

Stress fractures of the femur in runners

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ABSTRACT

Early diagnosis, followed by conservative management, permitted five of six long-distance runners to return to running after they had suffered stress fractures of the femur. The sixth patient developed a displaced fracture of the femoral neck which was openly reduced and internally fixated at surgery; this athlete returned to marathoning one year later. In the series there were two fractures of the femoral neck and four of the proximal medial shaft of the femur. Although early diagnosis depends upon a complete history, physical examination and x-ray film results, bone scanning is a further aid when x-ray films still do not confirm the presumptive diagnosis.

Stress fractures of the femur are relatively frequent in the elderly and osteoporotic, but in healthy young athletes they are less common.

Brethaupt⁵ first reported on stress fractures in 1885, and in 1905 Blecher³ described the first recorded cases of femoral neck stress fractures. Reports of stress fracture of the femur^{1, 3, 4-8, 11, 13, 18, 19, 21} with few exceptions have been limited to military recruits in basic training.

Six cases of stress fractures of the femur in younger runners, two of the femoral neck, and four of the proximal medial shaft, are discussed in this paper.

CASE REPORTS

Case 1

A 40-year-old woman (AC) presented with left thigh pain two days after attempting to compete in her fourth marathon.

The patient was in her usual good health and had been training regularly for marathon competition, running 50 to

60 miles per week (8-minute miles) when she entered her fourth marathon in February 1978. Her previous marathon times were: November 1977, 3 hours 27 minutes; February 1977, 3 hours 45 minutes; and November 1976, 4 hours.

On the fourth marathon attempt, the patient developed pain and discomfort in the left anterior thigh area after running five miles. By the 10th mile, she was unable to continue. The next morning the patient continued to have pain which increased with activity. Two days later, she was evaluated.

Physical examination showed comparable range of motion for both hips. There was minimal pain with the hip flexed to 90° and maximum internal rotation. The patient had a mildly antalgic gait with a slightly decreased stance phase on the involved extremity.

X-ray films, AP and lateral, of the hip were interpreted as normal (Fig. 1, A and B).

The patient was diagnosed as having a strain and advised that there was a remote possibility of a stress fracture, although it was not visualized on x-ray film. She was issued crutches to be used if the pain persisted, and antiinflammatory medication was prescribed. She was instructed to return in 10 days for repeat roentgenograms if the symptoms continued.

The patient did not return. Seven days after the injury she went to another physician who was a member of her running club. He evaluated her, reviewed the original x-ray films, and diagnosed her as having subtrochanteric bursitis. She walked without crutches and allegedly was less symptomatic 20 days after the marathon when she saw the second physician again. No further treatment was recommended.

After the 21st day, when she slipped in the rain, her condition got progressively worse, with markedly increased pain and discomfort. On the 31st day she was seen again by the same physician. No new x-ray films were taken. Her diagnosis continued to be bursitis and she was given a Cortisone injection in the lateral trochanteric area of the involved hip. She returned to our office on the 38th day postinjury. She needed crutches for ambulation and had pain with attempted motion of the hip. New roentgenograms revealed a displaced basal neck fracture of the femur (Fig. 1, C and D).

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Figure 1. A and B, AC's x-ray films two days after completing marathon were interpreted as normal, (1/16/78).

Ten years earlier the patient had been diagnosed as having hypothyroidism clinically and was given Synthroid (levothyroxine sodium, Flint Laboratories) 2 mg daily. (No articles were found relating abnormal bone metabolism to thyroid therapy) (F. Singer, personal communication).

The patient was hospitalized with the stress fracture of the femoral neck and underwent insertion of a compression screw after reduction of the fracture (Fig. 1E). Appropriate thyroid tests revealed the patient to be euthyroid and the Synthroid was discontinued. Bone density test results were normal, as were blood chemistries.

After a rehabilitative period of seven months, the patient's fracture appeared to be healed both radiologically and clinically. She had full, painless range of motion of the hip and gradually resumed running without symptoms. Eleven months after surgery, she competed in her fifth marathon, pain-free, finishing in less than four hours (Fig. 1, F and G). At three years from surgery she continued to run symptom free and completed a 50-mile race without abnormal symptoms. She has regularly declined to have the fixation device removed (Fig. 1, H and I).

Case 2

DM, a 24-year-old, healthy female jogger (25 miles a week), developed hip pain while on a five mile run. Examination showed pain with internal rotation of the hip. X-ray films

showed a nondisplaced basilar neck fracture of the femur with the fracture line visualized along the medial cortex of the neck (Fig. 2).

