ACUTE SEPTIC ARTHRITIS IN INFANCY AND CHILDHOOD

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The term septic arthritis includes all joint infections caused by pyogenic bacteria with the exception of tuberculosis. Its importance was recognised by Smith (1874) and pyarthrosis has subsequently been known as "Tom Smith's arthritis". It is not a common condition and the sequelae of delay in diagnosis or inadequate treatment can be crippling, particularly when the hip joint of an infant is involved. Septic arthritis in the hip of an infant warrants special emphasis, for diagnosis is often delayed, making the prognosis and later management perhaps different from septic arthritis in other joints.

The introduction of antibiotics has changed the natural history of septic arthritis and reports of patients managed before that time (for example Phemister 1924; Badgley *et al.* 1936; Heberling 1941) are of little relevance nowadays, except to point out the sequelae of inadequate management.

William Hunter (1743) described the macroscopic features of joint infection and its unpleasant sequelae of amputation or premature death "if the Patient labors under a bad Habit of Body". Benjamin Brodie (1819) wrote of the difficulties of draining a septic joint and the ultimate inadequacy of arthrotomy in chronic joint infection. After Lister introduced antiseptics, surgeons began to think in terms of supplementing arthrotomy with medication. Until comparatively recent times, arthrotomy of a septic joint, either through a purulent swelling or through the site of easiest access to the joint, represented the entire treatment of pyarthrosis (Bick 1948).

Almost every conceivable antiseptic has, at some time or another, been injected into joint cavities, but almost invariably the result has been disappointing or even harmful. Questions about the technique of arthrotomy such as whether drainage should be instituted for a long period, whether the joint should be closed or left open, or whether it should be immobilised or moved have evoked considerable argument over many years. Early in World War II sulphonamides were administered systemically and also into joints at arthrotomy and, later, penicillin was used in the same way.

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Now that the life of the patient is rarely at stake and the infected limb almost never requires removal, therapeutic endeavours must be directed to restoration and maintenance of normal function. Paterson (1970) has drawn attention to the fact that many opinions regarding the treatment of septic arthritis are based on theory and that there is a surprising paucity of accurate clinical reviews.

INCIDENCE

Acute septic arthritis is not common. Recent reports describe 52 cases in 16 years (Borella *et al.* 1963), 17 cases in 11 years (Nelson and Koontz 1966), 96 cases in eight years (Paterson 1970) and 50 cases in four years (Wiley and Fraser 1979). In the series of Nelson and Koontz (1966) 36 per cent of children were under the age of two years. Nade, Robertson and Taylor (1974) found in 45 cases, 14 (31 per cent) under the age of two years, and 22 (49 per cent) under three years. Borella *et al.* (1963) found a relatively low incidence between the ages of three and six months. The joint most commonly involved is the hip in infants and the knee in older children. These two joints together account for the majority of pyarthroses. Any synovial joint can be infected and in about 10 per cent of patients more than one joint is involved. The incidence between the sexes is about equal. In osteomyelitis boys are involved twice as often as girls—this raises questions about the relationship of the two conditions.

PATHOGENESIS

The inflammatory process in acute septic arthritis starts either within the synovium or within the fluid of a joint effusion, spread by bacteraemia or septicaemia. Spread from adjacent tissues, particularly from a focus of acute osteomyelitis in the metaphysial end of a long bone, is also important. This can occur by transphyseal spread in infants. In those joints in which the metaphysial portion of the bone is intracapsular, especially the hip and shoulder, direct spread from a metaphysial abscess occurs. The penetration of the joint from without, by diagnostic or therapeutic puncture, as a sequel to femoral venepuncture or following arthrotomy, are other pathways of bacterial infection. The virulence of the infecting organism and the resistance of the host determine

whether development of the inflammatory process in synovium or joint fluid with subsequent suppuration ensues. Infancy, trauma or prior arthropathy reduce the resistance to spread of infection. *In any acute joint disease, infection must be suspected.*

