

## Original Research Article

# The role of pre operative appendicular magnetic resonance imaging in cases of acute bone and joint infection in the paediatric age group

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### ABSTRACT

**Background:** Acute haemotogenous osteomyelitis can occur at any age group but is mainly a disease of children. They are a challenge to differentiate as they have overlapping signs and symptoms. Septic arthritis is considered a surgical emergency while acute osteomyelitis, when presented early can be treated with parenteral antibiotics. There is paucity in the approach (imaging guidelines and treatment) for cases where acute septic arthritis is associated with osteomyelitis. We aimed to analyse the role of pre operative appendicular MRI in the cases of acute bone and joint infection in paediatric age group.

**Methods:** This is a prospective study done in 38 children suspected to have acute bone and joint infections. All the patients underwent emergency appendicular MRI in the suspicion of bone and joint infections. Based on the MRI findings, all the patients were classified into cases of isolated septic arthritis and cases of septic arthritis with concomitant osteomyelitis. There was a change in the treatment modality between the two categories of patients.

**Results:** In our study 14 (36.84%) cases of the 38 suspected bone and joint infection had concomitant osteomyelitis with septic arthritis. These 14 cases were seen involving the knee, hip, elbow and shoulder joints. The incidence of septic arthritis with coexisting osteomyelitis was 36.84% in our study, which was diagnosed with pre operative emergency appendicular MRI.

**Conclusions:** Our study concludes that MRI should be included in the work up for suspected bone and joint infections provided MRI is done in a timely fashion without unnecessarily delaying surgical intervention if needed.

**Keywords:** Acute osteomyelitis, Septic arthritis, MRI, Arthrotomy, Decompression

### INTRODUCTION

Acute haematogenous osteomyelitis and septic arthritis can occur at any age group but is mainly a disease of children.<sup>1-3</sup> They are a challenge to differentiate as they have overlapping signs and symptoms.<sup>4-7</sup> Many of the children may present late after initial “suppression” of infection with antibiotics. Acute osteomyelitis when seen early before 48 hours of onset of symptoms and before abscess formation can be managed with intravenous administration of antibiotics. But septic arthritis, which is more common, is a surgical emergency.<sup>1-3</sup> Kocher’s

criteria is still considered as an important clinical practice guideline for the diagnosis of septic arthritis of the hip.<sup>8</sup> Commonly in infants, septic arthritis and metaphyseal osteomyelitis may co-exist.<sup>1-3</sup>

The imaging work up for suspected septic arthritis includes radiographs, ultrasound and at times MRI. Because the radiography (X-ray) results may be normal in the setting of acute septic arthritis and osteomyelitis, MRI may be an useful tool to confirm the diagnosis.<sup>9-12</sup> MRI helps us to differentiate septic arthritis, osteomyelitis without abscess, osteomyelitis with abscess, combination of septic arthritis

and osteomyelitis and sometimes soft tissue infection without bone/joint infection.<sup>9-12</sup> This helps us to plan our surgical strategy and decide on the antibiotic protocol as osteomyelitis requires a longer duration of therapy than septic arthritis.<sup>13</sup> But the availability of MRI as an emergency investigation and difficulty of procuring good images without sedation especially in children are caveats.

At our institution, we were able to perform an urgent MRI in all children with suspected bone and joint infection. We hypothesized that MRI may be of significant benefit in the management of a child with suspected septic arthritis/osteomyelitis. The aim of our study is to find if pre operative MRI is required for optimizing the treatment decision and to counsel the parents better regarding the prognosis of the disease.

## METHODS

After the approval of the Institutional Ethics Committee, we performed a prospective study between April 2014 to June 2019 for all children clinically diagnosed to have acute bone and joint infections in Sri Ramachandra institute of higher education and research, Porur, Chennai. All patients underwent emergency appendicular musculoskeletal MRI examinations for any suspected bone and joint infection. Exclusion criteria included patients above the age of 18 years, involvement of small joints of hand and feet, spinal infections and any previous intervention at the site of suspected infection. Children with a history of underlying fracture or implantation were also excluded because the objective of this study was to evaluate acute haematogenous septic arthritis and osteomyelitis. All the MRI were done using a 1.5 T MRI scanner available in our institution

A total of 36 patients with symptoms suspected of acute bone and joint infection were studied of which 2 patients had bilateral involvement. Total of 38 joints screened. Simple statistical analysis to calculate percentage of incidence of septic arthritis alone and septic arthritis with concomitant acute osteomyelitis done and compared.

### Study

After obtaining consent from the parents, proformas were filled up. The proformas included the symptoms, duration of symptoms, previous treatment taken (including medications with the duration), details of lab investigations, radiologic findings (including ultrasound, MRI). MRI reports were interpreted as osteomyelitis if intramedullary low T1 signal intensity and (or) increased signal intensity on T2/ fluid sensitive sequences-findings that can be attributable to edema, hyperemia or exudate. MRI reports for septic arthritis were reported as joint effusion if in the supraphysiologic levels.

