

STRESS FRACTURES OF THE TIBIA IN ATHLETES OR "SHIN SORENESS"

M. B. DEVAS, HASTINGS, ENGLAND

Formerly Senior Orthopaedic Registrar, the Middlesex Hospital, London

"Shin soreness," "shin splints" (and "Charlie Horse" on the Western side of the Atlantic) are terms used by athletes to describe a painful condition of the shin which can seriously interfere with training and performance in the various forms of running.

The symptoms start insidiously: at first the athlete feels a dull gnawing pain in one or other shin, which occurs towards the end of a run. The intensity of the pain, at first mild, gradually increases over the days, and will ultimately become so severe that running or sprinting cannot be continued.

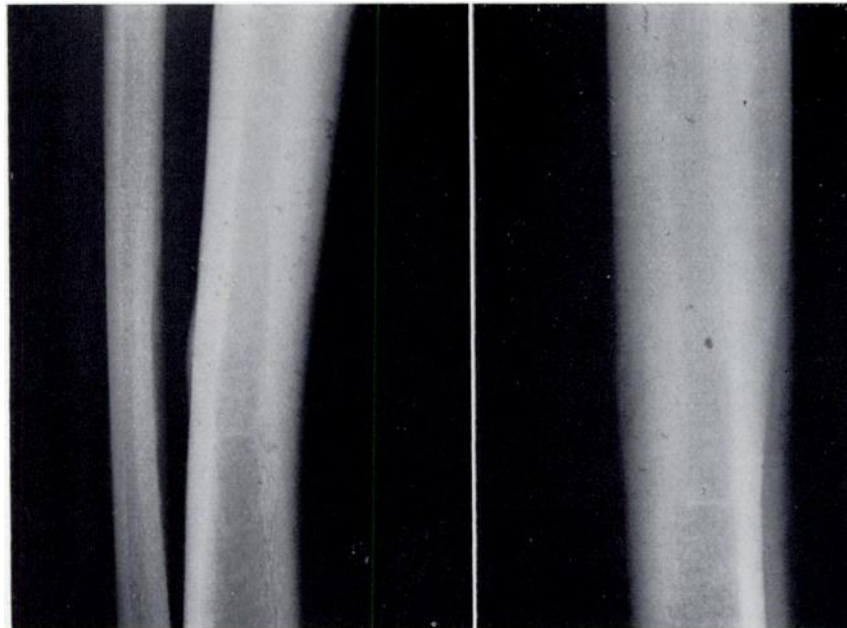


FIG. 1

A typical stress fracture of the tibia in "shin soreness." Two months after the onset of symptoms a periosteal reaction is visible in the antero-posterior view; in the lateral view the fracture line can be seen passing up through one cortex only.

At first the pain passes off with rest, but recurs with further running. Over the days shorter and shorter distances produce the pain, which persists for some hours after athletic activity has ceased. Finally the pain continues during the night, but does not prevent sleep, and any attempt at running causes severe pain at once and training has to be discontinued.

With a few days' rest from sport the athlete feels better and tries to run again, only to find that the pain recurs; in this way a whole season of training is spoilt.

The purpose of this paper is to show that "shin soreness" is caused by a particular type of stress fracture of the tibia which is difficult to diagnose because it is an incomplete fracture involving only one cortex of the bone, and is not apparent in the radiographs until a later stage (Fig. 1).

TABLE I

DETAILS OF SIXTEEN PATIENTS WITH STRESS FRACTURES OF THE TIBIA CAUSING "SHIN SORENESS"