"Pus and articular cartilage are incompatible" (Lloyd-Roberts 1971). Intracapsular inflammation, with synovial proliferation and an exudate or transudate of fluid, leads to distension of the joint capsule causing laxity and possible subluxation or dislocation as a sequel. The containment of suppuration within the joint, by virtue of thick anatomical barriers, results in increased intra-articular pressure and conditions for destruction of articular cartilage. These conditions are largely unknown and various theories have been advanced to explain the mechanism of destruction of the cartilage. Phemister (1924) felt that proteolytic enzymes released from neutrophils in the suppuration fluid were responsible, while Lack (1959; 1961) felt that staphylokinase produced by bacteria converted plasminogen to plasmin, which then exerted its proteolytic effect. Curtiss and Klein (1963; 1965) questioned these theories. Initially *in vitro* and later *in vivo*, they found little evidence to support them. They did find considerable loss of chondroitin sulphate from the articular cartilage, but this appeared to have no visible gross effect on the appearance of the cartilage. Daniel *et al.* (1973) found that gross changes in experimental septic arthritis in rabbit knees occurred many days after biochemical evidence of loss, initially of hexosamine and later collagen. Clawson and Dunn (1967) believed that fibrin, entering the joint from surrounding tissue, clotted to produce pocketing of pus and formation of dense adhesions that limit movement of the joint. They stated that production of hyaluronic acid was limited and the acid was of poor quality, resulting in the loss of lubricating effect and further trauma to the already damaged joint. The possible role of lysosomes has been mentioned (Stetson, DePonte and Southwick 1968); however, the precise mechanisms of joint destruction leading to the changes so well described by William Hunter in 1743, remain unknown. This is one area for investigation that may result in improved treatment.

THE CAUSATIVE ORGANISM

The most common causative organism of acute septic arthritis in all age groups is *Staphylococcus aureus*. Many other organisms have been isolated from septic joints. In 1966 Nelson and Koontz drew attention to the increasing importance of *Haemophilus influenzae* as a cause in the infant; this was reinforced by Almquist (1970). It is important to remember this when choosing antibiotics before the results of bacterial culture and antibiotic sensitivity are known. Other causative organisms reported include *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Escherichia coli*, *Proteus*, *Salmonella*, *Serratia marcescens* (Martin, Merrill and Barrett 1970), *Clostridium welchii* (Torg and Lammot 1968), *Neisseria*, *Staphy-*

lococcus albus, *Aerobacter*, *Meningococcus*, *Bacteroides* and *Paracolon*. However, organisms are not grown from all cases. Nelson and Koontz (1966), summarising previous reports of Samilson, Bersani and Watkins (1958), Oblatz (1960), Baitch (1962) and Borella *et al.* (1963), found that the causative organism was unknown in 25 of 133 cases (19 per cent), and in 46 of their 117 patients (39 per cent). Nade *et al.* (1974) did not find a bacterial cause in 19 of 45 patients with a clinical diagnosis of acute septic arthritis. Twenty-six joint aspirates produced organisms 16 times (62 per cent), and in 19 joints treated by arthrotomy pus was found on 18 occasions and organisms were grown from 15 of the samples (83 per cent). Several reasons have been proposed for the inability to obtain bacteriological proof of infection, including prior use of antibiotics, inadequate anaerobic cultures, the standard of microbiological laboratories, the changing patterns of the organisms involved and their cultural characteristics (for example, *Haemophilus influenzae*), and failure to obtain blood for culture or to perform arthrocentesis frequently enough.

Unusual organisms are more likely to appear when there has been penetration of the joint by a foreign body, retention of a foreign body within a joint, systemic disease altering the immunological status of the patient, or treatment with corticosteroids.

THE USUAL CLINICAL COURSE

There are significant differences between infection occurring in infancy and that in the older child. Neonatal disease, being the more frequent, the more deceptive in presentation and the more devastating merits special attention (Lloyd-Roberts 1979).

The infant. In the infant, especially the newborn, the major features of the infective process are those of a septicaemia. There may be irritability, apprehension, failure to feed or gain weight, muscular spasm, dislike of being handled, occasionally fever, tachycardia, anaemia, and the presence of associated infection. Localisation of the infective process in a joint, particularly the hip joint, is frequently not obvious and subtle changes in posture are important. The baby may look deceptively healthy and have "pyrexia of unknown origin". The traditional clinical signs of inflammation may be lacking. When infection in an infant is suspected, great care must be taken in clinical examination; all bones should be palpated and all joints moved.

