Original Article

Factors affecting the outcome of Chronic Osteomyelitis in Children

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Abstract

Background: Treatment of Chronic Osteomyelitis in children results in varied outcome ranging from uneventful bone healing to gap non-union. We evaluated the factors associated with adverse outcome after a uniform treatment executed at a single centre.

Methods: 40 patients (1.5 -14 years) with Chronic Osteomyelitis managed with debridement & splintage were included in this study. Detailed history, laboratory investigations, local X-rays and MRI were available for all the patients. Average follow up was of 2.5 years. Patients who had complete healing of the bone after primary treatment were defined as 'Good Outcome', patients who required additional procedures to improve function of limb or morphology of bone were defined as 'Fair Outcome' and when treatment resulted in a gap non-union, it was defined as "Poor Outcome.

Results: Delay in surgical intervention beyond 6 weeks after the onset of symptoms, multiple local debridement without pan-medullary decompression and presence of concomitant soft tissue abscess on MRI were the statistically significant factors associated with poor outcome.

Conclusion: Aggressive and early surgical debridement is suggested for patients with failed conservative treatment to avoid long term complications. The current study will help in identifying the patients who are likely to have long-term sequelae of chronic osteomyelitis.

Keywords: Chronic Osteomyelitis; Pan-osseous; Non-union; Debridement; Outcome.

Level of Evidence: IV, retrospective analytical study.

Introduction

Chronic osteomyelitis results from inadequate or delayed treatment of acute osteomyelitis in children [1, 2]. Treatment of chronic osteomyelitis is challenging. Outcome of the treatment can range from an uneventful restoration of bony architecture after primary surgical intervention to a gap non-union [3, 4]. Gap non-union is a major complication of chronic osteomyelitis which warrants a series of surgical interventions to regain the normal osseous anatomy [5].

It becomes difficult for the treating surgeon to predict the outcome in these patients at the time of their presentation. We retrospectively evaluated 40 consecutive patients of chronic osteomyelitis of long bones in children

treated with a uniform protocol at a single centre. The purpose of the study was to identify the factors associated with poor outcome; which in turn can help the treating surgeon to forecast the possible course and length of the treatment.

Material & Methods

Forty patients were diagnosed to have chronic osteomyelitis and received treatment at our centre between 2006 and 2012. These patients had acute hematogenous osteomyelitis as their primary diagnosis. We excluded patients with chronic osteomyelitis secondary to open fractures and post-operative infections from this study. Out of forty patients, twenty-seven were male & thirteen were female. Average age of patients was 8 years (1.5 -14 years). Sixteen patients had involvement of tibia, 10 had femur, 6 had humerus and 4 had affection of radius or fibula. Detailed history about the onset and duration of symptoms, its duration and previous surgical interventions were obtained. History of any associated illness was noted. Local X-rays and MRI were carried out for all the patients. MRI involved the standard T1, T2 and Fat suppressed images. Blood investigations & bacterial culture of the pus or tissue were sent.

Patients were treated with local or pan-osseous debridement and splintage. Decisions about the extent of the debridement were made from the MRI images. Patients who presented with pathological fracture or gap non-union were additionally stabilized with an external fixator and/or intra-medullary nail. Patients received parenteral antibiotics empirically or according to the culture reports for 5-7 days & oral antibiotics for a further 6 weeks. All the patients were followed up for an average of 2.5 years (1.5 to 7 years). Outcomes after the prescribed treatment protocol were classified in to three groups (Table 1). Those patients who achieved normal bony architecture without any surgical intervention or a single surgical intervention were defined as 'Good Outcome'. Patients who restored normal osseous anatomy with a single surgery but required further intervention to improve range of motion or to improve bone morphology were defined as 'Fair Outcome'. These interventions included soft tissue releases to improve motion, sinus tract excisions or late sequestrum removal. Thus, this group of patients required re-hospitalization after primary surgery. Patients who had gap non-union and required a series of further surgical interventions to restore the bony anatomy were termed as 'Poor Outcome'.