Case number	Sex	Age (years)	Length of history	Sport	Time off sport
1	M	15	5 weeks	Running	4 months
2	F	16	Unknown	School sports	Well after biopsy
3	M	18	Many weeks	School sports	5 months
4	M	20	5 weeks	Running	4 months
5	M	19	2 months	Running	3½ months
6	M	21	2 months	Athletics	2 months
7	M	27	3 months	Running	Unknown
8	F	20	3 weeks	Running	3 months
9	M	23	(L) 4 weeks (R) 4 weeks	Running	1 month Unknown
10	M	15	"Some weeks"	Running	More than 3 months
11	M	17	3 weeks	Running	More than 4 months
12	M	19	Unknown	Running	More than 3 months
13	M	18	3 weeks	Running	More than 3 months
14	M	23	2 months	Running	2 months
15	M	17	Unknown	Running	3 months
16	F	19	5 months	Ballet	Unknown

TABLE II

STRESS FRACTURES OF THE TIBIA RECORDED FROM 1938 ONWARDS

Age and type of patient	Athletes	Recruits	Other	Total
Children 4-16 years	2	—	20	22
Adults 16-28 years	2	26	18	46
Ballet dancers 20-26 years	—	—	5	5
Adults 28-44 years	—	—	—	0
Adults 44-68 years	—	—	5	5
			Total	78

(From Hansson 1938, Roberts and Vogt 1939, Weaver and Francisco 1940, Nordentoft 1940, Pfahler 1941, Hartley 1942, Krause and Thompson 1943, Robin and Thompson 1944; Proctor, Campbell and Dobelle 1944; Wolfe and Robertson 1945, Mann 1945, Leveton 1946, Kelly and Murphy 1951, Singer and Maudsley 1954, and Burrows 1956.)