Involvement of the hip joint must be suspected in any infant with a septicaemia and this is manifest by one or more of the following: pain on palpation or passive movement of the hip; unilateral oedema; swelling of an extremity, a buttock or the genitalia; lack of active movement of the leg; asymmetrical buttock creases; and abnormal posture of the leg. Occasionally a bulge over the buttock may be palpable.

The child. In contrast to the infant, the child with septic arthritis presents with an acute fulminating disease.

Fever and tachycardia are common, together with severe pain uniformly about the involved joint, evidence of joint effusion, muscle spasm and reluctance to move the joint, or even the whole limb. In such children, infection is usually suspected and the local signs, together with the history, localise the site of the infection. The presence of a focus of infection elsewhere, such as otitis media, pneumonia or a furuncle may reveal the source of the septicaemia.

DIAGNOSIS

In all cases of acute arthralgia, sepsis must be suspected. Infants with acute septic arthritis do not show clinical features seen in older children or adults. Oblatz (1960) pointed out that in the infant several days delay in diagnosis of septic arthritis of the hip was almost the rule. Clinicians had been slow to recognise the early clinical manifestations of septicaemia and suppuration in the hip joint, even when the features were recorded in the nursing notes! Usually the patient's temperature is elevated, as is the white cell count, showing a neutrophil leucocytosis, and the erythrocyte sedimentation rate is raised. However, these findings are not specific.

Radiographs of the affected site are usually quite helpful. Distension of the joint capsule and increased opacity within the joint, displacement of muscle surrounding the joint by the capsular distension, increased distance between the subchondral ends of bone and occasionally subluxation of the joint are frequently evident early in the course of the disease.

Any doubt about the relevance of these radiographical signs can be assessed by comparison with the opposite limb. In the infant, with the common delay in diagnosis, there may be evidence of erosion of the epiphysis or even its disappearance. Evidence of adjacent osteomyelitis should also be sought.

Aspiration of a suspected septic joint is a simple technique which does not appear to be practised often enough. Arthrocentesis should be performed with a wide-bore needle inserted into the joint through the site of easiest access, maximal tenderness, or fluctuation should the pus be loculated. Puncture of the joint through an area of cellulitis should be avoided because of the risk of infecting a joint containing a sterile "sympathetic" effusion. Fluid obtained should not be assessed by its macroscopic appearance, for turbid fluid may not be infected and clear fluid may be teeming with organisms. As well as bacteriological studies, cell counts should be performed on the fluid (Curtiss 1964). Fluid from septic joints contains on average 100 000 cells per cubic millimetre with a range of 25 000 to 250 000 cells per cubic millimetre. If there are more than 50 000 cells per cubic millimetre of which more than 90 per cent are polymorphonuclear leucocytes, then infection should be strongly suspected even if organisms are not grown (Ward, Cohen and Bauer 1960). Microscopy of smears of joint fluid treated with Gram's stain should also be done

as the type of organism seen gives a good guide to the most effective choice of antibiotic before sensitivities are available.

Blood cultures should also be obtained before antibiotic therapy is started. Any other septic areas in the body should be swabbed and cultured. On occasion, the only clue to the cause of a septic arthritis has been obtained by culture of pathogens from cerebrospinal fluid or stools.

DIFFERENTIAL DIAGNOSIS

In acute septic arthritis the diagnosis in the crucial period is a clinical one. There are eight conditions that may produce some difficulty in diagnosis. First, rheumatoid arthritis, in which the initial manifestation may be mono-articular. Secondly, traumatic synovitis, or joint effusion, in which a definite history of trauma is not always available, particularly in the child with an "irritable" hip. Thirdly, cellulitis, which usually shows more local skin redness and oedema than septic arthritis and a wider area of local tenderness. Lymphadenopathy usually accompanies cellulitis and the swelling is not circumferential. Fourthly, acute rheumatic fever. In this condition the symptoms tend to flit from joint to joint, and this can also occur during septicaemia of acute septic arthritis. Fifthly, acute osteomyelitis, which may present a very similar picture to acute septic arthritis with a sympathetic joint effusion adjacent to the involved metaphysis. The two conditions may occur together, particularly in the hip or the shoulder joint. In acute osteomyelitis, gentle clinical examination usually allows some joint movement, while in septic arthritis muscular spasm usually prevents joint movement which is nearly always very painful. Sixthly, haemophilia. This may present a diagnostic problem only. It may be the first presentation of a coagulation disorder. Seventhly, Henoch-Schoenlein purpura. This may present with single or multiple arthralgia before the cutaneous manifestations appear. And finally, Perthes' disease. In a child this may present with discomfort and restriction of movement of hip or knee by muscle spasm. If there is doubt on clinical or radiographical examination then aspiration should be performed.

