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STRESS FRACTURES OF THE FEMORAL SHAFT — FOUR CASE STUDIES

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INTRODUCTION

A stress fracture is a partial or complete fracture of bone due to the inability to withstand non-violent stress that is applied in a rhythmic subthreshold manner (McBryde, 1976). The concept of stress fractures as part of a spectrum of dynamic changes in the metabolism and architecture of bone is inherent in all definitions of this condition.

Approximately ten per cent of stress fractures occur in the femur, the majority being found in the tibia, metatarsals, fibula and tarsal bones (Taunton et al, 1980; Orava, 1980; Blatz, 1981).

Devas, in 1965, observed that athletes are more susceptible to femoral neck fractures than to fractures of the shaft and additional studies have supported this (Morris and Blickenstaff, 1967; Provost and Morris, 1969; Stanitski et al, 1978; Vidt et al, 1968).

Orava, however, in 1980 found in his study of 185 patients with stress fractures, seven fractures of the shaft and five fractures of the neck and McBryde in 1978 has also described neck fractures as being less common.

The clinical presentation of stress fractures has been well described (Devas, 1970) and typically consists of focal pain which worsens with activity and gradually becomes more severe if rest or modified activity is not undertaken. There may be focal tenderness and perhaps a little local oedema on examination and the diagnosis is readily confirmed by technetium bone scan (Matin, 1979; Prather et al, 1977).

Bone scans are performed on a large field of view gamma camera both immediately and 2 hours following an intravenous injection of Technetium — 99 m methylene diphosphonate. The early images give an indication of hyperaemia and may reflect soft tissue inflammation as distinct from bone injury per se. Later images (at 2 hours) are more suggestive of bone involvement. Often X-ray changes in bone are not seen for up to three weeks after a positive isotope scan has been reported.

Factors in the development of stress fractures include increased intensity and duration of training, unsuitable footwear with insufficient cushioning, repetitive activity such as bounding or jumping and training on hard surfaces (Taunton et al, 1980; Butler et al, 1982).

Recovery from stress fractures of the femur usually takes three to four weeks once rest or modified activity is undertaken (Taunton et al, 1980). Running in deep water and cycling are useful in rehabilitation.

This paper reports four patients whose radioactive isotope uptake scans suggested femoral shaft stress fractures. Possible aetiological factors and notable features of clinical presentation and diagnosis are discussed.

CASE 1

A 22 year old female rhythmic sportive gymnast and current national champion presented with myalgia and tenderness of the right quadriceps for one week, associated with an increase in intensity and duration of training sessions (approximately six hours daily). These were done barefooted on a gymnastics floor.

A technetium bone scan revealed increased isotope uptake in the upper mid-portion of the medial right femur (Fig. 1). Simultaneous X-rays were normal.

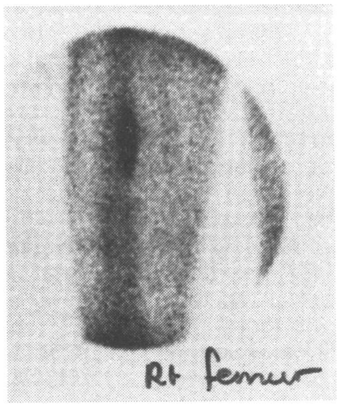

Fig. 1: Stress fracture upper mid-portion medial right femur.

Training was stopped for four weeks during which time the athlete undertook twice daily treatment with interferential therapy, magnetic pulse therapy and cycling and swimming. A repeat bone scan after five days training showed less uptake in the femoral shaft but a notable increase in uptake of the adductor muscles of both thighs associated with slight aching and tenderness (Fig. 2).

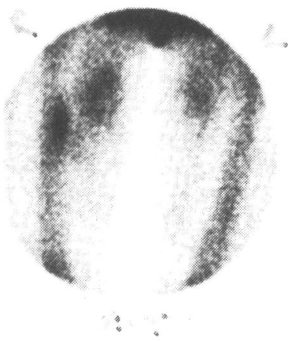

Fig. 2: Stress fracture upper mid-portion medial right femur with associated adductor muscle uptake bilaterally.

