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Case Report

Diagnostic Approach of Stress Fractures in Tibia or Fibula in Normal Children, Younger than 10 Yrs

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Abstract

Introduction: Stress fractures of tibia or fibula are rare in healthy children younger than 10 yrs. Clinical symptoms are limping and pain, usually obscure that require investigation. Radiological examination reveal cortical thickening. MRI scan reveals bone and periosteal edema that are usually confusing. Either malignancy or infection must be excluded in this age group.

Case Report: A group of 4 children, younger than 10 yrs, among those referred for pain and limping, were diagnosed as stress fractures. The initial MRI scan performed elsewhere, had extended bone edema that raised suspicion for malignancy. All children had a thorough clinical investigation with appropriate imaging with x-rays, MRI and CT scans.

Results: An accurate localization of the point of tenderness was clinically found in all children. Plain x-rays showed cortical thickening in one child. No fracture line was detected with x-rays. MRI findings were extended edema in the medullary canal and the surrounding tissues, with intact cortices. Only one child had a fracture line on the MRI scan. CT scan showed the presence of smooth periosteal elevation, with normal cortex on the affected bone. Fracture line was seen in 2 children.

Conclusion: The combination of plain x-ray, MRI and CT scan can provide appropriate information to achieve the correct diagnosis and avoid unnecessary procedures. Immobilization and restriction of weight bearing was the treatment provided that permitted healing of the fracture.

Keywords: *Stress Fracture; Tibia; Fibula; Children*

Introduction

Stress fracture in healthy young children is often a challenging diagnosis. Interpretation of plain films and MRI images that deal with periosteal elevation and bone marrow edema are confusing. It is important to exclude cases of malignancy or infection, in the first decade of life. Stress fractures have been described in young athlete adolescents, but they are unusual in the age group of children younger than 10 yrs. Stress fractures of insufficiency may be found in this age group in bones of children with underlying pathology such as rickets, secondary osteoporosis with thin cortices or localized benign osteolytic lesions. But the normal bone of a child rarely sustains stress fracture. Appropriate imaging with a combination of plain films, MRI and CT scan is essential for the correct diagnosis [1-3].

We present this case series, in order to draw attention to the diagnosis of stress fractures in this young age group. We report the methods and combination of examinations for the final diagnosis of stress fractures.

Case Report

During the last 5 years, 4 children aged between 5 - 8 yrs old, were diagnosed with stress fractures affecting the tibia or the fibula. They were 2 girls and 2 boys, participating in regular daily activities, with occasional ballet dancing for the girls and football for the boys. None of them was regularly training in a particular sport.

All of them had localized pain and limping with gradual presentation. No particular injury that initiated the symptoms was recorded. All children were initially examined elsewhere and x-ray and MRI were performed. On MRI examination the presence of edema of the bone and of the surrounding tissues raised the question of malignancy as possible diagnosis and they have been further referred to a center for pediatric orthopaedics. There was a delay in referral from 2 - 4 months since the beginning of their symptoms.

On clinical examination, all were in good general health. We could localize the exact point of tenderness after a thorough clinical examination. The most striking symptom was the difficulty to jump on the affected leg. Despite the fact that all of them had eliminated their sporting activities, pain and limping was persisting.

Results

We performed x-ray examinations in all of them. We examined only the affected limp. We found thickening of the cortex in a localized area of the affected bone only in one child. The cortex appeared normal with no evidence of cortical erosion. We could not detect a clear fracture line in any of our children. The other 3 patients had normal x-ray appearance.

On MRI examination there was edema affecting both the medullary canal and the periosteal area. The cortices appeared normal, the extension of the edema was significant, without skip lesions. Imaging of the bone and periosteal edema was best seen on STIR images. Edema appeared homogenous without areas of variation of the signal. One child had a clear fracture line on the MRI confirming the diagnosis for stress fracture.