THE PRINCIPLES OF TREATMENT

"Every hour that an acute suppurative process continues within a joint is of urgent significance to prognosis" (Paterson 1970). "This statement does not exaggerate the sense of urgency required when confronted by either the certainty, probability or even the possibility of this affection" (Lloyd-Roberts 1979).

There are three essential duties to perform: first, the joint must be adequately drained; secondly, antibiotics must be given to diminish the systemic effects of sepsis; and thirdly, the joint must be rested in a stable position. The last of these has been challenged recently by Salter, Bell and Keeley (1981)—but only in animal experiments.

Acute septic arthritis of the hip in infants

Following the account of the sequelae of this condition by Eyre-Brook (1960), most authorities (Paterson 1970; Lloyd-Roberts 1971; Sharrard 1971) advise surgical drainage as soon as possible if an aspirate of the joint reveals suppuration. Such drainage should be by a posterior approach making a wide hole in the capsule, either by partial excision or a cruciate incision, with adequate irrigation and primary skin closure. After surgical drainage, the hip should be splinted in abduction to prevent dislocation. Appropriate antibiotics (see below) should be administered systemically. Because of the high incidence of partial or complete damage to either the epiphysis or growth plate with sequelae that are difficult to treat later in life, Lloyd-Roberts (1971) advised routine exploration of the hip with a damaged femoral capital epiphysis at the age of one year. Possible management includes reduction of a displaced femoral head, replacement of a destroyed head with greater trochanter, or abduction displacement osteotomy of the greater trochanter.

Acute septic arthritis in childhood

The questions requiring discussion are as follows: which antibiotics should be used initially? by which route should they be administered? is aspiration and irrigation an adequate form of treatment or should open surgery be performed for drainage in all cases? after open drainage, should a closed-drainage system or suction-irrigation system be used? and what should be the duration of treatment?

The choice of antibiotics. Antibiotics used must be appropriate in type, dose and duration. If the diagnosis of acute septic arthritis is suspected, antibiotics should not be administered before blood has been obtained for culture and aspiration of the joint performed. Usually it is about 48 hours before sensitivity of organisms to antibiotics can be determined and during that period antibiotics should be given on a "best guess" basis. A knowledge of the natural history of the disease, the age of the child, and the type of organism (if seen) on a smear of fluid aspirated from a joint and treated with Gram's stain, are the best guide to the choice of the most appropriate antibiotic.

The organism most commonly involved is *Staphylococcus aureus* (Nelson and Koontz 1966), but where a clinical diagnosis is made, an aetiological agent is only found in about 60 per cent of cases, as confirmed by Paterson (1970) and Nade *et al.* (1974). Nelson and Koontz (1966) suggested that in the infant under six months of age, the most likely organisms were staphylococci or Gram-negative enteric pathogens; between six months and two years of age, staphylococci or *Haemophilus influenzae*; and over two years of age, staphylococci. Examination of smears of aspirates, treated with Gram's stain, from children under two years could therefore be useful in determining whether the most likely organism

