



Haematogenous pyogenic bone and joint sepsis – reducing avoidable morbidity

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Background and objectives. Delayed presentation of haematogenous bone and joint sepsis is common in our childhood population and leads to a large burden of avoidable morbidity extending into adult life. We set out to determine causative factors in these delays.

Design. A prospective study was undertaken over a 1-year period.

Setting. Ngwelezane Hospital, a regional hospital in Kwa-Zulu-Natal serving 9 rural district hospitals.

Subjects. Children under 15 years with their first presentation of bone and joint sepsis, comprising 80 consecutive cases. Tuberculosis cases were excluded.

Outcome measures. Children were categorised at follow-up into two groups. The first group had uncomplicated recoveries, with complete return of function and no clinical or radiological signs of unresorbed sequestra. The second group had complications, with evidence of one or more of the following:

chronicity of infection, pathological fracture, deformity, growth plate disturbance, avascular necrosis or joint stiffness.

Results. Delay in obtaining definitive treatment correlated strongly with initial misdiagnosis. Only 4/25 septic hips were correctly diagnosed and referred expediently; 19/50 osteomyelitis cases were initially misdiagnosed and treated as cellulitis, and a further 19/50 were misdiagnosed as trauma. Predictably, delayed treatment correlated strongly with a complicated outcome. No significant associations were found between delays and distance to nearest primary health care facility, relative levels of socio-economic deprivation within the study group, maternal educational attainment, or traditional healer consultation.

Conclusion. Health care professionals at all levels should be alerted to the continued high incidence of this disease. We propose some 'red flags' to assist primary health care workers in the diagnosis of this condition.

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The incidence of haematogenous pyogenic bone and joint sepsis in our population is estimated to be 1:4 000 per year in the under-15 age group (calculated from the number of cases in this study and the number of children in the hospital catchment population as recorded in the South African Census 2001).¹ This is a high incidence when compared with current European and North American populations.²⁻⁶ As such, it is a disease that receives diminishing attention in the Western medical literature.

The pathological anatomy of these conditions dictates that delay in treatment affects outcome adversely. Complications of advanced osteomyelitis include the formation of sequestra (Fig. 1), pathological fractures and deformity, growth plate disturbances and bony defects. In the pre-antibiotic era osteomyelitis was often a fatal condition.⁷

Hip joint sepsis causes particular problems of diagnosis and can frequently lead to devastating sequelae. Previous published series have demonstrated that avascular necrosis complicates

those cases in which there is a significant delay from the onset of symptoms to effective treatment. Morrey *et al.*⁸ found no unsatisfactory results if treatment was instituted less than 4 days after symptom onset. In a review of 148 septic hips in South Africa, Hastings⁹ found that all those with avascular necrosis of the femoral head had a history of more than 5 days. Additionally, duration from onset to arthrotomy was the only risk factor for avascular complications.

The goals of this study were to determine the causative factors for significant delay in cases that were late receiving treatment. Our initial presuppositions were that socio-economic problems, access to health care facilities, and prior visits to traditional healers played an important role in delay.

Methods

Over a 12-month period (September 2004 - August 2005) 80 consecutive children with bone and joint sepsis were studied. Inclusion criteria were children under the age of 15 years who presented for the first time with haematogenous pyogenic bone and joint sepsis. Data were collected from accompanying adults regarding the presenting complaint and the onset of symptoms. Particular attention was given to any prior visits to health care facilities, including the government, private and traditional sectors. For purposes of socio-economic evaluation, data were collected on total household numbers, number of employed members of the household, and the

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Fig. 1. Radiograph showing a large sequestrum in a child's tibia.

presence of piped tap water within the dwelling. The presence of tap water in the dwelling was found to be a useful discriminator of rural South African deprivation,¹⁰ and this was combined with the data on employment and fiscal dependency to categorise those relatively 'deprived' and 'non-deprived'. Those in our study deemed 'deprived' did not have tap water in the dwelling and had a ratio of employed persons to fiscal dependants of less than 1:7. Data on distance to the local primary health care facility and maternal educational attainment (highest standard achieved at school) were also collected. Bacteriological and radiological data were recorded as well as intraoperative findings.

