ACUTE HAEMATOGENOUS OSTEOMYELITIS

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Seventy-seven children admitted with a provisional diagnosis of acute osteomyelitis over a three year period have been reviewed. Acute haematogenous osteomyelitis was confirmed in 45 of these patients whose ages varied from three days to 14 years with a mean of 6.2 years. All patients were treated with intravenous fusidic acid and cloxacillin with splintage for three weeks followed by oral antibiotics for a further period of six weeks. Only seven patients required operation. One patient had recurrence of infection; all other patients were cured with no evidence of chronic osteomyelitis. It is suggested that surgical drainage of acute haematogenous osteomyelitis is seldom needed and that high intravenous doses of antibiotics in combination with splintage are adequate treatment in most cases.

Opinion is divided on the initial management of acute haematogenous osteomyelitis in children. The most widely held view is that early surgical exploration and drilling of the affected metaphysis should form part of the routine management of this condition (Trueta and Morgan 1954; Harris 1962; Merryweather 1972; Mullick 1972; Mollan and Piggot 1977). Reservations have been expressed about this form of initial treatment by others (Blockey and Watson 1970; Craven, Pugsley and Blowers 1970; Blockey and McAllister 1972; McAllister 1974).

This paper reports our experience with 77 patients who were admitted with a clinical diagnosis of acute haematogenous osteomyelitis. The start of treatment was based on clinical diagnosis only since failure or delay in treatment may have serious consequences. The results of further investigations and of treatment with a combination of fusidic acid and cloxacillin in high intravenous doses are reviewed.

Figures 1 and 2—Normal radiograph and a positive static bone scan of the tibia on admission. Figure 3—Positive radiographic changes have developed by the 12th day.

MATERIALS AND METHODS

Seventy-seven patients with a clinical diagnosis of acute haematogenous osteomyelitis were admitted between January 1977 and December 1979. After full clinical examination, a full blood count, estimation of the erythrocyte sedimentation rate (ESR), a blood culture and radiography of involved areas were carried out on all patients. Appropriate splints were then applied to the affected area and intravenous antibiotic treatment started using 100 milligrams of cloxacillin per kilogram per day in four divided doses and 30 milligrams
of fusidic acid per kilogram per day in three divided doses. These dose 
schedules maintain the serum levels of each antibiotic at about 20 
micrograms per millilitre. This level greatly exceeds the usual inhibitory 
concentrations for staphylococcal strains, which is 0.25 micrograms 
per millilitre for cloxacillin and 0.16 micrograms per millilitre for 
fusidic acid (Garrod, Lambert and O'Grady 1973).

Bone scans were performed later using technetium-99m methylene 
diphosphonate ($^{99mTc}$-MDP) in dynamic and static phases as outlined 
by Gilday, Paul and Paterson (1975). A scan of the affected area 
collecting 300,000 counts was obtained immediately after the intra-
venous injection of a bolus of $^{99mTc}$-MDP. The isotope is then 
contained within the intravascular space and this "bloodpool" image 
obtained reflects the regional blood distribution. In a case of 
osteomyelitis, a hot spot will be identified within the bony tissue while 
in a case of cellulitis or superficial soft-tissue infection the hot spot will 
be confined to these tissues.

A delayed static scan collecting 500,000 counts was obtained two 
hours after the injection and the images were reproduced on 
radiographic film. At this stage the tracer which has not localised to 
bone will have been excreted and better bone imaging is produced. 
Increased isotope deposition occurs in areas of osteomyelitis because 
of both the increased isotope delivery and the increased metabolism at 
the site. The hot spot at the osteomyelitic focus will extend towards the 
diaphysis (Figs 1 to 3).

Antibiotic therapy was started on admission and reviewed daily as 
the results of investigations became available. When the diagnosis of 
acute haematogenous osteomyelitis had been confirmed a long 
intravenous cannula was inserted under sedation. Progress was then 
monitored by clinical examination and serial estimation of the ESR. 
Intravenous treatment was continued for three weeks and this was 
followed by six weeks oral therapy.

In those patients in whom the clinical diagnosis of acute 
haematogenous osteomyelitis was not confirmed, treatment was stopped 
or altered as was appropriate.

