

## Original Article

### **Diagnostic dilemma in sicklers with acute bone crisis: Role of subperiosteal fluid collection on MRI in resolving this issue**

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#### **Abstract**

**Objectives:** To establish MRI criteria to diagnose early osteomyelitis in sickle cell disease patients with acute bone crisis and to differentiate it from normally occurring ischaemic changes in these patients.

**Methods:** MRI study with and without Gadolinium contrast was carried out in 59 sickle cell disease patients who presented with acute bone crisis from August 2007 to July 2008, and had clinical suspicion of osteomyelitis. We studied the ability of MRI especially the presence of subperiosteal fluid, for the early diagnosis of osteomyelitis and its differentiation from ischaemic changes in these patients.

**Results:** Depending on MRI diagnostic criteria, we diagnosed 32 cases for osteomyelitis. In 26 patients diagnosis was confirmed microbiologically while 6 patients were treated on clinico radiological basis which showed marked improvement on follow up. Five patients with osteomyelitis had established MR features of osteomyelitis while in 27 cases the diagnosis was made on the basis of presence of subperiosteal fluid

**Conclusion:** Early osteomyelitis is a challenging diagnosis clinically and radiologically in patients with sickle cell disease, which can be diagnosed on M.R.I if special emphasis is put on subperiosteal fluid collection (JPMA 60:819; 2010).

## Introduction

Sickle cell disease is a common hereditary disorder which results from the presence of abnormal B globin chains within haemoglobin. Patients with this disease often present with vaso-occlusive crisis and ischaemic changes.<sup>1</sup> Necrotic bone marrow is a fertile site for secondary infection. Patients with sickle cell anaemia have immunologic deficiencies making them susceptible to certain musculoskeletal infections than other people.<sup>2</sup> Clinically it becomes challenging to diagnose early osteomyelitis and to differentiate it from ischaemic crisis as patients usually have same signs and symptoms. However, osteomyelitis must be diagnosed early and treated immediately to prevent bone destruction and deformity; therefore, care must be taken to achieve an accurate diagnosis by identifying or excluding early bone involvement. Radiology can play its part in differentiating two conditions especially MRI with gadolinium. The major findings of established osteomyelitis on MRI are cortical destruction, adjacent fluid collections in soft tissues, abnormal bone marrow marginal enhancement with central non enhancing area, and intra osseous abscess formations.<sup>3</sup> Unfortunately the diagnosis of early osteomyelitis is more difficult and challenging due to overlap of radiological findings which include bone marrow and soft tissue oedema with enhancement on CE-MRI, and periosteal thickening.

Little emphasis is put in the literature on the MRI finding of subperiosteal fluid collection, which is usually seen in cases of early osteomyelitis and could be an important differentiating feature in sickle cell disease patients with acute bone pain. Sickle cell disease is quite common in Saudi Arabia and at our institution, we are encountering this problem routinely. The purpose of our study was to establish the role of subperiosteal fluid collection on MRI in early detection of osteomyelitis, and its differentiation from ischaemic changes in these patients with acute bone pain.

## Patients and Methods

A total of 59 contrast enhanced MRI examinations were performed from August, 2007 to July, 2008 in sickle cell disease patients who presented to emergency department with acute bone crisis, and with a clinical suspicion of osteomyelitis. This study was carried out in Medical Imaging Department of King Abdul Aziz Hospital, National Guard Health Affairs, Al-Ahsa, Saudi Arabia. Patients of all age groups were included. The exclusion criteria consisted of contraindication to the use of Gadolinium contrast medium and non availability of adequate follow up.

MR imaging was performed within first 3 days of hospitalization for all patients. MR imaging was performed using 0.5 T system (Gyrosan, Philips Medical System). Sequences were performed in either a head coil (single extremity) or a body coil (both lower extremities). Axial images were obtained with 5mm thickness and 1 mm interslice spacing.

Coronal and sagittal images were obtained with 3-4 mm thickness and 1-2 mm interslice spacing. Sequences consisted of axial T1 and T2 weighted fast spin echo images, axial and coronal STIR images and, fat suppressed coronal and sagittal T1 weighted and coronal T2 weighted images. After administration of Gadoteric acid (Dotarem, 1ml/5kg, Guerbet company), fat saturated T1 weighted axial and coronal, and spin echo axial T1 weighted imaging were performed.

MR images of each patient were reviewed by 2 experienced radiologists. MR evaluation included bone marrow oedema, cortical irregularity/destruction, periosteal thickening/signal abnormality, sub periosteal or soft tissue fluid collections, soft tissue oedema, and bone marrow/soft tissue enhancement on contrast enhanced MRI. The MR features of cortical irregularity/destruction, Subperiosteal or soft tissue collection with or without enhancement, and intra osseous abscess/irregular bone marrow enhancement around a non enhancing centre were considered specific for osteomyelitis. All patients had follow up MRI and were evaluated in OPD on follow up visits for their final outcome.

## Results

Out of a total of 59 patients, 3 were excluded due to inadequate follow up. From the remaining 56 patients, 39 were male and 17 were female. The age of the patients ranged from 2-34 years. The age group between 2-11 years was predominantly involved accounting for 24 patients. Ten patients were between 12-23 years and twenty two patients were between 24-34 years of age.

All patients presented with a clinical history of pain. The other common symptoms were fever (47 cases) and localized tenderness (41 cases). Limitation of limb movement was noted in 31 patients while swelling was seen in 20 patients.