For the preceding year the patient had been taking 10 mg per day of oral dexamethasone prescribed by an endocrinologist for unwanted facial hair. The steroids were tapered and discontinued and after the patient was placed on crutch therapy for six weeks the symptoms resolved. She returned to running gradually at 18 months with no sequelae at two years.

Case 3

TC, a 19-year-old male cross-country runner, presented with a two-week history of right hip pain when doing his routine training. Physical examination was unremarkable. X-ray films demonstrated a questionable medial subtrochanteric defect and the patient was symptomatically improved. X-ray films demonstrated a radiolucent line with sclerosis along the proximal medial cortex of the femur (Fig. 3) which was interpreted as a stress fracture. A program of limited weight-bearing was advised. One month later, x-ray films demonstrated healing of the stress fracture and the patient was advised to progressively increase his weightbearing. The patient has remained asymptomatic and returned to running without sequelae at two years.

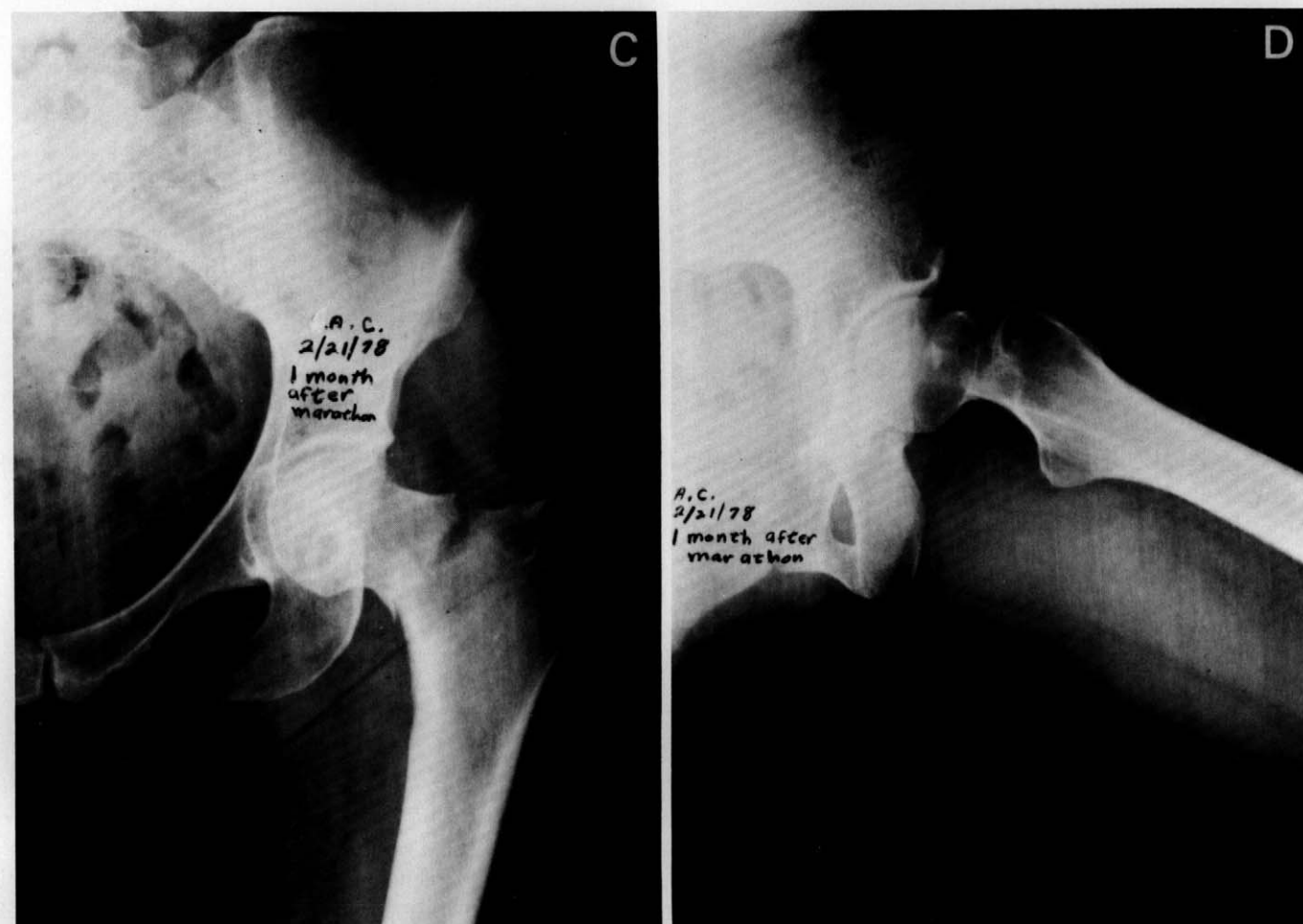


Figure 1. C and D, AC one month after marathon showing displaced femoral neck fracture, (2/21/78).