## RESULTS

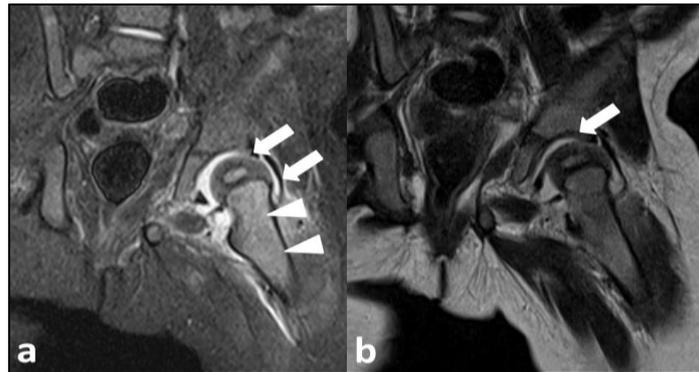
The total number of boys affected was 21 (58.33%) and girls 15 (41.66%). There were 18 (47.3%) cases involving

the right side, 16 (42.10%) cases involving the left side and 2 (5.26%) cases had bilateral involvement. The age distribution was between 14 days to 15 years (mean age-28.35 months). MRI reports had findings of only effusion (supra physiologic levels of fluid) in 22 patients (24 joints) and effusion with osteomyelitis (hypointense T1 signals and hyperintense T2/STIR in the adjacent epiphyseal-metaphyseal region) in 14 cases (Table 1). In our study 14 (36.84%) cases (Tables 1 and 2) had concomitant osteomyelitis with septic arthritis based on the pre-operative MRI. The duration between the onset of symptoms to surgery ranged between 1 day to 21 days, (mean 5.65 days). All the cases underwent arthrotomy with sampling of the synovial fluid and synovial tissue biopsy, followed by joint lavage. In the cases where concomitant osteomyelitis of the adjacent epiphysis/metaphysis were also noted on the MRI, in addition to the lavage 3-4 holes (using 1.8 mm Kirschner-wires) were made in the affected bone-metaphyseal region. Even though there are controversies that the small holes may be insufficient to address the osteomyelitis-may become clogged- we felt that it may be safer than a larger window, which increases the risk of pathological fracture. All the cases were closed in layers with a suction drain, which was monitored and removed post operatively. In all 14 cases with concomitant osteomyelitis there was serous (6 cases)/ sero purulent (8 cases) discharge from the osteomyelitis decompression site. Swabs were taken from the decompression sites. Among the 14 cases 9 (64.28%) had growth of organisms. The same organisms grew from the synovial fluid/tissue as well as the swab taken from the fluid, which came out of the holes made in the bone in all the 9 cases. In 5 cases the cultures were negative for growth, both in synovial tissue as well as in the swab taken from the fluid that came out from the metaphyseal drill sites. This was probably due to the injudicious use of oral antibiotics by the physicians who had seen the patient before they presented to us. *Staphylococcus aureus* grew in 5 (55.55%) cases, Coagulase negative *Staphylococcus* (CONS) in 2 (22.22%) cases, *Escherichia coli* in 1 (11.11%) case and *Klebsiella pneumoniae* in 1 (11.11%) case (Table 3). Histopathology reports of the tissue and the cytology of the fluid from the metaphysis holes showed acute inflammatory cells with predominant neutrophils suggestive of septic arthritis /osteomyelitis. This definitely correlated with preoperative diagnosis of septic arthritis with concomitant osteomyelitis. Sensitivity of the MRI in diagnosing coexisting infections is 100% but specificity may be slightly less. A normal MRI definitely excludes osteomyelitis. Based on the above findings, the cases with concomitant osteomyelitis in addition to septic arthritis were treated with parenteral antibiotics for a longer duration (4 weeks) than septic arthritis (2 weeks) cases as per the paediatric infectious diseases consultant's advice. Culture negative cases treated with empirical antibiotics as decided by the paediatric infectious disease's consultant.