was a staphylococcus, an enteric pathogen or *Haemophilus influenzae*. Nelson and Koontz (1966) recommended that if Gram-positive cocci were seen in the first six months of life then a methicillin-type antibiotic or bacitracin should be given, and if Gram-negative rods were seen then kanamycin should be given. Between six months and two years of age, methicillin-type antibiotics should be given if Gram-positive cocci were found and ampicillin if Gram-negative rods were seen. In septic arthritis in children over the age of two years, methicillin-type antibiotics were recommended. Clawson and Dunn (1967) recommended the combined use of methicillin and ampicillin until cultures and sensitivities were available, while Griffin (1967) recommended the use of penicillin and a methicillin-type drug given systemically, together with irrigation of the joint with penicillin, neomycin and bacitracin. Paterson (1970) recommended the use of penicillin. Nade *et al.* (1974), on the basis of a study looking specifically at the organisms found in acute septic arthritis and their sensitivities to antibiotics, recommended the use of methicillin or cloxacillin together with ampicillin. All authors recommend the parenteral (preferably intravenous) route for administration of antibiotics. Obviously, when organisms have been cultured and their antibiotic sensitivity is known, the appropriate bactericidal antibiotic should be used in effective dosage.

Nelson and Koontz (1966) demonstrated, in a careful study, the increasingly important aetiological role of *Haemophilus influenzae* since the 1950s. As the natural history of the disease changes and as bacteria change their characteristics of antibiotic sensitivity, the most appropriate antibiotic to use initially will vary from time to time, and from place to place. Continuing studies to monitor microbiological data are mandatory to ensure that the most effective therapy will always be used.

Already, ampicillin-resistant strains of *Haemophilus influenzae* have appeared as a cause of meningitis and septic arthritis (Chang, Controni and Rodriguez 1981). In geographical areas where the incidence of ampicillin resistance is high, consideration should be given to the use of chloramphenicol in the initial treatment of septic arthritis in children between six and 24 months of age.

The route by which antibiotics should be administered. The major question here is with respect to the intra-articular route. Bardenheier, Morgan and Stamp (1966) in an experimental study in rabbits found that the intra-articular administration of antibiotics produced sterility in the joint sooner than when they were given by the intramuscular route. In a further experiment, Orchard and Stamp (1968) concluded that irreversible joint damage occurred early in the course of suppurative arthritis, and that sterilisation of the joint, even by the intra-articular route, did not prevent this. It would appear that the early institution of appropriate treatment is more important than the route of administration. Schmid and Parker (1969) advocated removal of pus from the joint by aspiration, but felt there was no need for intra-articular

antibiotics because adequate concentrations of antibiotic in the joint could be achieved by systemic administration. Nelson (1971) drew attention to the paucity of previous information on the transfer of antibiotics across synovium, particularly when the latter is inflamed, and attempted to compare joint levels following intra-articular, intramuscular, and intravenous administration of antibiotics. He found that with penicillin, methicillin, ampicillin and cephalothin the intravenous route was just as effective as the intramuscular route in producing intra-articular levels which were the same or even higher than those obtained by giving the antibiotic directly into the joint. The levels obtained with the normally recommended doses were greater than *in vitro* levels required to inhibit bacteria. Drutz *et al.* (1967) and Parker and Schmid (1971) found the same for a larger number of antibiotics, of which only erythromycin did not reach adequate therapeutic levels.

This subject has recently been addressed by Fraser (1981), who has considered the pharmacodynamics of antibiotic penetration into joints. There have not been many suitable studies of this mode of drug behaviour, but evidence suggests that concentration of antibiotic in the serum may be the most important determinant of joint fluid penetration. Therefore, it is important once oral administration has been commenced to monitor serum levels of antibiotic and, by tube dilution methods against the causative organism, to determine the serum bacteriocidal titre.

In a novel approach, Finsterbusch, Argaman and Sacks (1970) found that, in rabbits, distally administered intravenous perfusion of antibiotics for half an hour daily for more than six days with the limb occluded proximal to the infected joint by a tourniquet, produced a greater number of sterile joints than when systemic antibiotics were used or animals were left untreated. Using this technique in human chronic osteomyelitis, favourable results have been reported (Finsterbusch and Weinberg 1972).