Table: 1 Outcome Definitions

Outcome	Definition	Intervention involved
Good	None or single surgical intervention to restore bony architect	• Antibiotics & Observation. • Local or Pan-osseous debridement & splintage.
Fair	Further intervention required to improve range of motion or bone morphology	• Soft tissue releases • Sinus tract excisions • Sequestrectomy
Poor	Gap non-union	• Staged debridement & local bone grafting with additional stabilization • Bone transport by using distraction osteogenesis through Illizarov apparatus.

Table: 2 Possible Factors associated with adverse outcomes

No.	Factors	p-value
1	Age of the Patient	0.937
2	Site of Affection	0.794
3	Type of Antibiotics §	0.179
4	Type of Causative Organism @	-----
5	Immune status of the patient	0.815
6	Presence or absence of soft tissue abscess on MRI	0.002
7	No. of previous local surgeries	0.006
8	Symptomatic days before first intervention *	0.04

§ Comparison was made between Cloxacillin / Cephalosporins and Linezolid/ Vancomycin. @ comparison could not be done due to small number of patients affected by Methicillin Resistant Staphylococcus Aureus (MRSA)[5-MRSA, 33- MSSA (Methicillin Sensitive Staphylococcus Aureus), 2-Gram negative bacilli]. * Good & Fair outcome were combined.

Factors which were studied for their possible association with adverse outcome are listed in Table 2. Statistical analysis was performed with the Chi-Square test and Kruskal-Wallis Test to ascertain the level of significance at 95% confidence limit.

Results

Out of 40 patients; eighteen patients (45%) had good outcome, ten patients (25%) had fair outcome & twelve patients (30%) had poor outcome (Figure 1, 2 & 3). We did not find statistically significant difference in the

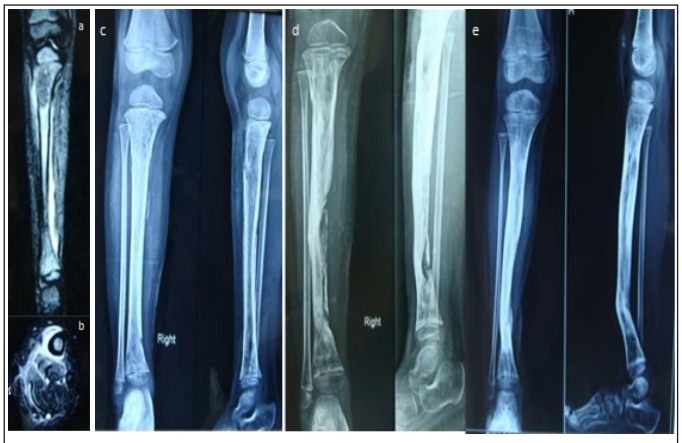

Figure 2: **2a & 2b.** A 4-year-old boy presented with swelling & pain along the Right leg for 3 weeks. Preoperative MRI images were suggestive of subperiosteal abscess along the medial cortex of distal meta-diaphysis. **2c.** Abscess was drained and medullary canal was decompressed. **2d.** At one year follow up, child presented with a pus discharging sinus with underlying sequestrum. Sequestrectomy was done and patient was splinted with plaster. **2e.** At 2.5 years follow up, the disease healed completely with mild procurvatum deformity at distal third tibia. This case is categorised as 'Fair Outcome'.

