Stress fractures

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In most circumstances, bone is in homeostasis. However, if enough stress is placed on bone over time it can exhaust its capacity to remodel, creating a weakened site that can result in a stress fracture. This sub-acute fracture results from repeated traumas not significant enough to cause a fracture in their own right, but when added together will overwhelm the osteoblasts.

Presentation

Stress fractures occur most commonly in weight-bearing bones, such as the tibia, fibula and metatarsals. The most common antecedent history is an abrupt increase in the duration, intensity or frequency of physical activity without adequate periods of rest.

Sometimes referred to as a "hairline fracture", stress fractures are frequently seen in military recruits and athletes (predominantly runners). Even Olympic-class athletes who do excessive quantities of graduated high-impact exercise are at risk. They also occur in inactive people who suddenly take up activity that their bones are not modelled to handle.

Beyond mechanical influences, predisposing factors include nutritional deficiencies, sleep deprivation (i.e. increased endogenous adrenocortical steroids with secondary osteoporosis) and metabolic bone disorders (such as osteoporosis, osteomalacia and Paget's disease). Some females who train competitively or extensively may have eating disorders/or suffer from amenorrhea with low oestrogen, both of which can decrease bone mineral density and predispose to stress fractures.

Diagnosis

Stress fractures produce pain in a limited area, directly over the fracture site – usually exacerbated by activity and relieved by rest. Bone tenderness is the most obvious finding on a physical examination.

Only 30% of stress fractures are evident on x-ray imaging initially. However, about 2 to 6 weeks after the stress fracture becomes symptomatic, up to 50% demonstrate some findings on x-ray – perhaps new periosteal bone formation, sclerosis, callous or a visible fracture line.

The best tool for early diagnosis is a nuclear bone scan (or MRI). A stress fracture may show up on bone scan as early as three days after onset of injury symptoms. Although bone scan will be abnormal in almost all stress fractures (as increased "activity" in the area of injury), it can be abnormal for other reasons (e.g. infection).

In athletes who have chronic pain and the initial x-rays show disconcerting features, a bone scan or MRI is required.

Triple phase bone scan findings (figs 1 & 2):

- Discrete localised areas of increased uptake in all 3 phases (soft tissue injuries reveal uptake in first 2 phases only)
- Intensity of activity on delayed images (Phase III) diminishes over 3 to 18 months

Magnetic resonance imaging findings:

- A stress fracture appears as a low signal band, arising from the cortex and extending perpendicular to the bone surface (fig 3).
- Low signal on T1 and T2 weighted images (figs 4,5 & 6).
- Stress reactions seen on short T1 inversion recovery (STIR) or fat suppressed T2 weighted fast spin echo (FSE) sequences.

MRI Classification of Stress Fractures with indicative rest period for treatment

Grade	MRI Findings	Treatment Period
1	Positive STIR	3 Weeks
2	Positive STIR Positive T2	3-6 weeks
3	Positive T1/T2 No def. cortical	12-16 weeks
4	Positive T1/T2 Fracture Line	16+ weeks

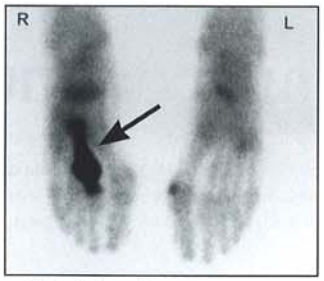

Fig 1: Delayed bone scan - metatarsal stress fracture.

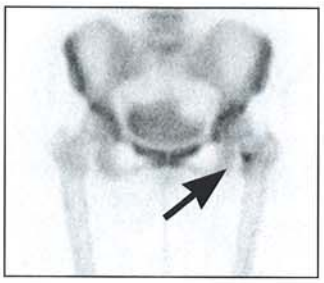

Fig 2: Femoral neck fracture.

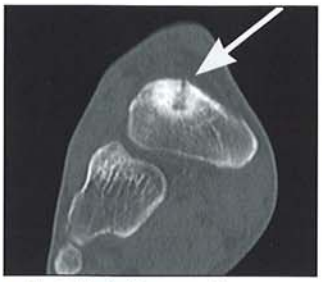

Fig 3: Navicular stress fracture.

Fig 4: MRI Tibial stress fracture - T1 weighted image.

Fig 5: MRI Tibial stress fracture - T2 weighted image.

Fig 6: MRI Calcaneal stress fracture (T2 image).

Treatment

Stress fractures can be broadly classified into two groups, low-risk injuries and high-risk injuries.

A high-risk stress fracture has the potential to become more serious (e.g. medial malleolus, talus, navicular, fifth metatarsal, or the base of the second metatarsal), potentially leading to a complete or displaced fracture. As a result of the high complication rate, high-risk stress fractures should be treated as a traumatic fracture, often with a cast. In extreme cases, surgery may be indicated.

A low-risk stress fracture is less likely to become a serious fracture (e.g. metatarsal shaft, calcaneus or fibula). It may not require nuclear imaging and in most cases can be diagnosed on the basis of a thorough history and physical examination and radiographs.

A rest period of 1 to 6 weeks of limited weight bearing, progressing to full weight bearing, may be required. Return to activities should be gradual. Low-impact activities such as swimming or biking can be performed to maintain cardiovascular conditioning once the initial pain subsides. As soon as low-impact activities are comfortable for prolonged periods, high-impact activities can be commenced. In most situations the athlete gradually increases jogging mileage and eventually is able to return to sport-specific activities.

Returning to activity too early or increasing the amount of activity too quickly may initiate the stress fracture process again. The first four weeks after symptom onset is the most vulnerable time during a fracture's reparative process.

Prevention

Stress fractures are best managed by prevention. Training errors, such as an excessive increase in intensity, are the most frequent culprit and should be corrected. New activities, such as hill running or running on hard surfaces, may also be contributing factors.

Adequate nutrition and the oral contraceptive pill in women athletes with amenorrhoea are other preventive measures. ■

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