Training was pursued without incident and at four months follow-up there were no further problems.

CASE 2

A 21 year old female hurdler who competed in the 1982 Commonwealth Games had been training for six months, encompassing winter, on an outdoor "Tartan" athletics track in cold conditions (daily temperatures mid-winter average 2-12°C). She presented with one week's duration of tiredness in both upper legs which had settled in the right but persisted in the left (her "leading") leg as an ache noted each morning for an hour or two. After a further week she developed a diffuse pain along the front of the left thigh.

A feature of her history was that the pain could be elicited by hanging the leg over the end of a bench with the knee flexed and limb hanging free — supported by the bench about half way along the thigh. If the hip was then rotated internally the pain was aggravated. Similarly pressure by the examiner's hands placed at upper and lower thigh, "bending" the femur over the end of the bench, aggravated the discomfort.

A bone scan done after four weeks history suggested a stress fracture in the medial cortex of the mid-shaft of the left femur (Fig. 3).

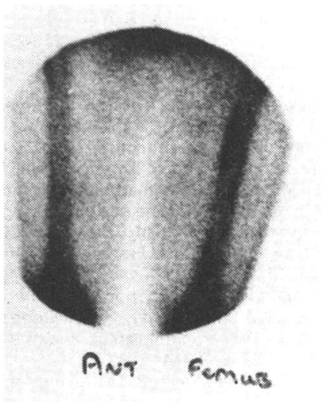

Fig. 3: Stress fracture medial mid-shaft left femur — cortical distribution.

Cessation from training was replaced by cycling and swimming with daily interferential and magnetic pulse therapy over three weeks. Symptoms resolved and training was resumed.

Three months later the athlete presented with an ache in the right thigh and a bone scan revealed a stress fracture of the medial cortex mid-shaft in the right femur. The left leg was clear.

A similar rehabilitation programme to that outlined was undertaken over three weeks and with resumption of training there were no further problems at two months follow-up.

CASE 3

A 26 year old male 5,000 metre and 10,000 metre runner and national champion presented complaining of two weeks aching in the lower left anterior thigh. This was diffuse, present at rest and worse with running. There had been no obvious changes in his training.

On examination there was tenderness of the lower two thirds of the left femur and some swelling of vastus medialis obliquus.

Bone scan done at three weeks showed increased uptake of isotope along the *upper* one third of the left femur distal to the lesser trochanter along the medial cortex, associated with diffuse but minimal increased uptake along the origin of the vastus intermedius muscle.

Training was reduced from his usual 80 or 100 miles per week to approximately half this distance and magnetic pulse therapy was administered once daily for one week. Over a further two weeks, as symptoms resolved, mileage was increased to full training levels.

At two months follow-up there were no problems.

CASE 4

A 29 year old male competition squash player presented with an ache of the left mid-thigh after six weeks on a new running programme and the recommencement of squash after a two month break. The thigh ached at rest and pain was noticeably worse running downhill.

The thigh pain was reproduced on the "hanging leg" manoeuvre as described.

A bone scan suggested a stress fracture of the mid-shaft left femur.

Running was ceased for three weeks and squash practice was undertaken no more than three hours per week. A graduated programme of skipping over two weeks was followed up by jogging and squash to normal levels over the next three weeks. There were no further problems at four months follow-up.

DISCUSSION

Reports of stress fracture of the femur, with few exceptions, have been limited to military recruits in basic training. There has been some documentation of stress fractures among athletes however, and our reports contribute to the relatively small body of available literature on this subject.

In three of the four athletes in this paper there had been a significant increase in the intensity and quality of training prior to the onset of stress fracture. The other athlete (Case 3) was a distance runner whose stress fracture we attributed to over-use.

An interesting feature in the presentation of three cases reported (Cases 1, 2, 4) was the "hanging leg" sign and it appears that suspending the affected limb from the end of a bench produces pain merely by the action of gravity dragging on the femur and "bending" it. Internal rotation moves the fracture site ventrally and places it under more stress, thus exacerbating the pain. This "hanging leg" sign has not been reported to date.