Figure 3a, 3b & 3c: A 12-year-old boy presented with discharging sinus and pathological fracture of the left proximal humerus. X-ray revealed sequestrum within the proximal humerus. MRI shows associated soft tissue abscess along the proximal metaphysis. **3d.** He was treated with pan-osseous decompression and fixation with intra-medullary nail and external fixator. **3e.** Patient developed a gap non-union. **3f.** Patient required three further interventions to achieve union. An example of "Poor Outcome".

occurrence of poor outcome with regard to the age of the patient, site of infection, type of antibiotics used, or the type of causative organism. Amongst the poor outcome group; five had affection of tibia, three had humerus and one each had involvement of the femur and radius. Thirty-three patients had MSSA (Methicillin Sensitive Staph. Aureus) as the causative organism, five patients had MRSA (Methicillin Resistant Staph. Aureus) and two patients had Gram Negative Bacilli. The immune status was compromised in five patients due to a pre-existing illness such as aplastic anaemia, splenectomy or systemic multifocal infections. All but one patient had a good outcome.

Seventy-five percentage of patients in the poor outcome group were found to have a circumferential soft tissue abscess around the periosteum on axial and coronal MRI images. Amongst the good outcome group, this occurrence was only 20%. There was statistically significant difference in the presence of soft tissue abscess in different outcome groups. (Figures 3)

Symptomatic duration before first surgical intervention were an average of 4 and 4.5 weeks amongst the good & fair outcome groups respectively. In poor outcome group this duration was up to 6.5 weeks. We found that as the duration of symptomatic days increased in line with the incidence of poor outcome. All but one patient had good or fair outcome when the first surgical intervention was done within four weeks from the onset of the symptoms.

Twelve patients in the poor outcome group underwent 19 surgeries before approaching us. These interventions were local abscess drainage or local metaphyseal debridement without pan-osseous decompression. The good outcome group comprising 18 patients, there were only five surgeries prior to presentation.

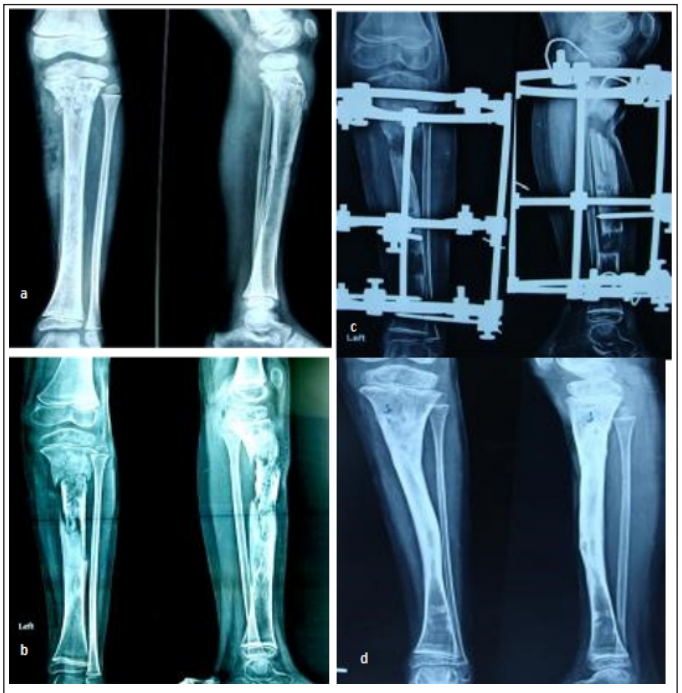

Figure 4: 4a. An 8-year-old boy presented with pain & swelling along the Left leg for 2 weeks. It was treated by drainage of abscess. **4b.** Patient presented to us with a proximal diaphyseal sequestrum formation. **4c.** Patient was treated by staged debridement, sequestrectomy, distal corticotomy & bone transport through Ilizarov apparatus. **4d.** Restoration of normal bony anatomy at 2.5 years follow up after five surgical interventions. This patient was categorised as 'Poor Outcome'.

Discussion

Adverse outcomes in patients with chronic osteomyelitis are associated with multiple factors. Delay in presentation and improper or incomplete treatment are the most common factors that lead to poor outcome in these children [1, 2, 3]. To the best of our knowledge, this is the first study which has attempted to quantify these factors.