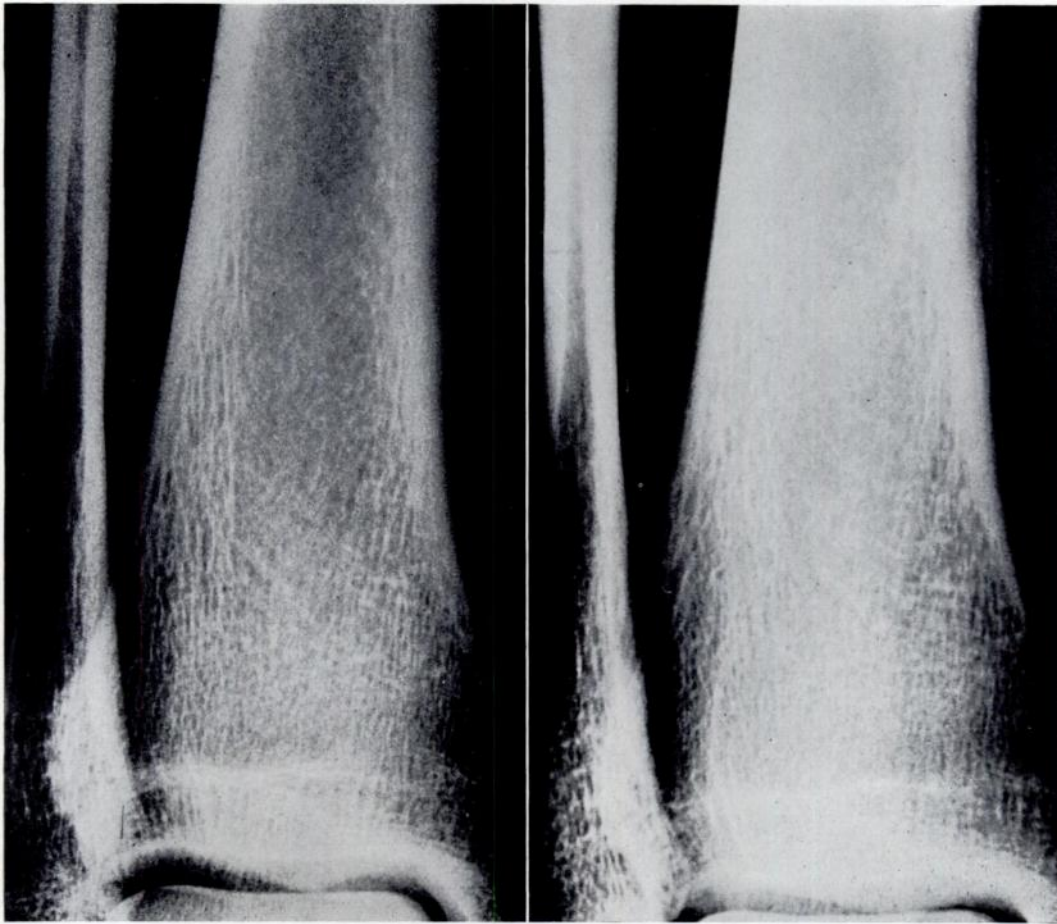


FIG. 2

FIG. 3

Case 6. Figure 2—Two months after the onset of "shin soreness" the radiographs of a twenty-one-year-old athlete showed a faint haze of periosteal new bone on the medial side of the tibia, which is barely visible in this reproduction. Figure 3—The same athlete as in Figure 2. After a further month the new bone formation is obvious, but no fracture line is visible.

CLINICAL MATERIAL

This study is based on a considerable number of patients with "shin soreness" seen at the Middlesex Hospital Athletic Clinic and elsewhere, in sixteen of whom there was definite radiological confirmation of the diagnosis of stress fracture.

It must be emphasised that radiological changes are almost invariably a late manifestation, and they are not seen in many cases of "shin soreness" which are typical in all other respects but have been diagnosed and treated early.

Table I gives details of the cases with radiological changes. For comparison, Table II summarises seventy-eight stress fractures of the tibia recorded in the literature since 1938. Of the twenty-six recruits included in this Table only three are said to have developed their symptoms while running.

SYMPTOMS AND SIGNS

A typical example of shin soreness is shown in Case 6 in Table I. The patient was a man aged twenty-one who worked as a clerk in an office; in the evenings and at weekends he trained as a middle-distance runner.



FIG. 4

Case 6—Three weeks after the previous radiograph (Fig. 3) the fracture line is visible. It is nearly four months since the onset of symptoms.

For two months before being seen he noticed a little pain in the lower right shin towards the end of a run, which gradually got worse until the day before attending hospital, when it became severe.

Examination showed a healthy young man, who complained of pain in the antero-medial part of the right shin. This area was very tender and slightly oedematous. A radiograph showed a slight haze of periosteal new bone (Fig. 2).

Elastic adhesive strapping was applied to the leg from the toes to below the knee, and the patient was instructed to rest from all sport but to continue with his office work. A month later there was considerably more new bone formation (Fig. 3). Pain was still present on activity but not at rest. A below-knee walking plaster was applied.

Three weeks later the plaster was removed and radiographs then demonstrated clearly a fracture running upwards and inwards in the postero-medial cortex of the lowermost third of the tibia (Fig. 4). The pain and tenderness had gone and the patient was allowed to begin training again. After a further six weeks there were no symptoms despite full activity, and the only physical sign was some thickening of the tibia at the site of fracture (Fig. 5).

Table I shows that most of the patients were in their late 'teens or early twenties, three being school children. Among the younger patients, a girl aged sixteen who was doing much running in school sports began to complain of pain in the shin, about the centre (Case 2, Table I). Radiographs showed new bone formation, and the possibility of a neoplasm was considered. A biopsy was performed, and histological preparations were reported to



FIG. 5

Case 6—The final healing of a "shin soreness" stress fracture, illustrated in the preceding figures. Only the postero-medial cortex of the tibia was involved. This type of fracture is always incomplete.

show a chronic inflammatory lesion. The fracture united quickly after operation and there were no further symptoms (Fig. 6). This case is unusual in that the lesion was in the centre of the shaft of the tibia anteriorly, whereas the most common site is near or at the

TABLE III
SITE OF SEVENTEEN STRESS FRACTURES

Type of lesion	Level in tibia		
	Lowermost third	Middle third	Uppermost third
Complete crack in one cortex	9	1	1
Periosteal reaction only	5	1	—
Total	14	2	1

junction of the middle and lowermost thirds postero-medially. Table III shows the site of the seventeen fractures under consideration, and Table IV gives the level of those fractures summarised in Table II.