MRI features found in these 56 patients are summarized in Table-1. Depending on the pre described MRI diagnostic criteria, we diagnosed 32 cases for early osteomyelitis out of 56 patients. All these 32 patients showed bone marrow and soft tissue oedema with enhancement and subperiosteal fluid collection. Twenty eight patients had periosteal thickening and 22 patients had marginal enhancement of sub periosteal fluid. Soft tissue collection was seen in 5 cases out of which 4 patients had irregular marginal marrow enhancement around a non enhancing centre and 3 patients had cortical irregularity, making the diagnosis of osteomyelitis relatively easy in them. The diagnosis of osteomyelitis was solely made on the basis of sub periosteal fluid in 27 cases. Out of 32 cases positive for subperiosteal fluid on MRI, 26 cases showed mild to moderate amount of fluid. The sub periosteal fluid aspiration was carried out in these patients by an orthopaedic surgeon or under image guidance by the radiologist. All these cases on culture analysis turned out to be positive for infection. Remaining 6 patients had minimal sub periosteal collection that could not be aspirated,

and they were treated for osteomyelitis on the basis of clinico-radiological findings and blood chemistry. Follow up MRI showed improvement in all of them.

The diagnosis of ischaemia was made in 16 patients, all of them had bone marrow and soft tissue oedema with enhancement on contrast enhanced MRI. Six patients also had periosteal thickening. None of them had subperiosteal or soft tissue fluid collection. These patients were treated symptomatically and showed improvement on follow up visits.

Six cases were equivocal for early infection and ischaemia. They had bone marrow/soft tissue oedema and enhancement, and periosteal thickening, however, suspicion of infection was high on the basis of clinical features and blood chemistry. They were then treated for osteomyelitis on clinical judgment and showed improvement on follow up.

Two patients out of 56, showed only soft tissue changes in the form of muscle and subcutaneous oedema and were treated symptomatically.

## Discussion

Sickle cell anaemia is an autosomal recessive genetic condition in which a defective form of haemoglobin, haemoglobin S, results from a single amino acid substitution in the B globin chain.<sup>3</sup> Sickle cell disease is seen in people from the Middle East and eastern Mediterranean region but is most prevalent in those of African origin. Sickle cell anaemia causes significant mortality and morbidity, with a decrease of 25-30 years in the average life expectancy.<sup>3</sup> In majority of cases, hospital admissions are due to painful crisis but severe complications are rare in these children probably due to high foetal haemoglobin.<sup>4</sup> These patients are at increased risk for both osteomyelitis and infarction of the long bones.<sup>5</sup> Although the diagnosis of acute bone crisis can usually be made on clinical grounds alone, sickle cell patients with acute painful events may have clinical and laboratory signs and symptoms that raise the question of osteomyelitis.<sup>6</sup> Early osteomyelitis is a challenging diagnosis clinically and radiologically in patients with sickle cell disease.

A variety of diagnostic imaging techniques are applied including Radiography, CT & Skeletal Scintigraphy.<sup>7</sup> All these techniques have limitations including low specificity and radiation exposure. MRI has been shown to be very helpful in solving this issue<sup>8</sup> and has been beneficial for evaluation of the marrow in both asymptomatic and symptomatic patients with sickle cell disease.<sup>9-11</sup> It is capable of showing the pathologic changes before they are visible on radiographs. Unfortunately the two conditions may still overlap or show similar findings on MRI as well. In our study, certain findings such as bone marrow oedema, adjacent soft tissue oedema, and abnormal gadolinium enhancement of bone marrow or surrounding soft tissues, were seen with infarction as well as osteomyelitis. However, these features are more useful as imaging indicators of the response to

antibiotic treatment in an established infection.<sup>12</sup> MRI features suggestive of obvious osteomyelitis including cortical irregularity/destruction, intraosseous abscess/irregular bone marrow enhancement around a non enhanced centre and adjacent soft tissue collections, were seen in only 5 of our cases. In rest of the 27 patients diagnosis of early osteomyelitis was made solely on the finding of subperiosteal fluid collection. Soft tissue collection was noted in 5 cases and all of them were finally diagnosed as cases of osteomyelitis. Yet, this finding is not very sensitive for the diagnosis of early osteomyelitis, and even not specific to this, as it has been described in literature to be associated with infarction as well.<sup>5</sup> In the absence of specific criteria, the diagnosis is equivocal for early infection or ischaemia as seen in our 6 cases. Although these patients were treated for osteomyelitis on clinical grounds and they improved, but still the final diagnosis was uncertain. Another limitation of our study is the small study group and perhaps more studies will be required to establish the role of MRI findings especially the subperiosteal fluid, in these patients.

It can be concluded, that MR imaging has an important role in demonstrating loculated subperiosteal fluid collections. This helps in diagnosis of early osteomyelitis and its differentiation from ischaemic changes. MRI can be valuable in excluding the possibility of either osteomyelitis or marrow infarction in those patients who had abnormalities limited to soft tissues only. MR imaging may also act as a guide to intervention identifying focal bone marrow or soft tissue fluid collection that can be aspirated for further evaluation.

## Conclusion

MRI has been shown to be helpful in the diagnosis of early osteomyelitis and its differentiation from ischaemia/infarction in sickle cell disease patients with acute bone crisis, especially if special emphasis is put on subperiosteal fluid collection.

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