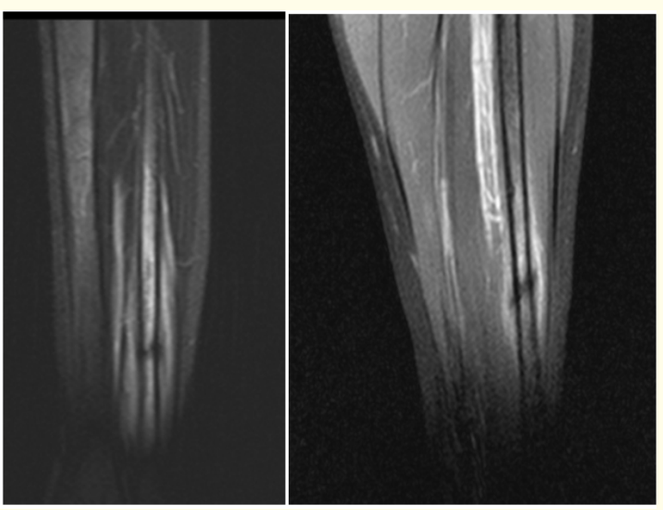

Figure 1a and 1b: *Fracture line in the fibula, in the STIR sagittal view, of the stress fracture of 5 yrs old boy.*

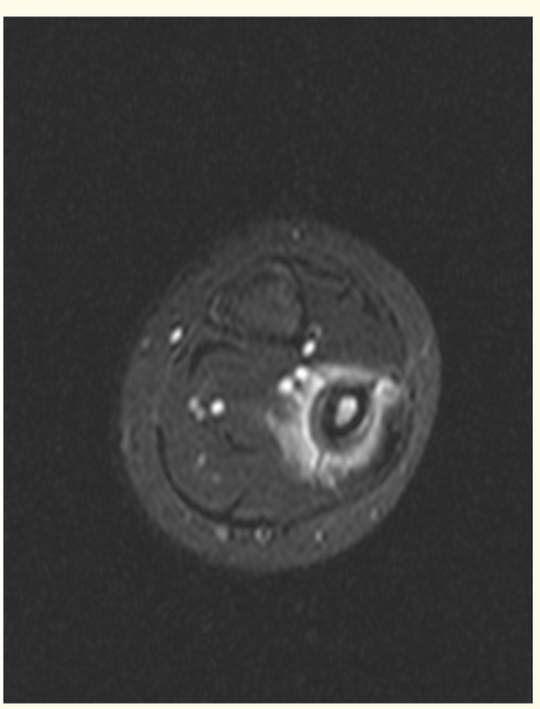

Figure 1c: *MRI scan, axial view with surrounding edema and intramedullary edema.*

In our patients, CT examination was the most useful examination. CT scans were performed in a localized area of the bone with multiple slices and 3 D reconstruction. That showed the presence of smooth periosteal elevation, with normal cortex on the affected bone. Furthermore the fracture line was seen in 2 children. For the 4th patient, the presence of periosteal elevation with normal cortex from the CT scan and the medullary and periosteal oedema found on MRI, confirmed the diagnosis of stress fractures, excluding malignancy or infection.