Case 4

A 30-year-old female runner (JG), averaging 60-miles per week for two years, presented with right proximal third medial thigh pain after running a half marathon seven days before being seen.

At the nine-mile mark of the race, the patient developed pain and discomfort but was able to finish in 90 minutes. Her pain persisted during ambulation.

Examination revealed pain to palpation along the proximal medial right thigh. Range of motion was normal except for pain with the extreme of external rotation of the hip. X-ray films of the pelvis and femur were normal. The presumptive diagnosis was stress fracture of the right femur. She was advised to limit activities and return in 10 days for repeat x-ray films if the condition was not improved. Twenty days postinjury her symptoms and examination were the same and the repeat roentgenograms were inconclusive. A technetium 99 methylene diphosphonate (MDP, SynCor, Sylmar, CA) bone scan showed increased uptake at the proximal medial aspect of the right femur, consistent with

stress fracture (Fig. 4A). Due to a past history of a tibia and fibula stress fracture the patient was referred to an endocrinologist, but evaluation for a metabolic disorder was negative.

The patient curtailed her activities and started swimming and running in waist-deep water for three months. She resumed a gradual running program thereafter. Followup bone scan at three months showed continued increased uptake and x-ray films still showed a questionable medial cortical thickening in the area of increased radioactivity on bone scan. She returned to running without problems at five months. Eighteen months later she returned with contralateral (left) tibial pain. The bone scan (Fig. 4B) showed no activity in the area of the original femur fracture on the right but did show increased radioactivity in the contralateral asymptomatic femur. There were other areas of increased radioactivity, including the symptomatic tibia (Fig. 4C).

Case 5

KC, a 35-year-old woman, had been an active runner for one year. When training for her first marathon (50-60 miles per



Figure 1. E, AC's postsurgery x-ray film after open reduction, internal fixation, (2/78).

week), she noted pain in the left groin which necessitated a three-day rest approximately two months before the marathon. She continued running and three weeks before the marathon noted pain in the contralateral right midthigh area. She rested for five days before the marathon and ran the marathon in 5 hours 42 minutes. The last six miles she walked and ran with pain in the right midthigh area.

Examination one week after the marathon showed pain over the left ischium and right midthigh area. Ranges of motion of the hips and knees were normal and her gait was normal. Roentgenograms showed fractures with callus formation of the left ischium and medial midthird of the right femur (Fig. 5, A and B). The patient's activity was curtailed and she was showing improvement at three months. She moved to New York and resumed marathonning at nine months. Presently her training program has to be limited to less than 50 miles per week or else she develops symptoms in her knees and Achilles tendons. She completed the New York marathon symptom free in October 1980 in 3 hours 52 minutes.

Case 6

DL, a 31-year-old male runner (50–80 miles a week), had a one-month history of left foot and right thigh pain. Two weeks before being seen he saw a podiatrist who prescribed a medial heel wedge for the left shoe after which the foot pain resolved and the thigh pain increased. Examination was normal except for right medial proximal thigh pain to palpation. X-ray films were normal. The diagnosis was a quadriceps strain or possible stress fracture. The patient was advised to refrain from running and have a bone scan, MDP, in two weeks if there was no improvement. This was done and it showed increased uptake in the proximal medial metaphyseal portion of the femur (Fig. 6). A diagnosis of stress fracture was made and he stopped running for three months. He returned to marathonning with a 2 hours 48 minutes time, symptom free, six months after his injury.

DISCUSSION

The literature renders different opinions and data with regard to stress fractures and the structural integrity of bones. A number of authors feel that Wolff's Law is applicable with stress fractures in that the bone is attempting to adapt to the ongoing stresses.^{12, 14} It appears that bone resorption with accelerated repetitive stress occurs at a greater rate than bone deposition. The end result is a stress fracture from repetitive, cumulative stress exceeding the structural strength of the bone.