FIG. 6

Case 2—A girl who did much running in school sports developed pain and swelling of the shin. The early radiograph (*left*) showed subperiosteal new bone formation. A month later the bone formation was considerably more marked (*right*). This site is more typical of the ballet dancer's fracture, being anterior and in the middle of the shaft of the tibia.

The fractures occurring in athletes are concentrated in the lower part of the tibia and in recruits in the uppermost third. In the series of stress fractures in ballet dancers recorded by Burrows (1956) all the fractures were in the middle third of the tibia (as was the stress

TABLE IV

SITE OF STRESS FRACTURES OF THE TIBIA IN SEVENTY-EIGHT PATIENTS REPORTED IN THE LITERATURE

	Level in tibia		
	Lowermost third	Middle third	Uppermost third
Number of fractures	6	7	65

fracture in a ballet dancer included in this series). The stress fractures of middle age occur in the lowermost third of the tibia and, in common with the type seen in recruits, involve both cortices of the tibia.

DIAGNOSIS

Diagnosis is difficult because many patients seen early and treated by rest recover without radiological changes sufficient to confirm the diagnosis.

There is usually a history of pain becoming more severe during several months. At first it is felt only at the end of a run, but it gradually comes on earlier and earlier. There is never a history of an injury immediately before the onset, or even of a sudden onset of pain. The pain is generally felt in the front and lower part of the leg.

Examination in an early case will elicit tenderness of the shin, usually the medial border, but not necessarily exactly where the pain is felt. A little oedema may be present early, and at a later stage there is a definite thickening of the subcutaneous surface of the tibia. Sometimes the swelling can be seen (Figs. 7 and 8).

It is possible to reproduce the pain in some patients by "springing" the tibia. This has to be done by straining the tibia against a fulcrum (such as the knee of the surgeon) placed against the outer side of the leg at the level of tenderness; when the leg, held at the knee and the ankle, is pressed on to this fulcrum a fracture through the medial cortex of the tibia is opened and pain occurs.

Radiological appearances—This type of stress fracture differs from the more common uppermost third fracture that occurs in recruits and the lowermost third fracture of the middle aged described by Singer and Maudsley (1954). Most stress fractures of the tibia previously recorded show as a transverse lesion across part or whole of the shaft of the tibia. In the earliest stage there may be only a slight loss in the density of the bone (Figs. 9 and 10). Later the bone immediately around this area becomes dense, and outside the cortex a little fluffy new bone can be seen which later condenses to form a hard thickened prominence. In the "shin soreness" type the fracture appears to disrupt the periosteum over a varying distance, but at first there is little or no disturbance of the cortical bone. Later a faint haze of subperiosteal new bone can be seen, and this thickens and spreads until finally a linear fracture is visible in the cortex, only one side of the bone being involved.

The line of fracture usually runs upwards and inwards from the postero-medial cortex. The direction is not, however, as constant as the comparable stress fracture of the fibula in athletes. Oblique views will often show new bone formation before any fracture line is visible (Fig. 11).

Sometimes the radiographs do not show the fracture until nearly three months after the onset of symptoms, despite repeated examinations (Fig. 12). Table III separates the patients in whom the only radiological change was the formation of a smaller or longer amount of new subperiosteal bone from those with a definite crack.

MECHANISM OF THE FRACTURE

The direction of the line of fracture suggests that usually a strain has been applied in such a direction as to open the postero-medial surface of the tibia at its lower end, and sometimes



FIG. 7

In this patient the swelling of the shin is seen and photographed only because the site is on the crest of the tibia. Usually the swelling is on the antero-medial surface of the tibia and is difficult to see and photograph. The patient illustrated was a ballet dancer.

the postero-lateral surface. In one instance the upper postero-medial border of the tibia was affected and the fracture line was directed downwards and outwards (Fig. 13).