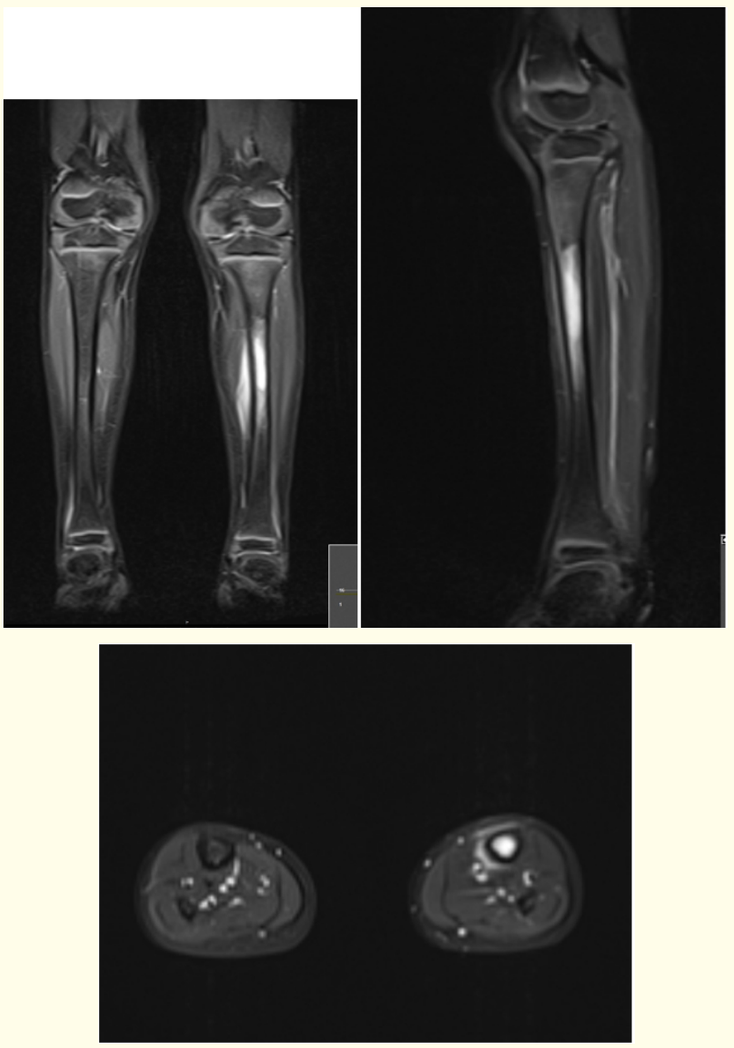

Figure 2a-2c: *MRI Scan STIR views coronal, sagittal and axial, with edema of bone and surrounding tissues of the tibia, of a 6 yrs old boy.*

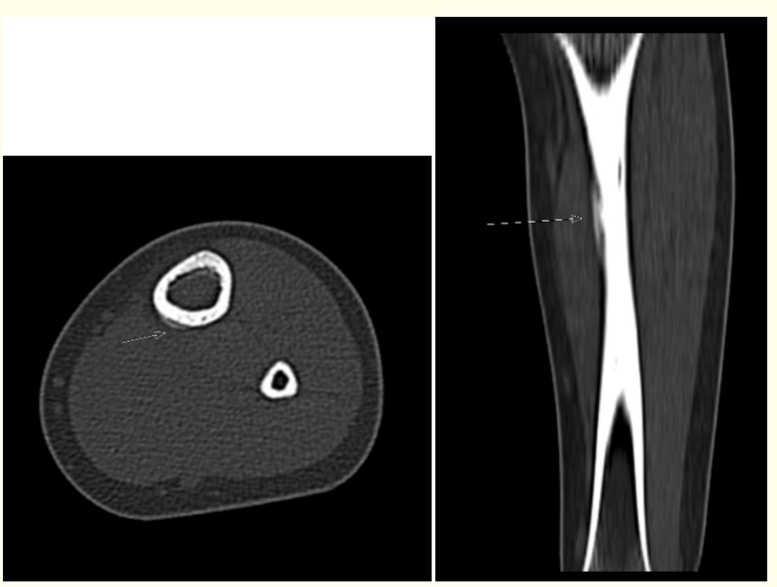

Figure 2d-2e: *MCT scan with periosteal elevation of the stress fracture of the tibia.*

Figure 3a and 3b: *MRI scan STIR sagittal and axial view with edema of the bone and soft tissue around the fibula, in a 6 yrs old girl.*

Figure 3c and 3d: *CT scan with the periosteal elevation and the intact cortices of the fibula.*

None of our patients had bone scan. No biopsies were performed.

We treated all our children with immobilization in a cast and non-weight bearing for a period of 4 weeks. We performed plain x-rays at 2 and 4 months, that showed smooth cortical thickening of the affected area, that was a healing fracture.

All children had an uneventful recovery. All returned to their activities after the treatment was provided.

Discussion

Stress fractures that are included in our study were diagnosed after referral to a pediatric orthopaedic center. The main concern for referral was the possibility of malignancy that was raised from the initial MRI that revealed extensive bone edema with edema of the surrounding soft tissues.

Stress fractures are well described affecting athletes or military recruits. The increasing level of sport activities, even in preschool children, could be an explanation for the incidence of stress fractures in this young age group. None of our children had increased sport activities, but they were participating in their normal actions.

Tibia and fibula are the most common sites for the long bones, to have sustained stress fracture. In epidemiology studies of stress fractures in US high school athletes, the lower leg is the most affected, with girls being more affected than boys. But the incidence is decreasing with decreasing age, in particular in those younger than 10 yrs, with only sporadically presented cases [4].

In 1963 Devas presented a series of 40 stress fractures up to the age of 16 yrs. The series presents 15 stress fractures in the tibia and 11 in the fibula. In that period he emphasized that no linear fracture was seen radiologically because this is a compression stress fracture. The periosteum is elevated because of hematoma formation and this calcifies and presents a thin line in the x-ray, usually more on one side. In the fibula, the earliest sign was an egg shell callus. Included among them were 2 children of 5 yrs with stress fracture of the tibia and 4 younger than 5 yrs with stress fracture of the fibula [1].

Cortical lesions of the tibia in conventional radiography can cause either cortical destruction or proliferation. Each of them may lead to a variety of diagnosis. The diagnosis of stress fracture may appear among others in cases of cortical proliferation [5]. Only 1 of our patients had cortical thickening on the initial x ray.