Histologically, as humans mature from adolescence, the bone in the femoral neck undergoes internal remodeling of circumferential lamellar bone to adult osteonal bone.¹⁰ Experimentally, the greater the percentage of osteones with lamellar bone, the greater the resistance to failure with repeated loading. Fractures appear to be related to the rate of loading, if the rate of loading exceeds the rate of the remodelling of bony buildup, then a fracture may occur with stress.

Clinically, decreased bone density with increasing age and decreased activity has been observed in the general population.⁹ On the other hand, Dow⁸ of Reno, Nevada, showed increased bone densities in the pelvis x-ray films of elderly long-distance runners compared to a control group. His study concluded that running retarded the aging process of decreased density in stressed bone, which is consistent with Wolff's Law.

Koch's free body analysis² of the femur suggests two points on the tension side of the proximal femur that are vulnerable to injury with repeated stress (8 and 24 in Koch's diagram). Interestingly, the locations of the fractures in this series, both femoral neck and shaft, correspond to the compressive side of these vulnerable points. We cannot explain why the fractures observed are on the compressive side of the bones, other than this suggests that the repetitive loads exceeded the strength of the bony structure at these points, with resultant bone failure.

Experimentally, Paul,¹⁷ using force-plate analysis, dem-



Figure 1. F and G, AC one year postsurgery with evidence of healing.

onstrated that in walking, peak forces of up to 6.4 times body weight pass through the proximal femur. No specific calculations for jogging or running are available but perhaps 10 to 20 times body weight may be a possibility.

In one series, involving military recruits,¹⁸ it was noted that most had led sedentary lives before induction into the service and nearly all had recently gained an average of 15 pounds. Negroes were seldom afflicted. There did not appear to be a relationship between the length of training and the occurrence of fractures. Nearly all occurred during basic training. An increased incidence was associated with "long marches."

In another series,⁴ 24 stress fractures of the femoral neck were diagnosed, although 16 of the 24 had normal appearing x-ray films initially. Of the 16 patients, three developed complete fractures, two of which displaced while the patients were in bed. Once displaced, the fractures were reportedly difficult to transfix due to density of the bone in these young individuals.

Several important aspects regarding the treatment of femoral stress fractures can be learned from the military experience.^{1, 4, 7, 11, 18, 21}

First, early diagnosis was difficult. Complaints were vague and poorly localized. Usual symptoms were "achy" hip pain, thigh pain or knee pain—noticeable on awakening in the morning, but with some improvement with activity. Continued activity usually resulted in worsening of discomfort, as was the case with the six patients in this series.

Physical findings on early examination were few. Initial diagnosis included back sprain, muscle strain, cramps, "charley horse" and "no disease found." In one series, 75% of the patients who eventually were diagnosed as having stress fractures of the femur were previously seen, most without having had x-ray films. The diagnosis in our series was relatively rapid since the index of suspicion was high.

Significant findings on physical examination were subtle. Slight limitation of flexion and internal rotation was sometimes present early in the femoral neck fractures, as seen in



Figure 1. H and I, three years postsurgery healed and symptom free.

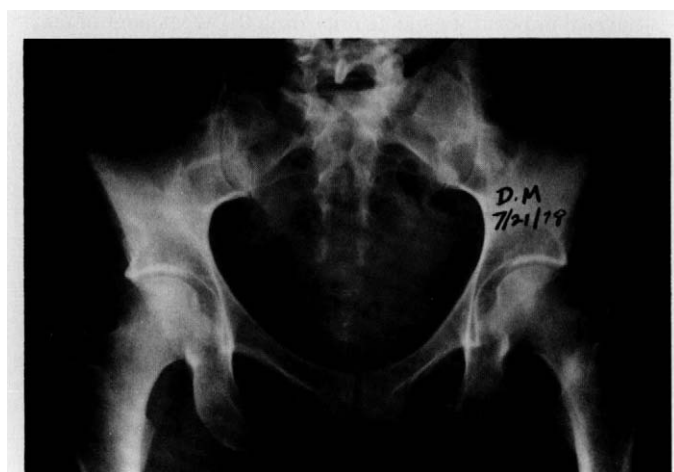


Figure 2. DM's nondisplaced femoral neck fracture with sclerosis of medial cortex (7/21/78).

one of our cases. Direct palpation or percussion over the involved bony area elicited pain in the femoral shaft fractures.

Laboratory studies failed to demonstrate any metabolic abnormality in the military group. The one patient on dexamethasone in our series had her drug discontinued. The other patient on thyroid medication was found to be euthyroid with normal bone density. When indicated, appropriate blood chemistries should be ordered to exclude a metabolic disorder.