The primary focus of acute hematogenous osteomyelitis is in the metaphysis. If untreated, intramedullary pressure increases and the exudate spreads through the thin metaphyseal cortex resulting in a subperiosteal abscess. A subperiosteal abscess may expand and elevate the periosteum along the diaphysis. Loss of osseous blood supply (from the increase in intra-medullary pressure and the loss of periosteal blood supply) can lead to bone necrosis. Delay in surgical decompression leads to higher chances of conversion to a metaphyseal or pan-osseous disease. This also leads to higher incidence of diaphyseal sequestrum formation [4]. Early intervention can halt the disease in the acute phase and limit it to only the metaphysis [5, 6]. In our series, all the patients but one with good outcome underwent surgical decompression before 4 weeks of onset of symptoms (Figure 1). Statistically, when more than 5.5 weeks had elapsed before operative intervention; it led to poor outcome.

MRI has been used extensively for the diagnosis of osteomyelitis. In chronic osteomyelitis, it provides important clues about the extent of marrow involvement [7]. We used this finding to judge the extent of our debridement. For patients with pan-osseous disease; it is important to undertake intra-medullary decompression. We routinely used paediatric forearm reamers for this purpose. For younger children, where it is difficult to negotiate the reamers; we used flexible Gigli saw wires. Multiple local debridement without assessment and treatment of pan-osseous disease leads to persistence of disease. It also affects local periosteal health. Devitalized periosteum fails to form strong involucrum and results in a gap non-union (Figure 4). In our study, we found that patients with Poor outcome had multiple local metaphyseal debridement without proper decompression of entire medullary canal. All the patients in this group demonstrated co-existing diaphyseal or far metaphyseal marrow edema on MRI, suggestive of untreated pan-osseous disease.

Subperiosteal abscess can trickle in to the surrounding soft tissue, if it is not drained in time [2, 3]. Axial and coronal MRI images provide clues about the circumferential and longitudinal size of the abscess respectively [10]. Periosteum receives its blood supply from intrinsic & extrinsic system of vessels. The intrinsic system is blocked

by local septic thrombus in chronic osteomyelitis. The extrinsic system consists of musculo-periosteal & fascio-periosteal blood vessels [11]. Soft tissue abscess beyond subperiosteal collection leads to occlusion of these vessels. As a result the periosteum is unable to regenerate an involucrum and the underlying area is predisposed to local bone loss. These anatomic facts are reinforced in our study where we found an increased occurrence of gap non-union (Poor Outcome) in patients who had a soft tissue abscess on MRI.

Belthur et. al. has found a significantly greater prevalence of subperiosteal abscess and greater circumferential size of such an abscess in the patients with a pathological fracture [12]. They also have reported a sharp zone of abnormally diminished enhancement of the marrow at the site of pathological fracture on Gadolinium-enhanced fat-suppressed T1-weighted images. We concur with their findings. Seven patients sustained spontaneous fracture in our series. Four patients who did not have active infection, were treated with plaster splints and healed uneventfully. Rest of the patients required debridement and fixation with an external fixator.

One of the limitations of the study is that we have partly relied on the history given by the patients and the physician involved in primary treatment. At 2.5 years average follow up, some patients included in the study are still under treatment for chronic sinus formation and sequestrum removal. These patients with fair outcome may require further surgical interventions at follow up.

Conclusion

It is not uncommon to see delay in the treatment of acute osteomyelitis leading to chronic osteomyelitis and its sequalae in developing countries. The treating surgeon may be in a dilemma regarding the outcome of the intervention done. This study will help in predicting the possible outcome in these patients based on the clinical history and MRI findings. We recommend an MRI of the affected part before starting treatment. Patients with chronic osteomyelitis who have symptoms in excess of 5.5 weeks before first surgical intervention, multiple local debridement without pan-osseous decompression and presence of soft tissue abscess on MRI are the significant risk factors associated with gap non-union.

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