RESULTS

Seventy-seven patients were admitted with the clinical 
diagnosis of acute osteomyelitis, but this diagnosis was 
not confirmed in 32 patients. Twenty-five of these 
patients were considered to be suffering from cellulitis, 
while three had an initially unsuspected injury and four 
others had unexplained limb pain with a pyrexia. None 
of these children had radiographic changes or scans 
suggestive of osteomyelitis and all had negative blood 
cultures. They all made an uneventful recovery and none 
showed any evidence of osteomyelitis on review at six 
months nor have they returned since with osteomyelitis.

Forty-five children (58 per cent of the total admitted), 
whose ages varied from three days to 14 years (mean age 
6.2 years) were confirmed to be suffering from acute 
haematogenous osteomyelitis. The sites of infection are 
shown in Table I. Except for one patient with osteomy-
elitis of a phalanx, all had a pyrexia of at least 38 degrees 
Celsius on admission. The ESR on admission varied 
from 15 to 135 millimetres in the first hour with a mean of 
52 millimetres (Fig. 4).

In 38 patients the signs of acute infection subsided in 
the 48 hours after the start of treatment. Six of these 
patients had visible radiological changes on admission 
while the other 32 patients had positive bone scans. 
Specific radiographic changes developed in three of these 
32 patients while they were in hospital and 13 had 

positive blood cultures. The remaining 16 patients had 
positive $^{99mTc}$-MDP bone scans, 12 of these having both 
positive blood pool and delayed bone images, while four 
had increased uptake on delayed bone scans only.

Operation was performed in six of the 38 patients 
because of clinical evidence of an abscess or failure to 
respond to treatment after two days. The average time 
from the onset of symptoms to presentation to hospital in 
this group was 30 hours (range 12 hours to 4 days), 
compared with an average delay of 38 hours in the group 
treated with antibiotics alone. For each patient the 
operation was decompression and drilling of the meta-
physis. Subperiosteal pus was found in all six cases, 
culture revealing Staphylococcus aureus in three, Haemo-
philus influenzae in two and Streptococcus pyogenes in one 

Table I. Sites of infection in 45 patients, one of whom had multiple lesions

| Distal tibia | 9 | Proximal humerus | 2 |
| Distal femur | 7 | Phalanx | 2 |
| Proximal tibia | 6 | Vertebra | 2 |
| Os calcis | 4 | Fibula | 2 |
| Distal humerus | 3 | Clavicle | 1 |
| Radius | 3 | Ilium | 1 |
| Proximal femur | 2 | Ribs (multifocal) | 1 |

Histogram of erythrocyte sedimentation rate (millimetres in 
the first hour) on admission in 45 cases of acute osteomyelitis.
**Staphylococcus aureus** was the most common infecting organism, being found in 83 per cent of positive blood cultures. Two of the three cases caused by *Haemophilus influenzae* required surgical decompression. When *Haemophilus influenzae* (three cases) and *Streptococcus pyogenes* (one case) were identified as the responsible organism ampicillin was added to the intravenous therapy.

**DISCUSSION**

The place of early surgical exploration and drilling in acute haematogenous osteomyelitis is still controversial, though it was first proposed by Platt in 1928 as a limb or life saving procedure in the era before antibiotics. The use of penicillin in treatment led in time to the infecting organism developing resistance. Blockey and McAllister (1972) reported resistance to penicillin in 67 per cent of their cases. There was a lack of confidence in treatment by antibiotics alone. Trueta and Morgan (1954) and Harris (1962) established the place of surgery in treatment, while Mollan and Piggot (1977) stated that "routine exploration, drainage and culture of pus should be part of the correct management of acute osteomyelitis".

The main indications quoted today for early operation are to make a definite diagnosis, to provide a specimen of the infecting organism for identification and assessment of antibiotic sensitivity, and to release subperiosteal pus. These three reasons should not now be regarded as justifying operations in every case.

Radioisotope studies can now provide early proof of bony inflammation (Gilday et al. 1975; Gelfand and Silberstein 1977; Hughes 1980). A combination of positive blood pool and positive delayed bone images is almost pathognomonic of an intra-osseous infection. The initial phase of infection involves purulent necrosis within the bone marrow which explains the early changes seen on bone scan compared with the later changes seen on radiography. The routine use of bone scanning in patients with the clinical possibility of osteomyelitis but without radiological changes allows the clinician to treat with confidence early in the course of the illness. Bone destruction and demineralisation are rarely seen less than 10 to 14 days after the onset and skeletal radiographs can be misleading in early diagnosis. A positive delayed bone scan with clinical and haematological evidence of osteomyelitis must be interpreted as acute osteomyelitis even in the absence of radiographic changes whether or not the blood cultures are positive.

