LONGITUDINAL STRESS FRACTURES
Another Variety Seen in Long Bones

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Stress fractures are not difficult to diagnose if the symptoms and signs are understood and if it is remembered that there is a varying—but usually lengthy—delay before there is radiological confirmation of the fracture.

Such fractures, in long bones, are commonly transverse or oblique (Fig. 1), the latter often being through only a part of the cortex of the shaft. In each case only a short length of the bone is involved.

There appears to be no previous description of a longitudinal stress fracture, which may involve half the length of a long bone, and which can be very misleading in symptoms, signs and radiographic appearances unless the natural history of the condition is understood.

MATERIAL

This fracture has been seen in athletes, in the middle-aged and in the elderly. So far it has been observed in the tibia and the femur. Table I summarises the clinical material, and illustrative radiographs are reproduced in Figures 2 to 13.

CLINICAL FINDINGS

The patient usually complains of pain and tenderness in the shin (or thigh) coming on gradually over a period of several weeks or months; the pain is worse with activity, but there is a varying degree of aching at rest. Swelling, which is worse towards the end of the day, may be quite severe especially when the lower part of the tibia is involved in older patients.

The onset of pain may be abrupt, or the symptoms, previously moderate, may be exacerbated by tripping or stumbling.

Examination will reveal tenderness over the shaft of the tibia or femur which may be more severe in one part than another. When the tibia is examined the unaffected bone must be palpated to obtain a true knowledge of the degree of tenderness because even a normal tibia may be tender on deep pressure.

Sometimes, in the later stages, a hard lump may be felt attached to the tibia, but this is by no means as constant as that found in stress fractures of the tibia causing shin soreness in athletes.

The swelling, which may be obvious, is accompanied by increased heat and redness, especially in the older patient with a long history of pain.
Subacute osteomyelitis.

None were suspected. Tibial periostitis was considered.

In the differential diagnosis of periostitis, thrombo-phlebitis, varicose periostitis and intermittent claudication may all be considered to be the cause if the true nature of the lesion is not understood. That this type of fracture could occur was first realised when an athlete...

**TABLE I**

**DETAILS OF SIX PATIENTS WITH LONGITUDINAL STRESS FRACTURES**

<table>
<thead>
<tr>
<th>Case number</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Bone affected</th>
<th>Time before radiological confirmation</th>
<th>Initial diagnosis</th>
<th>Treatment</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Figs. 2-3)</td>
<td>19</td>
<td>M</td>
<td>Tibia</td>
<td>3 months</td>
<td>Shin soreness, Clinically atypical that radiographs were repeated until the fracture showed</td>
<td>Elastic adhesive strapping and rest from sport</td>
<td>When the fracture line was first seen it was thought to be an artefact</td>
</tr>
<tr>
<td>2 (Figs. 4-5)</td>
<td>54</td>
<td>F</td>
<td>Tibia</td>
<td>6 weeks</td>
<td>Subacute osteomyelitis</td>
<td>Penicillin and bed rest</td>
<td>Bed rest is undoubtedly excellent treatment but unnecessarily drastic</td>
</tr>
<tr>
<td>3 (Figs. 6-7)</td>
<td>61</td>
<td>F</td>
<td>Tibia</td>
<td>3 months</td>
<td>Tibial periostitis of unknown etiology</td>
<td>None</td>
<td>At the onset felt as though she had been kicked. Was fully investigated for possible systemic disease</td>
</tr>
<tr>
<td>4 (Figs. 8-9)</td>
<td>76</td>
<td>F</td>
<td>Tibia</td>
<td>Immediate</td>
<td>Correctly made</td>
<td>Immobilisation in plaster</td>
<td>Sudden onset of pain. Denies any form of injury</td>
</tr>
<tr>
<td>5 (Figs. 10-11)</td>
<td>48</td>
<td>F</td>
<td>Tibia</td>
<td>Several weeks</td>
<td>Correctly made</td>
<td>Immobilisation in plaster after elastic adhesive strapping had failed to give relief</td>
<td>Had recently started a job with much unaccustomed walking</td>
</tr>
<tr>
<td>6 (Figs. 12-14)</td>
<td>35</td>
<td>M</td>
<td>Femur</td>
<td>8 weeks</td>
<td>Possibly neoplasm</td>
<td>Fully investigated. Subjected to biopsy which showed normal callus. This rest cured him</td>
<td>This man habitually ran for his train every morning until increasing thigh pain stopped him</td>
</tr>
</tbody>
</table>

Forced distraction or bending of the bone may cause pain in patients with an extensive fracture, but may cause no more than slight, if any, discomfort in the smaller fractures.

**RADIOLOGICAL FINDINGS**

Radiographs may not show any abnormality for some weeks. Occasionally a periosteal haze is seen over one surface of the bone earlier than the fracture itself, which runs for several inches along the shaft. In other patients, particularly those with an abrupt onset, the fracture may be seen immediately, but this is unusual.

A macroradiograph has, on occasion, shown the fracture line before it would have been seen on the normal radiograph. Figure 2 shows a macroradiograph in Case 1 reduced in size but still showing the fracture line which was not visible in the ordinary radiograph similarly reduced.

The length of the periosteal reaction may indicate the longitudinal nature of the fracture, which is difficult to visualise in the radiograph, particularly if the fracture extends up one cortex only. Oblique radiographs may be necessary before the fracture line can be seen.