It is possible that the strong calf muscles which arise from the middle and upper part of the back of the shaft of the tibia may, when used at their greatest strength, cause the tibia to bend slightly in such a way that it bows forwards. It has been shown by Devas and Sweetnam (1956) that strong muscular activity can draw the fibula towards the tibia, and this is perhaps

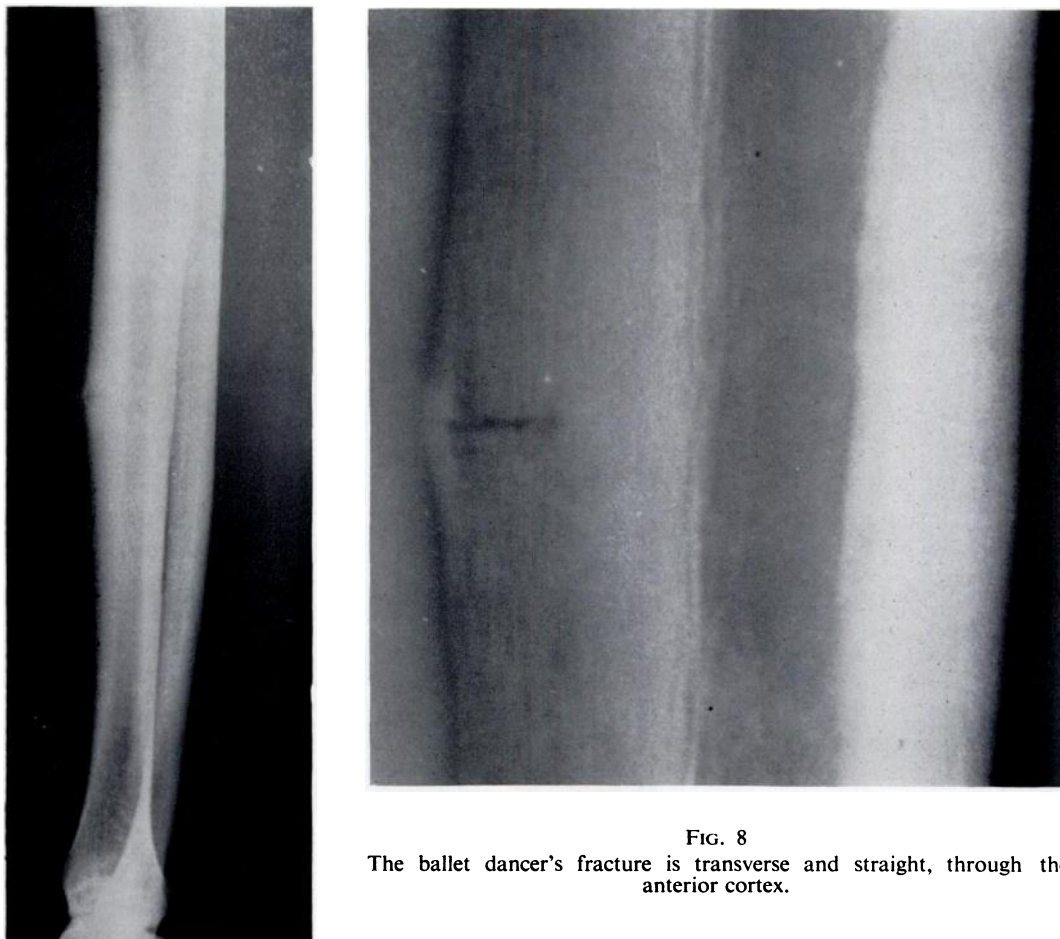


FIG. 8
The ballet dancer's fracture is transverse and straight, through the anterior cortex.

the cause of stress fractures of the fibula in athletes. These two types of fracture occur in the same type of individual, and it seems likely that the same mechanism is responsible for the tibial fracture also (Figs. 14 and 15).

TREATMENT

Rest is all-important and probably the only essential part of treatment. By rest is meant abstention from running and all activity that causes symptoms.