Aspiration, irrigation or arthrotomy. The basic aims of treatment are to sterilise the joint, evacuate the bacterial products and debris associated with infection, relieve pain and prevent deformity. Griffin (1967) stated that to achieve these goals required the appropriate use of aspiration, irrigation, antibiotics, surgical drainage and care of the joint locally. He advocated aspiration for confirmation of diagnosis, and at the same time irrigation with an antibacterial mixture, stating that antibiotics, even in dilute solution, caused irritation of synovium "but the advantages from local use of antibiotics probably outweigh this disadvantage". There is no evidence to support this statement. Furthermore, he stated that "Surgical drainage is an important part in the management of septic arthritis. Most patients with septic arthritis will need surgical drainage of the affected joint, but there are patients in whom it is not necessary. Older children whose disease is diagnosed early and who respond

dramatically to conservative treatment that includes traction or protection with a bi-valved cast *may get by* without surgical drainage". The sensible interpretation of that statement is that surgical drainage should be recommended.

Paterson's survey (1970) is of critical importance and bears reiteration:

"By the 1950s, most writers believed that early diagnosis should be made and early arthrotomy performed, and that destruction of cartilage was more likely thus to be obviated than it was in the treatment by repeated aspiration. Early arthrotomy has not, however, been widely practised; in consequence, the late effects of acute suppurative arthritis in infants and children are still seen today despite the wide use of antibiotics for control of local and systemic infection. The literature contains, in the main, opinions based upon theory and there is a surprising paucity of clinical review.

"Dissatisfied with the results of treatment by aspiration, drainage or antibiotics, orthopaedic surgeons at the Adelaide Children's Hospital have since 1960 treated these patients according to a strict routine, none of which is new, but is simply a combination of accepted methods. The method is based on four main principles and it is considered that anything short of the full routine is inadequate."

The principles stated were that the patient should be treated by immediate arthrotomy, complete skin closure without drainage, immobilisation of the joint and antibiotics.

Paterson's clinical review of older children with proven suppurative arthritis treated by the regime outlined showed no failures in 50 patients if the arthrotomy had been performed within five days of the onset of symptoms. All four patients in whom arthrotomy had been performed after five days had bad results. With all other forms of treatment, there were 15 bad results in 33 patients. Comparing the results of patients in whom only the hip joint was involved it was found that when arthrotomy was done within five days there were no failures in 14 patients; when done after five days there were four failures in four patients, and with other methods, there were five failures in 10 patients. *This is a compelling argument for early arthrotomy in all cases of acute septic arthritis.*

Ward *et al.* (1960) felt that systemic administration of antibiotics gave results superior to those obtained by surgical drainage alone. They suggested that there should be no apparent advantage in surgical drainage of the joint. They advocated repeated aspiration of the joint in order to relieve pain and to remove material which might inhibit some antibiotics, and reserved surgical drainage for those cases that responded inadequately to antibiotics and aspiration. Schmid and Parker (1969) stated that the presence of retained pus retarded the action of many antibiotics by inhibiting the rate of growth of infecting bacteria. It is thus possible that some bacteria can exist

even in the presence of bacteriocidal concentrations of antibiotics within the joint fluid. They advocated needle aspiration of joints as often and as soon as the fluid accumulated. Analysis of such joint fluid over five to seven days was said to give a guide as to whether closed drainage by needle aspiration was adequate. They accepted, however, the suggestion of incision and drainage at the onset of treatment rather than later in the course, in infants with involvement of deeper joints such as the shoulder or hip. Much of their argument was based on a comparison with other closed space infections, especially lung abscesses.

With the advent of modern anaesthesia and adequate pre-operative preparation, one feels more confident of obtaining a satisfactory long-term result if early arthrotomy is performed.

Paterson (1970) has made a case against repeated aspiration of joints as a drainage procedure and as a treatment. His reasons were that broad-spectrum antibiotics are irritants to cartilage, the tension within the joint recurs, the procedure is painful, the results are uncertain and pus is often thick and cannot be aspirated, even when under tension.

I would support the view of Lloyd-Roberts (1979) that "the misguided conservation of the needle should yield to the conservation of the knife".

There should be no remorse if, from time to time, we explore a hip needlessly. The issues are formidable and an occasional error is therefore justifiable. Failure to explore may result in the patient going through his adult life with a lurching gait, a high boot, a walking stick and, often, aching pain—this closely resembles the archetype of an eighteenth century cripple.