**DIFFERENTIAL DIAGNOSIS**

Differential diagnosis is important. In the athlete a sarcoma or other tumour may be suspected. Subacute osteomyelitis may be suggested by the swelling, increased heat, tenderness and radiographic appearances, as in Case 2. In middle age there appears to be a ready made diagnosis of "tibial periostitis" for which the patient is fully investigated, with, of course, no abnormal findings. Infective periostitis, thrombo-phlebitis, varicose periostitis and intermittent claudication may all be considered to be the cause if the true nature of the lesion is not understood. That this type of fracture could occur was first realised when an athlete...
presented with a typical shin soreness but without the usual lump to be felt on the shin (Case 1). In spite of the lack of this clinical sign, and normal early radiographs, the patient was brought back for further radiographs until the fracture line was observed in a macroradiograph. Being of such an odd appearance, it was thought to be an artefact, but further radiographs confirmed the lesion.

**FIG. 2**
Case 1. Figure 2—After three months' symptoms a macroradiograph showed a shadow extending vertically up the shaft of the tibia. This was thought at first to be an artefact. Figure 3—Five weeks later the nature of the "artefact" is clear. The fracture runs longitudinally up only the posterior cortex of the tibia, the lateral radiograph showing clearly that the anterior cortex is unaffected.

**TREATMENT**
According to the severity of the symptoms, treatment will vary from simple rest from sport or excessive activity—with or without an adhesive elastic bandage—to immobilisation in a full-length plaster. In all patients the fracture has united, sometimes despite incorrect treatment prescribed before the diagnosis had been established.

Walking, with the shin supported, is allowed provided it does not cause pain in a tibial fracture. The absence of pain on simple activity should be the guiding principle in judging the degree of support or immobilisation required.

**DISCUSSION**
Although only six patients have been presented the diagnosis of longitudinal stress fracture has been made in others; but these have been excluded from the series because the diagnosis has not been unequivocally confirmed radiologically.

This type of stress fracture often appears radiologically to involve only one cortex in a longitudinal direction; hence it is difficult to demonstrate if the fracture is not at right angles to the radiographic plate. Case 3 illustrates this well, for the fracture line can be seen only in the antero-posterior view, whereas the callus, lying on the fracture, appears only in the lateral view (Fig. 7).
This fracture can be difficult to diagnose on clinical grounds because the symptoms may not be severe, the clinical signs are difficult to interpret, and radiological confirmation is often long delayed and even then the changes may not be obvious. In only three of the six cases reported had the correct diagnosis been made. In the other three one patient was subjected to a course of antibiotics, one was investigated fully for periostitis, and one was subjected to biopsy. The author, who takes a considerable interest in stress fractures, was personally responsible for two of these misdiagnoses.

The mechanism of the fracture is not easy to understand, but it seems that a rotational stress may be responsible. The great difference in the ages and activities of the various patients adds to the difficulties in finding a factor common to all.

Probably all the fractures follow in part the pattern most clearly shown in Case 2, where the fracture runs down the anterior and posterior cortices and is joined transversely across the medial cortex (Fig. 5).

The treatment by simple rest with adhesive elastic bandage, or a plaster if necessary, has been uniformly successful. The importance, therefore, of the diagnosis of this longitudinal stress fracture lies in avoiding unnecessary treatment or investigation that may result from a misconception of the true nature of the lesion, and in reducing the disability of the patient by prescribing the correct and simple measures necessary for the relief of symptoms.
Case 3.—The "tibial periostitis" for which this patient was extensively investigated can be seen in the lateral view anteriorly (Fig. 6). Two weeks later (three months after the onset of symptoms) the periosteal reaction was more extensive (Fig. 7) and a longitudinal fracture line in the anterior cortex of the tibia was clearly visible. There is no fracture in the posterior cortex, for there is no callus to be seen.
Case 4—A woman of seventy-six felt a sudden pain when walking downstairs. She is certain that she did not fall. The longitudinal stress fracture was apparent in the initial radiograph taken the same day (Fig. 8). Two months after the onset of symptoms further radiographs (Fig. 9) showed that the fracture line was still visible but only in the lateral view. There is a little callus to be seen in the antero-posterior view.

Case 5—A woman of forty-eight noticed pain in the lower leg after much unaccustomed walking. Several weeks after the onset radiographs showed callus towards the back of the tibia (Fig. 10). The radiograph in Figure 11 was taken after a further two weeks. The fracture does not show clearly because it runs in the plane of the radiograph.
Case 6—Eight weeks after the onset of pain in the thigh on running a fracture line and some callus can be seen in the femur (Fig. 12). The fracture was not recognised at the time and the patient underwent biopsy. One year later the irregularity of the surface of the femur shows the extent of the bone involved in the fracture (Fig. 13).

Case 6—The histological section of the bone taken at biopsy shows normal fracture healing. Normal bone is seen at the bottom of the section, with "provisional" callus above it to the left, and formed callus to the right.

SUMMARY

Six patients with longitudinal stress fractures of the tibia and femur are described. The difficulties of diagnosis and its confirmation are emphasised.

I wish to thank Mr Philip Wiles for his great help in starting the stress fracture bureau at the Middlesex Hospital, Mr Philip Newman for continuing that assistance, and all the many colleagues who continue to send to me the details of patients with stress fractures.

In particular, I am grateful to Mr Lipmann Kessel and Dr Hoadley Gabb for details of two of the patients in this series, and I wish to thank Mr M. Turney of the Photographic Department of the Middlesex Hospital for the photographic reproductions.