Elastic adhesive strapping applied from the toes to below the knee appears to help; the patient is usually able to follow a sedentary occupation. In patients who continue to have symptoms with ordinary daily activities a below-knee walking plaster will allow them to keep about.

Physiotherapy does not help until the fracture has united, and hydrocortisone injected into the fracture site in one patient had no success.



FIG. 9

The early stages of a stress fracture in the lowest third of the tibia in a middle-aged man.



FIG. 10

Two months later healing is taking place. The fracture is transverse and involves both cortices of the tibia.

When there is no longer any pain or tenderness at the fracture site the patient is allowed to start gentle training, which is gradually increased to full training over four to six weeks, provided there are no further symptoms.

DISCUSSION

A fracture of the type described has been reported by others on five occasions (Weaver and Francisco 1940, Pfahler 1941, Krause and Thompson 1943, Wolfe and Robertson 1945, and Kelly and Murphy 1951) but the association with "shin soreness" does not appear to have been recognised previously. The text-books and papers on athletic injuries ascribe shin soreness to strains of muscles and such like conditions (Lloyd, Deaver and Eastwood 1936; Symposium on Athletic Injuries, Medical Press and Circular 1937; Thorndike 1948, Tucker 1950, Knight 1952, Woodard 1954, and Fletcher 1956).



FIG. 11

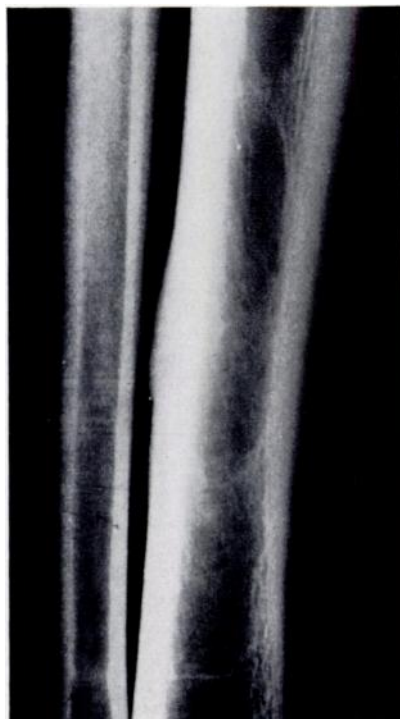


FIG. 12

Figure 11—An oblique view showing the periosteal new bone formation on the postero-medial border of the lowest third of the tibia. Figure 12—This patient, a middle-distance runner, had typical "shin soreness" but the only radiological change observed was a little periosteal new bone formation towards the back of the tibial shaft.

Stress fractures of the tibia have been known for many years, particularly in recruits; indeed, Aleman in 1929 noted that there were reported one hundred cases of so-called "periostitis tibiae ab exercito" each year in the Swedish army, but he considered the condition an "insufficiency fracture."

Since then many reports on stress fractures of the tibia have appeared, but it was not until shortly before the second world war that the condition began to be recognised for what it is. Even more recently material from biopsy performed in two reported cases (Roberts and Vogt 1939, Weaver and Francisco 1940) was thought to show a form of chronic inflammation and this would be misleading unless the clinical picture is understood, because both the histological and the radiological appearances of stress fractures do not differ greatly from those of a low-grade inflammatory process.

One of the patients in this series was subjected to biopsy and the pathological report was that of chronic inflammation, but the histological section was not available for study.

It seems likely that the five ballet dancers recorded by Burrows (1956) in great detail had injuries of a similar nature, for the symptoms, signs and progress appear to have followed a comparable course to that of shin soreness, although the site and radiological appearance



FIG. 13

A girl aged twenty had the typical signs and symptoms of "shin soreness" except that the site was in the uppermost third of the tibia. The fracture line runs downwards and inwards but is only through one cortex. There is some evidence from the radiographs and the history that there has been a previous stress fracture in the lowest third of the same tibia.

of the lesion suggests a different mechanism. The case recorded in this series was seen before Burrows's description was published, and at that time was considered to be an atypical "shin soreness" type of stress fracture.