The criteria for the diagnosis of acute osteomyelitis proposed by Blockey and Watson in 1970 were: definite radiographic changes, positive blood culture and culture of the organism from pus collected at operation. Blockey and McAllister (1972) suggested that a change in criteria would have to be made, in that when operation was not done and blood cultures were negative in patients treated with antibiotics alone the diagnosis of acute osteomyelitis could not be excluded. We consider that a fourth criterion should be accepted in which the bone scan is positive in the presence of clinical and haematological evidence of acute osteomyelitis. Bone scanning can provide the extra evidence needed to confirm the disease in the previously unaccepted group of "clinical osteomyelitis".

**Staphylococcus aureus** has remained the most common organism isolated in acute osteomyelitis (83 per cent of positive blood cultures in this series). This finding is consistent with other reported series (Colville, Brady and Regan 1976; Mollan and Piggot 1977; Nade 1977). Early fears of the development of resistance to cloxacillin were unfounded, and *Staphylococcus aureus* remains consistently sensitive to this drug (Rountree and Vickery 1973). Operation done only to provide a specimen of pus for the identification and culture of the infecting organism is therefore unwarranted. Blood cultures will allow discovery of the type and sensitivity of the infecting organism in about 50 per cent of cases (Blockey and Watson 1970; Mollan and Piggot 1977; Nade 1977).

Subperiosteal pus may develop early causing stripping of periosteum and loss of cortical blood supply with fear of the development of an infected sequestrum. The ready penetration of bone and pus by fusidic acid administered in full doses allays this fear (Lauen 1969; Blockey and McAllister 1972; Chater, Flynn and Wilson 1972; de Louvois and Hurley 1977). Blockey and McAllister (1972) have demonstrated the resorption of subperiosteal pus in a case treated with fusidic acid. In early or mild cases of acute osteomyelitis this process will take place all the more readily. Early surgical decompression of subperiosteal infection without trial of antibiotic therapy is not indicated.

The facts that operation has its own morbidity and resultant scar and that the exact site of infection in early cases may not be localised (Blockey and Watson 1970) are further arguments against early operation.

Blockey and Watson (1970) demonstrated that cloxacillin was the most effective antibiotic in acute osteomyelitis but feared the development of resistance. The usefulness of fusidic acid in the treatment of osteomyelitis is also well documented (Chater 1963; Blockey and McAllister 1972). Its penetration of bone and its anti-staphylococcal action make it an ideal choice. Combined antibiotic therapy is recommended to reduce the development of resistance to fusidic acid (Jensen and Lassen 1969) and the combination of cloxacillin and fusidic acid in our view provides the best anti-staphylococcal activity in the treatment of bone infection. Intravenous administration of these antibiotics provides the earliest effective serum levels. This is more important for cloxacillin which has unreliable absorption by the oral route (Kislak, Eickhoff and Finland 1965).

Superficial thrombophlebitis is a complication of this regime caused by the irritant effect of fusidic acid. To reduce this problem 250 units of sodium heparin is added to each 500 millilitres of infusion fluid containing fusidic acid. When the diagnosis of osteomyelitis has
been confirmed, a long sterile intravenous cannula is inserted under sedation into a peripheral vein and passed into a large central vein.

Bone scanning with 99mTc-MDP within 24 hours of onset can provide the earliest firm evidence of acute osteomyelitis while radiographs are still normal. Positive evidence means that intravenous therapy which had been started on admission can be continued with confidence. The scan also localises the lesion accurately and may identify other lesions; it is, however, of no prognostic value. The efficacy of early diagnosis and antibiotic therapy with fusidic acid and cloxacillin in the treatment of acute haematogenous osteomyelitis is demonstrated by the results. Although the mean period of follow-up was only two years, there was only one possible failure in the series in which symptoms recurred after discharge from hospital but were apparently cured permanently by a further intravenous course of fusidic acid and cloxacillin. The results compare very favourably with the best reported results of early operation. Our series demonstrates that the single most important factor in the treatment is adequate antibiotic therapy, and that this should be combined with careful monitoring so that late surgical exploration can follow if it becomes necessary. This can provide a satisfactory outcome in almost every case.

REFERENCES