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Computed Tomography of Stress Fracture

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Abstract. An athletic young female developed gradual onset of pain in the right leg. Plain radiographs demonstrated solid periosteal reaction in the tibia compatible with stress fracture. She stopped sport activites but her pain continued. Follow-up radiographs of the tibia revealed changes suspicious for osteoid osteoma. Computed tomography (CT) scan demonstrated periosteal reaction, but in addition, lucent fracture lines in the tibial cortex were evident. CT obviated the need for more invasive diagnostic procedures in this patient. In selected cases CT may be useful to confirm the diagnosis of stress fracture when plain radiographic or routine tomographic studies are not diagnostic.

Key words: Computed tomography – Stress fracture

Differentiation of stress fracture from osteoid osteoma in certain patients continues to be difficult based on clinical, plain radiographic, and routine tomographic findings. The authors present a case in which computed tomography (CT) was the definitive diagnostic study. The CT findings of stress fracture have not been previously described.

Case Report

An 18-year-old athletic female developed pain along the anterior aspect of her right tibia. Although initial radiographs were unremarkable, she was advised to stop her sport activities as stress fracture was suspected. Nonetheless, her pain continued. Follow-up plain radiographs demonstrated solid periosteal reaction along the posterior tibial diaphysis. Despite decreased physical activity, her leg pain and local tenderness continued and she was referred to Thomas Jefferson University Hospital for evaluation. Plain radiographs (Fig. 1 A) and polytomography (Fig. 1 B) showed solid periosteal reaction and a central lucency paralleling the cortex. The latter finding suggested the possibility of osteoid osteoma. CT of the right lower extremity demonstrated thickening of the right tibial cortex (Fig. 1 C). In addition, multiple linear infractions were evident in the cortex when mean and window settings were adjusted to examine the bone (Fig. 1 D). No such linear lucencies were visualized in the normal left tibia. The patient was placed in a leg cast for 10 weeks and following removal of the cast the patient remains symptom free. Additional plain radiographs show complete healing of the fracture.

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Discussion

Stress fracture has been defined as a partial or incomplete fracture of bone due to the inability of the bone to withstand nonviolent stress that is applied in a rhythmic subthreshold manner [4]. Stress fracture occurs during remodeling of normal bone, when resorption of bone exceeds repair, making it a process, not an occurrence. In the sequence of remodeling, resorption of bone is followed by bone replacement. Bone replacement is a slow process, whereas resorption proceeds rapidly producing a temporarily weakened cortex. Sufficient weakening leads to periosteal new bone formation until the refilling process has caught up and solidified the cortex. A true fracture occurs when the removal of cortex is accelerated beyond the capacity of the periosteal reaction to offer adequate reinforcement [8].

The diagnosis of a stress fracture is usually made from history and clinical examination [1]. Pain is the main symptom and characteristically it is relieved by rest and recurs with activity. However, as in our case, the clinical findings may be atypical.

Confirmation of the clinical diagnosis of stress fracture is usually made with plain radiographs or by bone scintigraphy. Bone scintigraphy reveals local-

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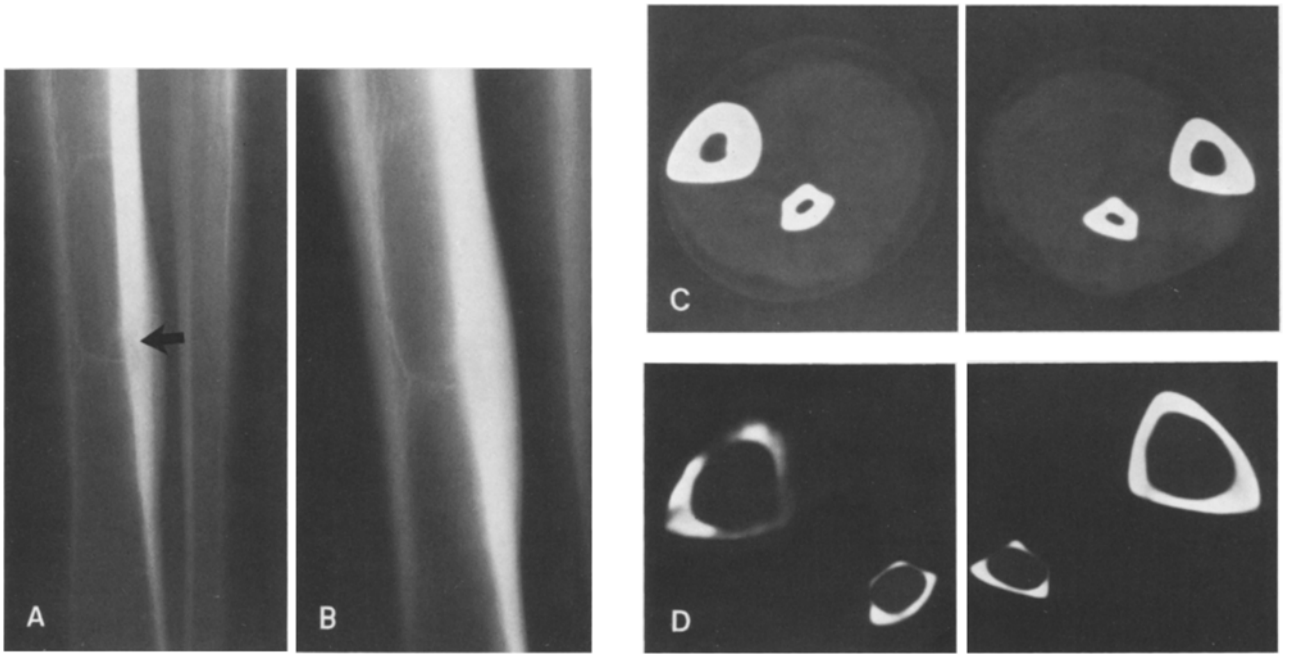