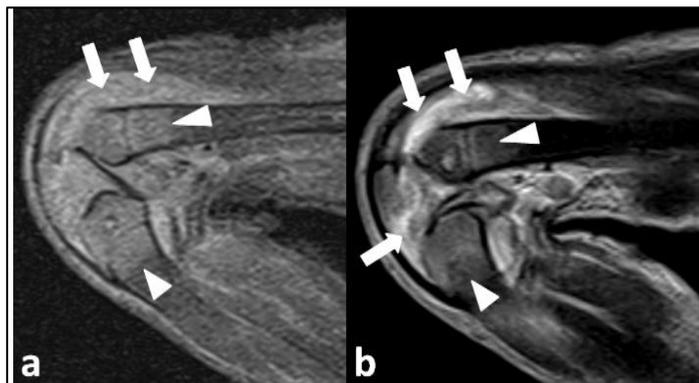
The symptom-surgery interval for the 14 cases of septic arthritis with concomitant osteomyelitis ranged from 1 day to 21 days (mean 5.92 days), which was higher than the

mean duration for all cases combined (septic arthritis and septic arthritis with osteomyelitis). Most of the children (71.42%, 10 cases) affected were less than 2 years of age of which 4 (28.75%) were neonates, 2 (14.28%) were infants, 4 (28.75%) were between the age of 1 to 2 years. Two children were between 2 to 7 years of age and two were between 7 and 15 years of age (Table 4). The osteomyelitis was noted in the proximal femur in the case of hip joint (Figure 1), distal femur and proximal tibia in the case of the knee joint (Figure 2), proximal humerus in

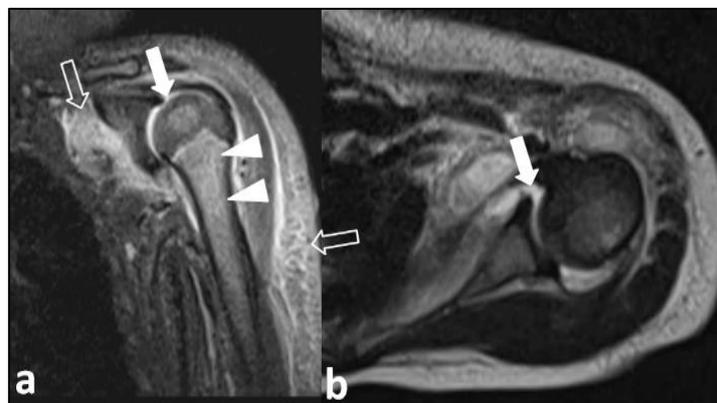
the case of the shoulder joint (Figure 3) and proximal radius/ ulna and distal humerus in the case of elbow joint (Figure 4). The involvement of the knee joint with osteomyelitis of distal femur and proximal tibia were seen in 5 (35.71%) of 14 cases. Elbow joint with involvement of radius/ulna, and distal humeral epiphysis/metaphysis were seen in 3 (21.42%) cases. Involvement of proximal femur especially in the femoral neck region were seen in 4 cases of the hip joint (28.57%) and 2 (14.28%) cases in shoulder joint with involvement of the proximal humerus.



**Figure 1 (A and B): Coronal short tau inversion recovery (STIR) and T2W and effusion in left hip (arrows) and marrow edema in left proximal femur (arrow heads).**



**Figure 2 (A and B): Sagittal STIR and T2W and synovial thickening -effusion in the left knee (arrows) and marrow edema in left distal femur and proximal tibia (arrow heads).**



**Figure 3 (A and B): Coronal STIR and axial T2W and showing effusion in the left shoulder joint (arrows) and marrow edema in left proximal humerus (arrow heads). Edema seen in the periarticular soft tissues (open arrows).**



**Figure 4: Plain radiograph of the elbow showing widening of the humerus with a lytic lesion in the distal metaphysis (arrow). Coronal STIR and sagittal STIR and synovial thickening-effusion in elbow joint (broken arrows), marrow edema in the distal humerus, proximal radius and ulna (arrow heads). Diffuse periosteal thickening seen in the humerus (open arrows).**

**Table 1: MRI findings.**

MRI findings	No. of patients	Hip	Knee	Elbow	Shoulder
<b>Osteomyelitis+ septic arthritis</b>	14	4 femur neck- 4	5 distal femur + proximal tibia-5	3 distal humerus- proximal radius+ ulna-3	2 proximal humerus-2

**Table 2: Bone involved.**

Bone involved	No. of cases	Age (range) (years)	Age (mean) (years)
<b>Distal femur+proximal tibia</b>	5	21 days-8	2.42
<b>Femoral neck</b>	4	14 days-15	5.23
<b>Distal humerus/ proximal radius/ ulna</b>	3	1-1.5 (18 months)	1.33
<b>Proximal humerus</b>	2	23 days- 3.5	1.78

## DISCUSSION

In our study, emergency appendicular MRI was made mandatory in all suspected bone and joint infection among the paediatric age group. Most of the MRIs in younger children were done under sedation (Triclofos, pheniramine) in consultation with the paediatricians. A few MRIs were done under anaesthesia and the child was directly shifted to operation theatre with the provisional report of the MRI. Surgery was done under the same anaesthesia.