Diagnosis was easily confirmed by technetium scanning and all athletes made a quick return to their sport with traditional methods of treatment incorporating modified activity and physiotherapy as outlined. The relapse of the athlete in Case 2 serves to caution us all to remain watchful after a return to full training from injury.

Some thought was given to the mechanism of the stress fractures, particularly in light of the scan which showed increased uptake in the adductor muscles of the gymnast (Case 1).

Both female athletes were involved in short periods of high intensity work and their stress fractures were fusiform linear in distribution along the area where the hip adductors attach to the femur — in particular adductor brevis, adductor longus and the upper one third of adductor magnus.

Basmajian (1978) has stated that the upper part of adductor magnus is active almost constantly through the whole cycle when walking. Adductors brevis and longus show triphasic activity with the main peak at toe-off. Adductors longus and the upper fibres of adductor magnus are also active in medial rotation of the hip. From this it could be deduced that in sports activities such as those undertaken by the two athletes being considered, significant stresses will be felt by adductor muscles and their insertions. Such increases in muscular forces applied across the bony attachment can cause an increase in the rate of remodelling of cortical bone and lead to eventual breakdown and stress fracture (Stanitski et al, 1978).

The long-distance runner and the jogger/squash player may have developed their stress fractures more from repetitive over-use than rapid explosive muscle action on bone. This over-use would have its effect via longitudinal stresses on the bone and studies on such stresses in the normal femur (Koch, 1917) have indicated that maximal tensile stresses occur on the medial side of the upper mid-shaft of the femur and in the femoral neck.

The authors thus postulate that an interplay of forces exists between muscular action at their insertions and the longitudinal impact forces through bone both serving to fatigue and fracture the medial femur mid-shaft. The different types of activity highlighted by the different athletes illustrate the ends of the spectrum of biomechanical stress.

CONCLUSIONS

Stress fractures of the medial femoral mid-shaft are being diagnosed in athletes.

The authors have noted a feature of the presentation of this condition which has been described for the first time as the "hanging leg" sign.

Consideration of the biomechanical factors at play amongst the athletes studies has led to the consideration of muscular forces and longitudinal stress through bone. We believe that it is a combination of these that contributes to the development specifically of medial mid-shaft stress fractures in the femur of the athlete at risk.

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BOOK REVIEW

Title:	**REHABILITATION OF THE INJURED KNEE**		
Editors:	Letha Hunter and F. James Funk, Jnr.		
Publishers:	Mosby. UK: Blackwell, Oxford		
	Price: £52.50	440 pages	Figs. Tables

This is a four hundred and forty page book with multiple authorship by distinguished international experts in their fields. The initial chapters on anatomy, biomechanics and surgical reconstruction are excellent reviews with thoughtful considerations for future developments. To an Orthopaedic Surgeon they cover familiar ground to anyone who has wandered and groped through the clinical maze through the last five years.

The chapter on chemical basis of tissue repair is one hundred and sixteen pages in length and divided into sections on the biology of ligaments; and the biology of cartilage. This is unfamiliar territory for an Orthopaedic Surgeon, for example "These hydroxylysine-derived cross-links have resonating forms, with the initial imminium forming an enamine, which can tautomerize to the more stable ketoimmine"!

However, there is much that seems to ring true in a clinical context and the relevant historical view for "English speaking" publications appears to be very sound, informative and interesting. There is, for example, an excellent section on the regeneration and repair of menisci which has enjoyed a recent interest.

The Neuromuscular basis of rehabilitation includes a useful account of the technique of muscle biopsy and the clinical relevance of classification of muscle type.

There is a fascinating chapter on protective motion and dynamic splinting; and most instructive accounts of physical therapy which includes conditioning; exercise therapy programmes and special chapters on women's and children's rehabilitation.

Overall this is a very good book and a worthwhile addition to a departmental library.

M. L. Harding