Fig. 1A–D. **A** Plain radiograph of right tibia demonstrates solid periosteal reaction and small central radiolucency (*arrow*) suspicious for a nidus. **B** Tomogram of right tibia demonstrates similar findings as **A**. No fracture lines evident. **C** CT shows diffuse cortical thickening of right tibia. Compare with normal left tibia. **D** CT scan at same area as **B** with "bone window" demonstrates areas of cortical thinning. Note fracture lines throughout the cortex

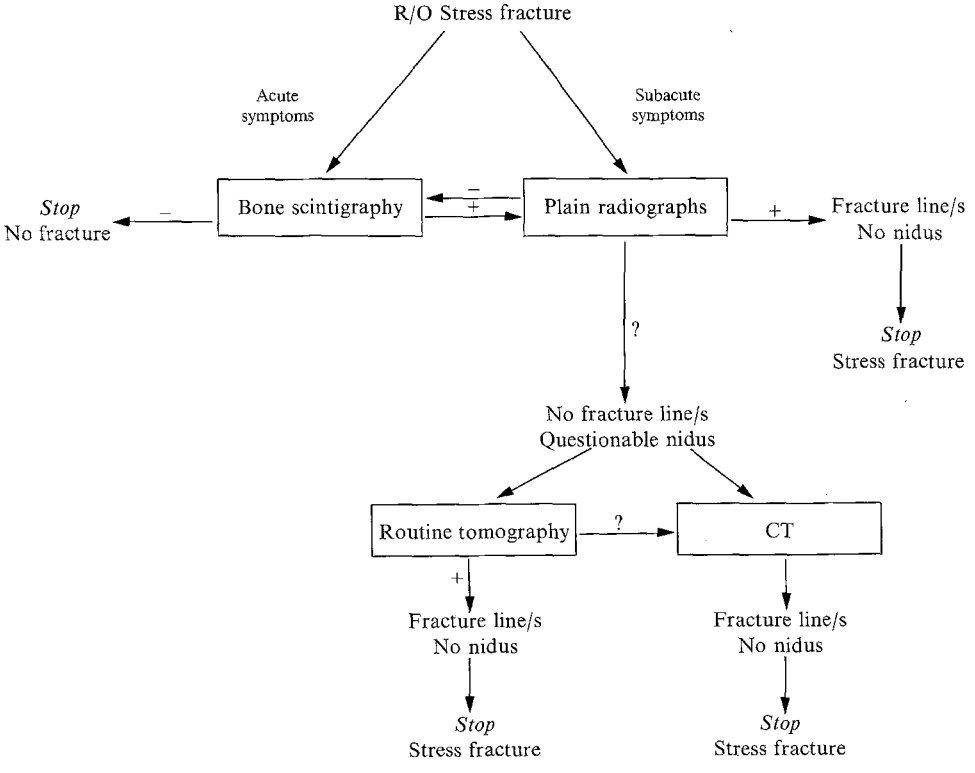

Fig. 2. Imaging algorithm in the diagnosis of stress fracture

ized increased isotope uptake secondary to osteoblastic new bone formation. The bone scan will be positive before plain radiographic changes are demonstrated [5]. Plain radiographs reveal periosteal new bone formation and/or a cortical break perpendicular to the shaft of the long bone. Stress fracture in the end of the long bones or in short bones, such as the tarsal bones, is detected radiographically by the presence of medullary sclerosis [6]. Not infrequently, the radiographic appearance is not typical for a stress fracture and other diagnoses are suggested.

Osteoid osteoma, a benign cortical tumor, is frequently, the main differential diagnosis included especially when the lesion is located in the tibia [7]. In osteoid osteoma, the presence of a radiolucent nidus with calcification of the central portion of the nidus will be highly suggestive of this diagnosis. However, not all cases have this characteristic appearance and more invasive procedures such as arteriography [2] and even surgery have been recommended to differentiate stress fracture from osteoid osteoma.

Computed tomography of osteoid osteoma has been reported [3, 9]. CT scan shows the exact location of the nidus of the osteoid osteoma facilitating removal of the lesion and reducing the amount of resection of cortical bone required. The CT appearance is totally different from our case of stress fracture in which infractions were evident throughout the cortex.

We believe the diagnosis of stress fracture is straight-forward in the great majority of cases based on clinical information and bone scintigraphy and/or plain radiographs. If the diagnosis is still in doubt after plain radiographs or routine tomography, CT should be utilized (Fig. 2). CT diagnosis of stress fracture is based upon the demonstration of fracture lines in the involved cortex. Additional case material is needed to determine if CT can demonstrate cortical infractions before significant cortical buttressing has occurred.

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