In the military group initial x-ray films frequently appeared normal, as was noted in four of the six cases in this paper. Serial roentgenograms of the femur result in delayed diagnosis. Bone scanning has been used to delineate stress fractures earlier than x-ray films^{15, 22} as shown in two of our femoral shaft fractures. When pain persists, despite normal appearing roentgenograms, then a bone scan should be done. The patient (Case 1) who went to another physician and had

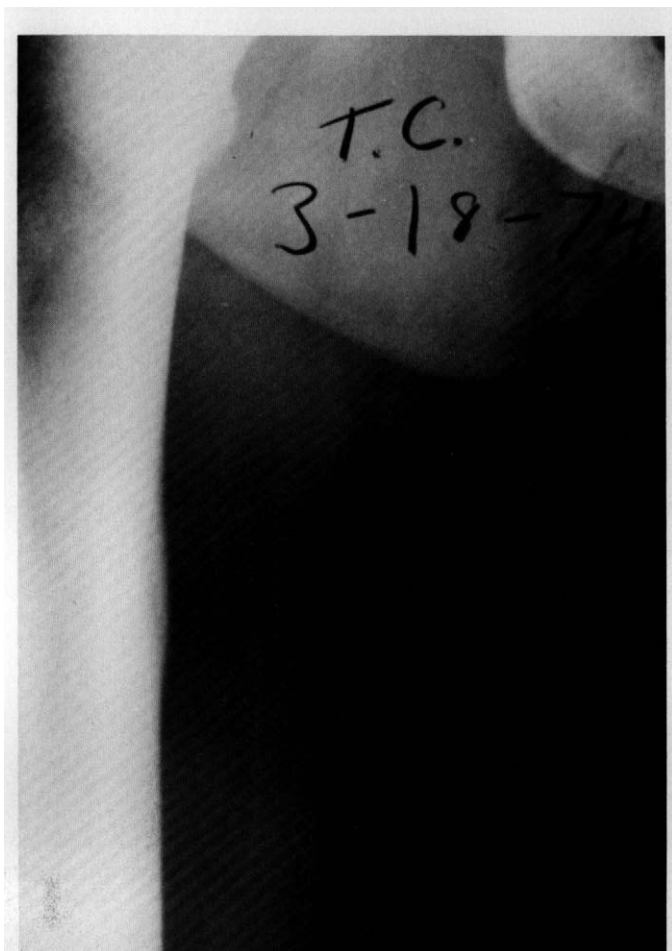


Figure 3. TC, radiolucency with sclerosis medial cortex of femoral shaft, (3/18/74).

no follow-up x-ray films until the fracture displaced may have avoided surgery if bone scanning had been done earlier. The patient's postsurgical activity was monitored closely for clinical and radiological evidence of ischemic necrosis. At 3½ years she remains clinically and radiologically without sequelae. The need for close follow-up is recognized, as incomplete fractures may become complete. Complete fractures have occasionally displaced in spite of bed rest and/or traction.

With femoral neck fractures, it is important to differentiate the type of fracture,^{6, 16} i.e., the compressive or distraction type. The compressive type occurs at the lower border of the femoral neck with internal callus present. This type rarely displaces except when continued stress causes a progression in the fracture, as seen in one of our cases.

The distraction type is transverse in direction, seen more often in older people, with the first radiological sign a radiolucency in the superior neck. The fracture lines develop at right angles to the lines of stress and displacement is not uncommon. Internal fixation is often necessary in this type. None of the patients in our series were in this category.

RECOMMENDED TREATMENT

For incomplete fractures we recommend limited weight-bearing and close follow-up with serial x-rays or bone scanning until the lesion is healed. For complete fractures of the femoral neck percutaneous fixation is advised as the possibility for displacement exists.

CONCLUSIONS

Stress fractures of the femur in healthy athletes are uncommon. A high index of suspicion is necessary if there is to be