All patients with joint sepsis had an arthrotomy to decompress and drain the joint, as well as to obtain a synovial specimen for histological assessment in order to exclude mycobacterial infection. All arthrotomies and incision and drainage procedures were performed at our centre. During the course of this series 3 mycobacterial joint infections were drained as an emergency and were excluded after histological confirmation. All subperiosteal abscesses were drained. An estimate of the length and percentage of circumferential periosteal stripping of the affected long bone

was made by the operating surgeon feeling with a finger around the exposed, denuded bone. Very early cases of osteomyelitis were either managed medically or explored and drilled to obtain a microbiological specimen from the infected marrow. A standardised antibiotic regimen was followed. This comprised intravenous cloxacillin (200 mg/kg/24 hours) until toxicity settled, followed by oral flucloxacillin for 1 month (100 mg/kg/24 hours). A second anti-staphylococcal agent (oral erythromycin) was also given while the child was in hospital. Children under the age of 2 received a 3rd-generation cephalosporin (intravenous cefotaxime) in place of the second anti-staphylococcal agent, until bacteriological sensitivity results were available.

Patients were followed up at a dedicated bone and joint sepsis clinic, with monthly clinical and radiographic assessments. The minimum follow-up period was 3 months. Outcomes were categorised into two groups. Those who made full recovery with no signs of sequestra or chronicity of infection either clinically or radiologically were defined as 'uncomplicated'. The others were categorised as 'complicated' outcomes.

To determine possible factors influencing delays we compared maternal educational attainment, distance to the local clinic, relative deprivation within the group, initial misdiagnosis and whether a traditional healer was consulted with the time delay to receiving adequate treatment. The Mann-Whitney U-test was used to assess differences in time delay (between symptom onset and adequate treatment) with poor outcome, initial misdiagnosis, prior consultation with a traditional healer and socio-economic deprivation. Spearman's test was used to assess the associations between time delay and mother's educational attainment and distance to the primary health care facility. The relationship between the presence of complete circumferential periosteal stripping of a long bone and subsequent complicated outcome was determined using Fisher's exact test (Analyze-it for Microsoft Excel).

Results

Overview

Of the 80 cases, 54 (68%) were male. There was an even age distribution, the median being 7 years. Fifty-eight per cent of all cases reported a history of trauma, and 28% had received traditional medicines before hospital attendance.

Most pathology was found in and around the large joints of the lower limbs. Hip sepsis accounted for 25 cases (31%). Two of these patients had bilateral hip joint sepsis. Knee sepsis and osteomyelitis of the distal femur or proximal tibia comprised a further 35 cases (44%). There were 9 cases of multi-focal bone and joint sepsis. Of the 17 cases of tibial osteomyelitis, 4 were pan-tibial, involving the whole length of the shaft. Other sites



of sepsis included the shoulder and humerus, forearm, tarsal bones, calcaneus, ilium and fibula.

Review of the microbiological culture analysis of all specimens revealed the dominance of *Staphylococcus aureus* (92%). We found the community-acquired *Staphylococcus* organisms to be mostly penicillin-resistant but sensitive to cloxacillin and erythromycin. Other organisms were mainly confined to the under-2 age group and included *Klebsiella* species, *Salmonella* and *Streptococcus pneumoniae*. In 38% of cases no organism was cultured, probably reflecting the widespread prior use of antibiotics. Blood cultures were positive in 22% of cases and reflected the same organism as the pus culture specimen. Blood cultures were positive in 4 cases where pus specimens were negative, demonstrating the value of this investigation. The extent of the delays to adequate treatment is illustrated in Fig. 2. Of the hip sepsis children, only 4/25 received arthrotomy within the desired 5-day period from symptom onset. Of the children with osteomyelitis, only 20/50 were adequately treated within 7 days of symptom onset.

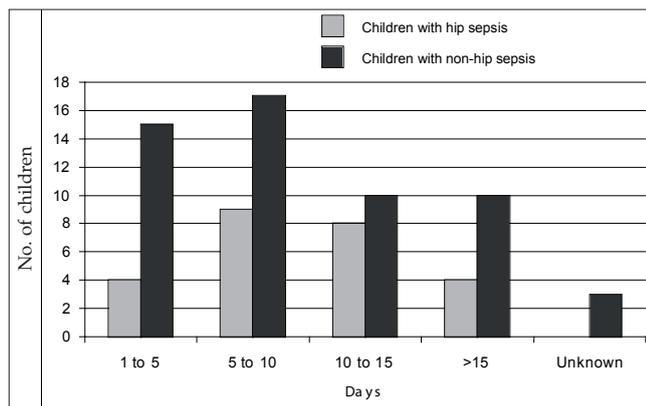


Fig. 2. Delays to surgical treatment.

With regard to bony pathological anatomy, 18% of long-bone osteomyelitis cases were early and confined to the medullary cavity. These were confirmed by bone drilling and culture of organisms from the septic marrow or managed non-operatively on intravenous antibiotics alone. However, 24% of the long-bone osteomyelitis cases were very advanced, with circumferential periosteal stripping.