Drainage. The institution of open drainage following arthrotomy is of historical interest only and has no place these days, though used by Stetson *et al.* (1968). Following adequate debridement of the joint at arthrotomy, Paterson believed that closure of the skin without any form of drainage was perfectly adequate, as long as the joint capsule was not closed. This is similar to the principle laid down by Trueta (1968) for the treatment of acute osteomyelitis. Closed drainage systems using suction, with or without irrigation, are currently in vogue (Compere, Metzger and Mitra 1967), but nowhere have the end results after closed drainage or suction-irrigation been compared with those after primary skin closure and no drainage.

The duration of treatment. The duration of immobilisation and antibiotic therapy in acute septic arthritis is empirical. Paterson (1970) quoted a period of six weeks immobilisation and six weeks antibiotic therapy. Clawson and Dunn (1967) suggested that a period of two to three weeks after the patient had become afebrile and joint effusion had ceased. They also advocated irrigation with saline as often as the effusion occurred and advised surgical drainage only if the infection failed to subside. Suction-irrigation was then advised. Griffin (1967)

recommended the systemic use of antibiotics by an intravenous route for three weeks and then orally for three weeks using as a guide the return to normal of the erythrocyte sedimentation rate and of the clinical appearance. Stetson *et al.* (1968) recommended four to six weeks of intravenous therapy for hip pyarthrosis followed by three months oral therapy. Studies such as those performed by Blockey and Watson (1970) on the duration of antibiotic therapy in acute haematogenous osteomyelitis have not been performed in patients with septic arthritis. This area requires investigation.

COMPLICATIONS

Eyre-Brook (1960) and Sharrard (1971) listed the sequelae of hip sepsis as follows: destruction of the capital epiphysis with dislocation of the hip; destruction of the capital epiphysis, the femoral neck remaining in the acetabulum; destruction of the epiphyseal plate with the femoral head remaining in the acetabulum connected to the femoral neck by fibrous union; and recovery with coxa magna but no other deformity. In the era before antibiotics complications of septic arthritis were frequent. Badgley *et al.* (1936) studied the end results in 113 cases of septic hips and found only seven in which a normal hip joint resulted following treatment. A further 23 cases had what they called a functional hip joint, having more than 50 per cent of the normal range of motion. Concomitant osteomyelitis produced a far worse prognosis than if the infection was in the synovium of the hip joint alone.

Dislocation of the hip joint was common; this can be avoided by placing the leg in extension and abduction. Sequestration of the head of the femur with spontaneous absorption (epiphysiolysis) or requiring removal occurred in 43 cases. Although it is usually quoted as being "aseptic necrosis" due to ischaemia after increased intra-articular pressure, there is no good evidence for this, and transphyseal spread of osteomyelitis in infants is more likely. After loss of the femoral head some patients had a normal range of movement but a marked gluteal gait and others had a less than normal range of movement. Fibrous or bony ankylosis was a common sequel to loss of the femoral head.

Since the introduction of antibiotics, death no longer appears to follow acute septic arthritis. However, there are very few studies of the outcome of septic arthritis in the antibiotic era. None of them are long term. Borella *et al.* (1963) found that 39 of 52 patients had no disability through follow-up periods varying from a few months to 10 years. Thirteen patients showed one or more of the following: limitation of movement, osteomyelitis and dislocation of the hip. Samilson *et al.* (1958) followed 15 patients with 21 involved joints for periods exceeding 10 years; eight patients showed disturbances in growth (seven hips and one shoulder), and 10 out of 19 hips had dislocated. All 19 hips demonstrated destruction of the femoral capital epiphysis.

Growth disturbance could also be found as coxa magna. All complications had a direct relationship to the duration of joint symptoms before diagnosis and definitive treatment, a conclusion reached by Heberling (1941). Seventy-seven per cent of all complications occurred in those children who had symptoms for seven or more days before establishment of diagnosis and beginning of treatment. Seventy-five per cent of the hips with sepsis treated by aspiration showed dislocation, but only 47 per cent treated by incision and drainage did so.

However, Lloyd-Roberts (1960) emphasised that a translucent zone in the radiograph did not necessarily mean that part of the bone, epiphyseal cartilage or plate had been destroyed. Clinical examination, occasionally augmented by arthrography, can usually confirm that cartilage or decalcified bone has survived infection, particularly in the knee joint in which the prognosis is far better than that of the hip joint. Where there has been involvement of the growth plate, conventional treatment for shortening or deformity is indicated.