Fottner., *et al*. presented a retrospective study of 22 patients that were also referred as having bone tumor and ended up as stress fracture. There was a wide range of age groups from 6 to 80 years. They presented a great confidence in the interpretation of the MRI scans. But they confirmed the diagnosis in doubtful cases, with additional CT scans [6]. This was done mainly for the stress fractures of the tibia and fibula.

Stress fractures may appear in preexisting bone pathology as fibrous cortical defect or non-ossifying fibroma, in skeletally immature patients. The presence of localized weakness predisposes to stress fracture. Six cases were diagnosed as stress fractures in an orthopaedic oncology unit, where there were referred for sarcoma or infection. Four cases affected the tibia, in the posteromedial cortex. They confirmed the diagnosis on the basis of absence of aggressive features such as interrupted periosteal reaction, cortical breach and soft tissue mass. Follow up x-rays supported the correct diagnosis [7]. Our children had normal bone, with no signs of any underlying pathology.

De Pina., *et al*. presented their patient, a 13 yrs old girl, who participated in sports, with a lesion in the proximal fibula, with periosteal reaction and thickening in the plain radiograph. MRI findings showed periosteal edema with no medullary or cortical alterations. With uncertain diagnosis, they performed biopsy to exclude osteomyelitis or malignancy [8].

Roth., *et al*. presented a 14 yrs old girl, with bilateral fibular periosteal reactions seen on plain radiographs, in order to exclude sarcoma or infection, had assisted from bone scan. Final confirmation was done with a CT scan [9]. The same principles applied for the diagnosis of bilateral distal fibular stress fracture by Tsuchie., *et al*. 2010. They presented a 16 yrs old girl, where the combination of plain films, CT scan and bone scan confirmed the diagnosis [10].

On the other hand Di Friori, in a 14yrs old boy, confirmed their diagnosis of stress fracture of the proximal fibula, with calcification on the fibula, based on MRI findings [11].

A double stress fracture of the tibia of a 10 yrs old boy has been reported. Based on combination of clinical evaluation and the appearance on MRI with absent soft tissue involvement, the diagnosis of stress fracture was established [12].

In a cohort of 20 patients, with ages ranging from 10 - 21 yrs old, in 12 of them a thickening of the cortex and a visible fracture line on plain films were found. Thickening of the cortex is difficult to be measured. In our patients this finding appeared on x-ray at the end of treatment. On MRI imaging increased uptake on the STIR signal was found and that confirmed the diagnosis, in cases with no fracture line in plain films. No CT were performed and only one patient had a bone scan [3].

Sofka in imaging of stress fractures refers on the use of CT that provides fine osseous details, demonstrating a fracture line that is not apparent of plain films. Bone scan can provide information for osseous turnover in the area but it is the MRI that provides the most comprehensive evaluation of stress injuries [13].

Shelat and El Khoury [14] in a review article for general stress fractures in children, report the use of MRI, with low intensity on T1 sequences and edema as a useful finding to confirm the diagnosis. Regarding diaphyseal tibia or fibula injuries, they refer in adolescents, using the Frederickson classification for stress tibia fractures.

Interpretation of periosteal reaction in a young child, of less than 10 yrs is difficult. Diagnosis of stress fracture is an exclusion diagnosis, after being confident that there is no case of malignancy or infection. In adolescents clinical history and imaging is easier to be assessed.

In all our patients, initial x-rays showed cortical thickening in 1 child while in the others they were normal. MRI scan revealed the fracture line in one case confirming the diagnosis, while in the remaining cases the findings of bone marrow edema and soft tissue edema were of an uncertain diagnosis. The intact cortex without evidence of erosion, the homogenous diffuse edema with edema of the periosteal area was indicative of benign lesion but not clear evidence of stress fracture. CT scan, in all cases, showed periosteal elevation with a normal cortex, findings indicative of a stress fracture. Furthermore, the fracture line was seen in 2 cases. One patient, where the fracture line was not evident, was diagnosed as stress fracture with the combination of findings of CT and MRI scan. Follow up radiographs confirmed the diagnosis of healed stress fractures. None of our patients had a biopsy.

In this young age group, we propose the combination of x-rays, MRI and CT scan in order to provide a definite diagnosis.

Conclusion

Young children with pain and limping require appropriate evaluation. The presence of cortical thickening on x-ray and bone edema on MRI examination is often obscure and needs appropriate investigation to exclude cases of malignancy. The combination of x-rays, MRI and CT scans can lead to accurate diagnosis of stress fractures, in this age group

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