Outcome

Eight of the 80 cases were lost to follow-up. Of the remaining 72 cases available for long-term follow-up, 29 (40%) were complicated. Approximately half of this complicated group were hip sepsis cases, with 14 of 24 cases (58%) followed up having a complicated outcome. Of the remaining 48 non-hip cases, 15 (31%) had complications.

There was 1 death in the study group. This was a 4-year-old boy who was comatose at presentation, with bilateral hip sepsis and a severe staphylococcal pneumonia. He died of overwhelming sepsis on day 4 in the ICU after drainage

of both hips. Ultrasound was used routinely in all the suspected hip sepsis cases; in this child ultrasound confirmed a subcapsular collection in the index right hip but also a collection in the clinically unsuspected left side. Overall ultrasound as performed by the authors and one radiographer was a very helpful adjunct to clinical evaluation, although we did experience 2 false-negative scans. One of these resulted in a delay to arthrotomy of 48 hours in a child who had a synchronous iliopsoas collection, which was drained immediately on presentation.

Of the hip sepsis group, 5 children developed gross avascular necrosis of the femoral head as demonstrated in Fig. 3. A further 6 had joint stiffness and irregularity either on the acetabular or femoral side of the joint. Three had coxa vara owing to a combination of slipped epiphysis and femoral neck fracture, which malunited in varus. It was apparent that many of the hip sepsis patients were being misdiagnosed and treated inappropriately. Of the 25 cases only 4 were referred timeously (less than 48 hours). Two had non-surgical treatment for a number of weeks and a wide variety of initial erroneous diagnoses were made (Table I).

Of the 43 osteomyelitis children available for follow-up, 8 had unresorbed sequestra and chronicity of infection that required surgical intervention. There were 10 patients with pathological fractures and of these, 3 had significant deformities requiring surgery. Two had physeal damage. A number of patients had multiple complications. In the osteomyelitis group, we found that initial misdiagnosis was commonplace; 19/50 cases were initially diagnosed as trauma and 19/50 were initially diagnosed as cellulitis, being treated with short courses of oral antibiotics.

These misdiagnoses were made by primary health care workers at all levels, including primary health care nurses in clinics, doctors in government hospitals and general practitioners in private practice. As expected, significant differences in time delay were found between those who had complications and those who had no complications (median 14 days v. 5 days, $p < 0.001$).

Significant differences in time delay were found between those who had initially been misdiagnosed and those who were correctly diagnosed (median 12 days v. 4 days, $p < 0.001$). There were no statistical differences in time delay to surgery either between those deemed deprived and not deprived (median 10 days v. 8 days, $p = 0.25$), or between those who consulted a traditional healer and those who did not (median 9 days v. 7 days, $p = 0.13$). No significant associations were found between time delay and mother's educational attainment ($\rho = -0.065$, $p = 0.71$) or distance to the primary health care facility ($\rho = -0.17$, $p = 0.232$).

Among those with long-bone osteomyelitis, a very strong association was found between circumferential periosteal stripping and complicated outcome ($p < 0.001$).



Fig. 3. Radiograph showing complete avascular necrosis of the left hip (10 months after hip sepsis). This child underwent surgery 3 weeks after the reported onset of symptoms to relocate and drain a septic dislocation.

Table I. Initial diagnoses in patients with hip sepsis

Initial diagnosis	Cases
Ileopsoas abscess	2
Acetabular fracture/hip dislocation	5
Appendicitis	1
Cellulitis	2
Diagnosis not ventured	2
Knee sepsis	2
Malaria	1
Rheumatic fever	1
Correct but treated non-surgically	5
Correct	4

Despite the aforementioned complications, a number of patients did have surprisingly good outcomes. Three of the hip sepsis children with long delays to adequate treatment (10, 10 and 12 days) made complete recoveries. Of note, these children had received courses of antibiotics before their referral. Of the osteomyelitis cases, a number of older children (over 5 years) resorbed significant sequestra. These tended to be in the smaller bones such as the metatarsal, radius and fibula.

Discussion

The male predominance of these conditions was also seen in other series,^{6,8,11} and preceding trauma was commonly reported, as in other series.^{2,8} Children at that active age do have regular

trauma. However the history of such 'trauma' must not be allowed to completely distract the clinician from making a diagnosis of sepsis. Against our presuppositions, only 28% of children received traditional medicines (as reported by accompanying adults).