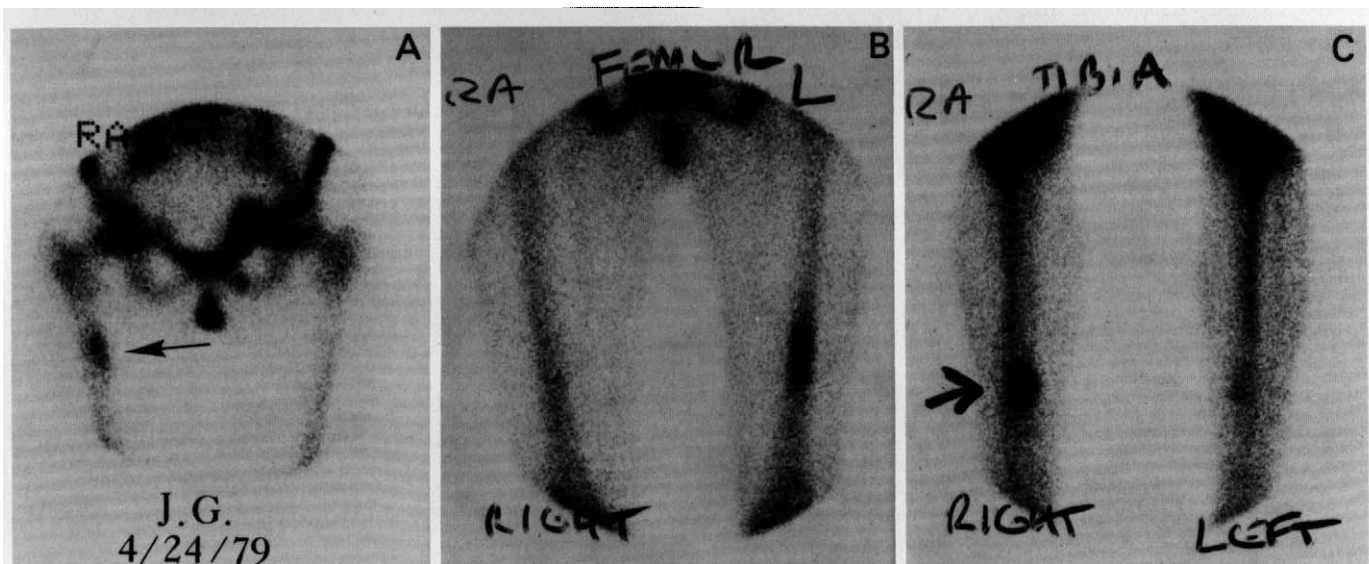


Figure 4. A, JG's bone scan with Technetium 99 (MDP) with increased uptake on medial cortex of right femur (4/24/79). B, bone scan—two years later medial cortex (R) femur negative but with other areas of increased uptake including (L) asymptomatic femur (3/81). C, 2 years later with increased radioactivity in symptomatic right tibia (3/81).



Figure 5. A and B, KC fractures with callus formation of the left ischium and medial midproximal third of right femoral shaft (12/6/78).

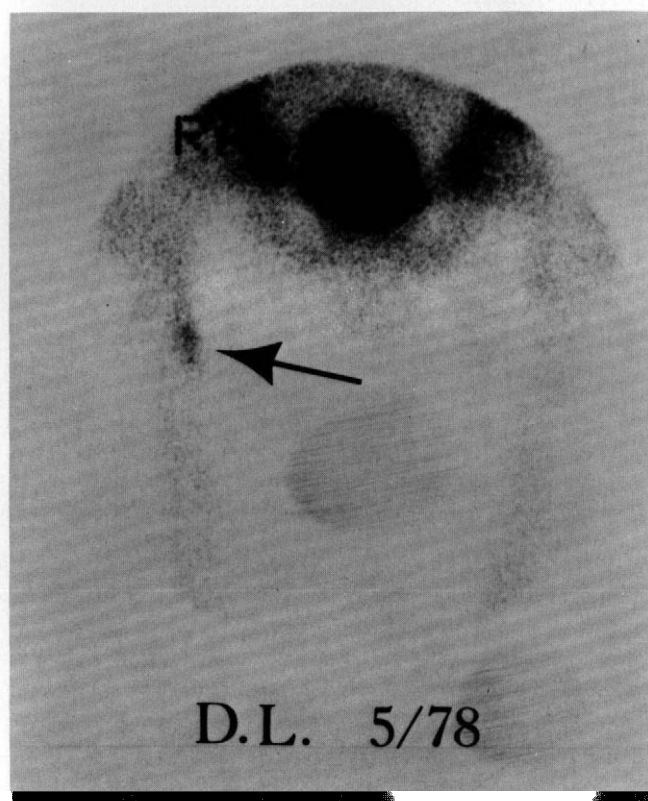


Figure 6. DL Technetium 99 (MDP) bone scan showing increased uptake of the proximal medial shaft of the femur (5/78).

an early diagnosis as complaints are often vague and findings few. Roentgenograms often do not demonstrate the lesion early, but bone scanning will usually delineate the problem. A complete past medical and drug history is essential to exclude possible exogenous causes of the fracture.

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