By pursuing a policy of arthrotomy for all septic arthritis, Paterson (1970) performed an unnecessary arthrotomy in 11 cases; 10 were in the first five years of his study, and only one in the next two years. The effect of operation was not noticeable in the incised joint. In three patients a Brodie abscess was seen.

Baitch (1962) concluded that complete destruction of hip and shoulder joints can be expected in the premature and neonatal periods if incision and drainage is not accomplished within 48 to 72 hours of onset. The most important single factor for the preservation of a well-functioning joint is early diagnosis and adequate treatment.

It is of interest to note the findings of Kuo *et al.* (1975), who postulated that the variability in presentation of this disease might be a function of immunological competence. In a retrospective study of 12 children known to have pyogenic arthritis in infancy, six still had hypofunction of the antibody-complement-phagocyte pathway. Furthermore, the extent of joint destruction was directly related to the presence of immunodeficiency.

Lunseth and Heiple (1979) reviewed 38 patients with 39 involved septic hips seen over a period of 21 years in order to determine which factors affected prognosis. They found only two significant correlations with poor prognosis—the duration from clinical onset to initiation of therapy and the age of the child (especially if under one year of age). They also felt that non-staphylococcal organisms were possibly less destructive to the femoral head in infants.

Argen, Wilson and Wood (1966) used the term “post-infectious synovitis” to describe joints which were warm and tender with accumulation of fluid within them, and had thickened synovium, in children without evidence of fever or other systemic disturbance. The one feature common to all patients who developed this syndrome was the use of repeated injection of antibiotics

into the affected joint and it was never observed in patients who did not receive instillation of antibiotics. Repeated arthrocentesis increases the risk of superinfection.

SUMMARY

Acute septic arthritis in childhood and infancy is an uncommon condition. Early diagnosis and early introduction of adequate treatment can prevent the crippling sequelae, especially when the hip joint of an infant is involved.

Successful treatment of acute septic arthritis demands adherence to two fundamental principles: the antimicrobial agent used must achieve effective concentrations within the joint and the purulent contents of the infected joint must be resorbed by the host or removed by the medical attendant.

Effective concentrations of an antibiotic are present in an infected joint during systemic therapy and this obviates the need for local installation of antibiotics into a synovium-lined cavity with attendant risks of destruction of articular cartilage and persisting synovitis. Blood cultures and arthrocentesis should be performed before antibiotics are administered in all cases of suspected septic arthritis. Antibiotics to be administered initially, before identification of causative organisms and antibiotic sensitivity, can be chosen on a “best guess” principle. Antistaphylococcal drugs should always be given. In infants under the age of six months a wide range of organisms may be the cause, and broad-spectrum bacteriocidal cover may be required. Between the age of six months and two years the most common causative organism is *Haemophilus influenzae*, and ampicillin is an additional drug of choice. Over the age of four years, staphylococci are the most common cause and should be treated with cloxacillin. Microscopy of a smear, treated with Gram's stain, from the first aspirate may help in choosing the most appropriate antibiotic. If no organisms are seen or grown on culture, the combination of cloxacillin with ampicillin appears most appropriate.

The incidence of complications is directly related to the duration between onset of symptoms and introduction of effective treatment. Septic arthritis of the hip, particularly in the infant, should be treated by antibiotics and surgical incision and drainage of the joint in all cases. In arthritis of joints other than the hip, there is still considerable controversy as to whether open operation and drainage should be performed in all cases, or whether this should be reserved for those which do not respond adequately to repeated arthrocentesis. The value of closed drainage with or without irrigation has not been adequately assessed. There is no place for intra-articular installation of antibiotics. It is the author's belief that no other measure will so quickly bring a septic arthritis under control than proper incision and drainage, accompanied by antibiotic therapy. As the natural history of the disorder changes and micro-organisms alter their

antibiotic sensitivity, continuing studies regarding the causative organisms are mandatory. Advances in therapy will come when the mechanisms of joint destruction by infection are better understood.

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