Along with other published work, this study shows that complications following bone and joint infection arise from a delay in instituting appropriate and timely treatment.^{2,8,9,12,13} This is entirely consistent with the natural history of the disease. We found that initial misdiagnosis was the major factor delaying presentation and initiation of appropriate effective treatment. Through education, this is the one factor most amenable to change.¹² We propose some simple 'red flag' signs to alert health care workers and those in training to a correct diagnosis and prompt referral. These guidelines are intended to heighten awareness of bone and joint sepsis (Table II).

We recommend that any child presenting with acute hip pain be assessed further as a matter of urgency with the aim of first excluding sepsis. It is worth mentioning that a thorough examination of any septic child, particularly when the focus is unclear, must include an assessment of the hips. Furthermore, a neonate or infant presenting with hip sepsis may not display the classic signs even on passive movement but display 'pseudoparalysis' only.² A plain anteroposterior (AP) radiograph of the pelvis is valuable in cases of suspected childhood hip sepsis and often shows subluxation of the distended joint (Fig. 4). On an AP radiograph of the pelvis the distance between the proximal femur and ischium can easily be measured and compared.¹⁴

Ultrasound of the hip joint further defines the presence of an intra-articular collection and is well recognised for its diagnostic utility.¹⁵ It can also be used to assess hepatic and cardiac involvement in severe multi-focal sepsis cases. As with all ultrasound, assessment of the hip joint is operator-dependent and false-negatives will occur, as in our series. As such, we believe that diagnostic ultrasound should only supplement good clinical assessment.

Inflammatory markers and white cell count, as well as inpatient observation, are all useful in further assessment of those with equivocal, very early signs. If there is a high diagnostic suspicion then an arthrotomy can be performed to decompress the joint, obtain a specimen of pus and a synovial biopsy. In our centre, the preferred method of drainage is through an anterior skin crease approach, lateral to the femoral sheath. Negative arthrotomies do occasionally occur but the devastating complications of missed hip joint sepsis offsets the few unnecessary procedures.

Children with swelling, temperature and erythema of an extremity in our population should not be presumed to have cellulitis. This remains a 'diagnosis of the naïve'.⁷ In addition, significant acute swelling of an extremity irrespective of a



Table II. Five red flags to aid diagnosis of bone or joint sepsis. Children with any of these signs require emergency referral to a hospital capable of dealing surgically with bone and joint sepsis.

- Acute hip pain in a child
- Infant with loss of movement in a limb
- Acute limb pain in a febrile child
- Acute limb swelling in a febrile child
- Swollen limb with a normal radiograph



Fig. 4. Radiograph showing subluxation of a child's left hip due to a high-pressure collection distending the joint.

reported trauma episode should be investigated further. As a minimum, temperature and pulse must be taken. A 'negative' radiograph showing no fracture should in fact direct the doctor towards the diagnosis of infection. We re-emphasise the maxim that 'any child with spontaneous acute metaphyseal pain and tenderness has osteomyelitis until proven otherwise'.⁷ Urgent referral is recommended. In cases where diagnostic uncertainty persists, admission and close observation for 24 hours can be valuable. This is particularly the case where ready access to bone scan or other radiological facilities is limited.

Surgical drainage of an abscess cavity can be supplemented with assessment of the degree of subperiosteal stripping. As shown in this study, those with circumferential periosteal stripping of a long bone are likely to have a complicated course. Protection for possible pathological fracture and close follow-up are advised. After surgery, clinicians must remain observant for the recurrence of collections and the presence of other septic foci. This includes the heart, lung and liver as well as other bone and joint locations. One 13-year-old child in the study spent 2 months in ICU with multiorgan failure. He had 9 sites of bone and joint sepsis, including bilateral septic hips and a staphylococcal pneumonia. He was eventually discharged from hospital 3½ months after admission.

Our 58% complication rate for hip sepsis compares poorly with a series from Cape Town⁹ where a retrospective review of 186 hip sepsis cases found an 11% complication rate. In a large retrospective review from New Zealand, Gillespie and Mayo¹¹ found an overall complication rate for osteomyelitis of 20%, which is also better than our 31%. However, since prognosis is so dependent on the stage of disease presentation, outcome comparisons serve mainly as a proxy measure of presentation delay. For example, in a series from Namibia³ where the majority of osteomyelitis patients presented very late (by our definition), there was a far higher complication rate.

Conclusion

Childhood bone and joint sepsis will remain a relatively common orthopaedic problem in the foreseeable future in South Africa. Morbidity from these conditions is substantial and is related to misdiagnosis and a delay in effective treatment. The diagnosis is an important one to keep in mind when examining a child with a painful extremity or a painful joint. We propose 5 'red flags' to aid the primary health care worker in the diagnosis and treatment. Prompt referral of such cases should reduce the morbidity and complications of acute haematogenous bone and joint sepsis.

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