients had a positive bone scan. A radionuclide scan was performed in only five of the 51 runners, and all the results were positive (Fig. 1).

There were 57 fractures present in 51 patients. Thirty fractures were on the right side and 27 on the left. The sites and frequency of occurrence are recorded in Table 2. The most common fracture sites (tibia, fibula, and metatarsal) were distributed randomly throughout the overall group. Eleven of the 12 fibula fractures occurred in high school or college runners. The six pelvic fractures occurred in runners over 30 years of age; all fractures were located in the inferior pubic ramus and five occurred in women (Fig. 2). Six patients developed two stress fractures concurrently; four were located in the tibia and fibula, one in the second and third metatarsal, and one on the calcaneus and the inferior pubic ramus.

Treatment

The primary treatment was rest, which involved curtailment of all running. Cardiovascular tone and flexibility were maintained by swimming, bicycling, and stretching. Forty-

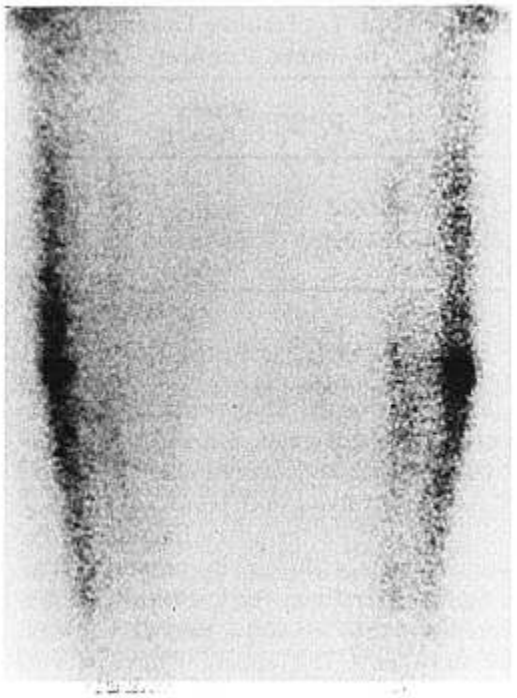

FIG. 1. Radionuclide bone scan positive for bilateral tibial stress fractures. (Reprinted with permission from Pavlov, H., Torg, J. S., Hersh, A., and Freiberger, R. H.: The roentgen examination of runners' injuries. Radiographics 1:17, 1981.)

four runners were treated by rest ranging from two weeks to one year (with a mean of seven weeks) before running was resumed. Five patients were treated by running-shoe inserts or a change of shoe, in addition to rest. One patient with a pubic fracture required partial weight-bearing for six weeks, and one patient with a tibial fracture was treated by non–weight-bearing for four weeks. No patient required cast immobilization.

FOLLOW-UP EVALUATION

All 51 runners eventually resumed running. Nine runners suffered recurrent pain at the fracture site, and one suffered a recurrent fibular stress fracture after resuming running on a board track. One woman with recurrent pain after a pelvic stress fracture stopped running; she now exercises in other ways and has no pain. The remaining seven runners with recurrent pain continue to run and describe their symptoms as "occasional," "minor aches and pains," and "soreness." None have suffered recurrent injury. The nine runners with recurrent pain did not differ from the larger group in age, training methods, injury location, treatment method, or duration.

DISCUSSION

"The runner's fracture," according to Devas, refers to the distal fibula stress fracture.[8,9] This has been seconded by other reviewers.[13,23] Eight of the 12 fibula stress fractures reported in the present study were in the distal third of the fibula and appeared predominantly in the competitive younger runner. Orava *et al.*,[17] in a review of 142 athletes with stress fracture, found tibial stress fractures to be most common. Twenty-five of the stress fractures in the present group were tibial and were found in all age groups and all categories of runners. Pelvic stress fractures, as reported by one of the authors and as seen in the present group, occur predominantly in women runners over 30 years of age.[18] This finding has been supported by others.[12]

The majority of injured runners trained at a distance greater than 20 miles per week and ran on hard surfaces. The runner is most likely to develop a stress fracture within three months of a training modification. Nineteen runners with pes planus developed stress fractures. It is speculated that pes planus may be a predisposing condition of stress fractures as described by Spengler *et al.*[21] In this study, loss of energy storage capacity and altered gait led to abnormal loading.

Clinically suspected stress fractures require documentation by radiograph. In the present series, 44 patients had a positive radiograph at initial presentation. An area of localized cortical hyperostosis or thickening in which there is periosteal and endosteal reaction constitutes a stress reaction and is the earliest radiographic sign of fracture.[19] This stress reaction, correlated with the supporting history

and physical examination, is considered diagnostic. Radionuclide bone scanning has been well established as a technique for early confirmation of stress fractures. Bone scans are more sensitive than plain radiographs in the detection of stress fractures but may also indicate neoplasm or infection. Radiographic correlation of bone scan results is required.[16,22]

Rest is the basis of any treatment regimen for stress fractures. The length of rest will vary with the individual and the injury, but at least six weeks of rest is essential to permit healing. Aerobic conditioning and flexibility may be maintained by exercise and stretching, but running should be discouraged during this period. It is not necessary for the roentgenograms to be normal before the runner may return to his sport, as these changes may persist even when the injury is healed.[9] However, before running is permitted, the patient must be free of significant pain with activity and exhibit no signs of tenderness during examination. The return to running must be gradual; training distances and techniques that produce pain should be avoided.

To avoid stress fracture the runner should be cautious regarding alterations in his training program. Most of the runners in the present study who developed stress fractures had been running for some time. Mileage gains should be gradual, and the amount of increase should be guided by the distance already being run.

TABLE 2. Skeletal Sites and Frequency of Stress Fracture

Bone	*Number of Fractures*
Pubis	6
Femur	2
Tibia	
Proximal third	9
Middle third	9
Distal third	7
Fibula	
Proximal third	1
Middle third	3
Distal third	8
Calcaneus	3
Metatarsal	
First	1
Second	3
Third	4
Cuboid	1

The 20-miles-per-week runner would be wise not to increase his distance by more than two miles per week; the 80-miles-per-week runner may sustain a larger increase. Similarly, the runner should be cautious regarding changes in running surface, as in transferring from a track to the pavement or concrete. As higher forces are generated, a stress fracture may occur. It is advisable to decrease the mileage prior to a surface change; the use of better shock-absorbing shoes may be beneficial also. Overall, it appears that most stress fractures

FIG. 2. Stress fracture of the inferior pubic ramus. (Reprinted with permission from Pavlov, H., Nelson, T. L., Warren, R. F., Torg, J. S., and Burstein, A. H.: Stress fracture of the pubic ramus. J. Bone Joint Surg. 64A:1020, 1982.)

are preventable and that the treatment of rest for six weeks is successful in curing most patients.

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