The interesting feature about this fracture in athletes is that it is incomplete, involving only one cortex of the tibia. Other forms of stress fracture of the tibia have gone on not only



FIG. 14

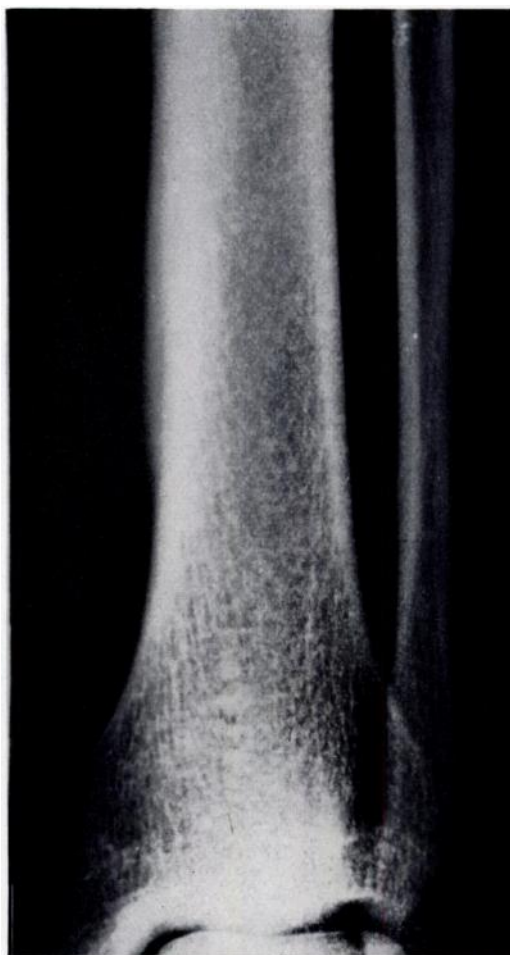


FIG. 15

Figure 14—Five weeks after the onset of symptoms in this athlete a typical haze of new bone is seen on the medial cortex of the tibia. Figure 15—Five weeks later this is more obvious. The previous season this patient had a stress fracture of the fibula.

to involve both cortices but on occasions have developed into complete fractures; one such case was mentioned by Burrows (1956) in a ballet dancer, and others were reported by Roberts and Vogt (1939), Hartley (1942), Krause and Thompson (1943) and Leveton (1946).

A close similarity exists between stress fractures in athletes that occur in the tibia and those seen in the fibula. This similarity is also seen in the stress fractures of middle-aged people, the series reported in the lowest third of the tibia by Singer and Maudsley (1954) being comparable to those seen in the lowest third of the fibula to which Burrows first drew attention in 1940.

A form of chronic anterior tibial syndrome has been suggested by Mavor (1956). The symptoms and signs appear to be very like those of shin soreness, and differentiation might be difficult in the early stages before radiological changes had occurred.

In treatment, absolute immobilisation is probably not necessary provided the forces sufficient to strain the fracture are eliminated; elastic adhesive strapping is sufficient in most cases, but great emphasis must be placed on rest from sport and other activities causing pain at the fracture site. Provided the diagnosis is made early the athlete may well be able to resume training within a few months; but when advice is neglected until late, or the condition is not recognised and sport allowed to continue, many months of disability may ensue.

SUMMARY

1. A type of stress fracture of the tibia in runners is described.
2. This type of fracture, associated with "shin soreness," has not been recognised before.
3. The signs, symptoms and radiological appearances are discussed, and treatment is outlined.

It is a pleasure to thank my former chiefs, Mr Philip Wiles and Mr Philip Newman, for their kindness in allowing me to use their patients for this study; and I am also most grateful to Mr Wiles for his help and advice in the preparation of this report. It is also a pleasure to thank the staff of the Radiological Department of the Middlesex Hospital for their co-operation and assistance.