The incidences of septic arthritis with concomitant osteomyelitis in various studies were between 17-33%.<sup>14-22</sup> The incidence of osteomyelitis with septic arthritis was 14 cases (36.84%) among the 38 joints that were studied. The current paediatric septic arthritis diagnostic criteria for hip joint (Kocher’s criteria) do not include routine MRI. The ACR (American college of radiology) advocates the use of ultrasound in a limping child with suspected underlying infection.<sup>23</sup> However the ultrasound can detect, quantify effusion in a joint and can also detect abscess underneath the periosteum, which occurs quite late in the pathogenesis of osteomyelitis. Our study suggests MRI should be preferably done compared to an ultrasound in a safe and timely fashion. The previous study by Montgomery et al found an incidence of 21.5% of

concomitant osteomyelitis in septic arthritis among 200 cases studied retrospectively.<sup>4</sup> Montgomery et al found that 72% of their shoulder cases had concurrent osteomyelitis.<sup>4</sup> In our study we had maximum incidences of concomitant septic arthritis and osteomyelitis involving the knee joint based on the pre operative MRI. In another study by Perlman et al reported the incidence of osteomyelitis associated with septic arthritis as 33%.<sup>24</sup> It was a study that was done with 66 children who were divided into two groups. One group was cases of osteomyelitis with no involvement of adjacent joint. The second group consisted of cases of osteomyelitis with adjacent joint involvement. There was however no clear data on the number patients who underwent MRI. Another study by Monsalve et al published a retrospective study on septic arthritis with consistent osteomyelitis, but there is no clarity about the timing of MRI or change in the treatment plan in cases of septic arthritis associated with osteomyelitis.<sup>25</sup> The sensitivity and specificity of MRI done pre operatively was 38% and 95% respectively by a study done by Schlung et al but the drawbacks were that it was studied only with respect to infections of the hip. It was a retrospective study which introduces the possibility of missing or in-accurate data.<sup>26</sup> In 2014 Gottschalk et al did a retrospective study about the analysis of pelvic and hip MRI versus emergency hip aspiration for suspected hip sepsis, they concluded that reoperation was 2.8 times more

likely to be required in patients who did not have early advanced imaging as compared with patients who received early advanced imaging. The drawbacks were that it was a study done for hip infections alone and no proper data about the sensitivity was discussed.<sup>27</sup>

There is a potential for delay in the emergency procedure of arthrotomy if pre operative MRI is performed for all cases of suspected infection.

The clinical significance of this is however not known. We also believe that MRI prevents neglecting or missing a co-existing osteomyelitis or a periarticular abscess that could require a return to the operating room. The significance in the cartilage injury related to the delay in the surgical treatment (while taking MRI) is far lesser than subjecting the neonate/infant/child for another surgery or worse under treatment. The 10 (71.42%) out of the 14 cases of concomitant osteomyelitis with septic arthritis in our series were found in patients less than 2 years of age. In infants and particularly neonates, septic arthritis is more likely to occur secondary to adjacent spread of osteomyelitis especially in joints having an intra articular metaphysis e.g., shoulder, elbow and hip.

The sequelae of un treated or under treated osteomyelitis is far more devastating for the child than a few hours spent in the MRI room before surgery, The other drawback we had to encounter in slightly older children >2 years was the need for sedation/ anaesthesia due to lack of co-operation and fear. Stress reaction/ reactive osteitis have been misinterpreted as osteomyelitis on MRI images. However, this bias is limited when clinical features and laboratory findings are correlated and a re-review of the imaging diagnosis is done.

Though short term and midterm follow up of the cases are available, the weakness of our study is that we do not know whether a change in surgical strategy or antibiotic protocol based on the MRI findings has affected the long-term outcome of all the patients. But MRI is now easily available in most centers and at reasonable costs. It also entails no risk of unnecessary radiation. In our institution performing an MRI in a child delayed the surgical procedure by only an average of 6 hours. There is evidence from various animal studies that visible chondral damage can occur in septic arthritis as early as 24 hours, however irreparable damage usually takes place in 3-4 days.<sup>28-30</sup> There is an option of treating all cases of septic arthritis as septic arthritis with co-existing osteomyelitis and follow the treatment regimen as done for septic arthritis associated with osteomyelitis. But the need for prolonged parenteral antibiotics for a period of at least 2 weeks, its financial implications in terms of prolonged hospitalization (OPAT's-Out patient parenteral antibiotic therapy are relatively less common in India) and the cost of procuring the drugs. Secondly the side effects of the prolonged use of antibiotics in unwarranted situations are also to be kept in mind.

## CONCLUSION

When all cases of suspected septic arthritis undergo MRI, coexisting osteomyelitis is frequently present in all age groups, especially <2 years. Important advantages of MRI are its ability to detect early changes in septic arthritis/osteomyelitis, depict the true extent of the disease, evaluate the extraosseous spread of infection and help in planning the surgical management. Our study concludes that MRI should be included in the work up for suspected bone and joint infections provided MRI is done in a timely fashion without unnecessarily delaying surgical intervention if needed.

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