REFERENCES

- ALEMAN, O. (1929): *Tidskrift i Militär Hälsovård*, 53. (Quoted by Hansson 1938.)
- ATHLETIC INJURIES (1937): Symposium No. 4, Medical Press and Circular Supplement, Oct. 20.
- BURROWS, H. J. (1940): Spontaneous Fracture of the Apparently Normal Fibula in its Lowest Third. *British Journal of Surgery*, 28, 82.
- BURROWS, H. J. (1956): Fatigue Infraction of the Middle of the Tibia in Ballet Dancers. *Journal of Bone and Joint Surgery*, 38-B, 83.
- DEVAS, M. B., and SWEETNAM, R. (1956): Stress Fractures of the Fibula. A Review of Fifty Cases in Athletes. *Journal of Bone and Joint Surgery*, 38-B, 818.
- FLETCHER, W. D. (1956): Discussion on Injuries in Sport. *Proceedings of the Royal Society of Medicine (Section of Physical Medicine)*, 49, 451.
- HANSSON, C. J. (1938): On Insufficiency Fractures of Femur and Tibia. *Acta Radiologica*, 19, 554.
- HARTLEY, J. B. (1942): Fatigue Fracture of the Tibia. *British Journal of Surgery*, 30, 9.
- KELLY, R. P., and MURPHY, F. E. (1951): Fatigue Fractures of the Tibia. *Southern Medical Journal*, 44, 290.
- KNIGHT, S. S. (1952): *Fitness and Injury in Sport*. London: Skeffington and Son Limited.
- KRAUSE, G. R., and THOMPSON, J. R., Jun. (1943): March Fracture of the Tibia. *Radiology*, 41, 580.
- LEVETON, A. L. (1946): March (Fatigue) Fractures of the Long Bones of the Lower Extremity and Pelvis. *American Journal of Surgery*, 71, 222.
- LLOYD, F. S., DEAVER, G. G., and EASTWOOD, F. R. (1936): *Safety in Athletics*. Philadelphia and London: W. B. Saunders Company.
- MANN, T. P. (1945): Fatigue Fracture of Tibia. *Lancet*, ii, 8.
- MAVOR, G. E. (1956): The Anterior Tibial Syndrome. *Journal of Bone and Joint Surgery*, 38-B, 513.
- NORDENTOFT, J. M. (1940): Some Cases of Soldier's Fracture. *Acta Radiologica*, 21, 615.
- PFÄHLER, G. E. (1941): Insufficiency Fracture of the Tibia Resembling Osteogenic Sarcoma. *American Journal of Roentgenology*, 45, 209.
- PROCTOR, S. E., CAMPBELL, T. A., and DOBELLE, M. (1944): March Fractures of the Tibia and Femur. *Surgery, Gynecology and Obstetrics*, 78, 415.
- ROBERTS, S. M., and VOGT, E. C. (1939): Pseudofracture of the Tibia. *Journal of Bone and Joint Surgery*, 21, 891.
- ROBIN, P. A., and THOMPSON, S. B. (1944): Fatigue Fractures. *Journal of Bone and Joint Surgery*, 26, 557.
- SINGER, M., and MAUDSLEY, R. H. (1954): Fatigue Fractures of the Lower Tibia. *Journal of Bone and Joint Surgery*, 36-B, 647.
- THORNDIKE, A. (1948): *Athletic Injuries*. London: Henry Kimpton.
- TUCKER, W. E. (1950): *Athletic Injuries*. In *British Encyclopaedia of Medical Practice*. Second edition. Vol. 2. London: Butterworth & Co. (Publishers) Ltd.
- WEAVER, J. B., and FRANCISCO, C. B. (1940): Pseudofractures. *Journal of Bone and Joint Surgery*, 22, 610.
- WOLFE, H. R. I., and ROBERTSON, J. M. (1945): Fatigue Fracture of Femur and Tibia. *Lancet*, ii, 11.
- WOODARD, C. (1954): *Sports Injuries*. London: Max Parrish.