REFRESHER COURSE FOR GENERAL PRACTITIONERS

ACUTE OSTEOMYELITIS AND SEPTIC ARTHRITIS

BY

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Although it is true that the outlook in acute osteomyelitis and septic arthritis has been almost miraculously changed by the use of penicillin, successful treatment still requires early diagnosis, first-class medical and nursing care under continuous supervision, and adequate local and general supportive measures. In this article the discussion is limited to blood-borne pyogenic infections, and in particular to the bone and joint disease of children usually due to infection by *Staphylococcus aureus*.

Osteomyelitis is a general systemic infection with focal pyaemic lesions in the bone, skin, and other soft tissues. The importance of the disease is due to the severity of the lesion in bone occasioned by the anatomical and physical peculiarities of its structure and blood supply. As in other general infections, the invasion of the body by pathogenic organisms, and their circulation in the blood stream, is not the full explanation of the development of the disease. Injury has often been invoked as a factor in osteomyelitis because it affects boys predominantly and the bones of the lower extremity more frequently. The susceptibility to injury, though probably commoner in boys, is a feature of childhood. The stresses borne by the infantile skeleton are greatly out of proportion to the weight of the child: the vulnerability of bone is particularly found at the metaphyses. If to injury is added the presence of organisms circulating in the blood stream there must also be a general constitutional defect causing a temporary breakdown of antibody defences.

Osteomyelitis used to be regarded as a disease peculiar, more or less, to the poorer strata of society in which hygiene was defective. This is not the experience of an orthopaedic hospital away from the big cities but dealing with both urban and rural populations. In a random selection of 10 cases admitted to the Princess Elizabeth Orthopaedic Hospital the number of children in the private residential school group was equal to that from local education authority schools. A seasonal incidence is sometimes to be noticed, particularly in December and the early months of the year.

The Clinical Picture

The fact that a patient may have a single focus of bone or joint infection should not cause the practitioner to overlook the general constitutional disease, which, though never trivial, can be so serious as to mask local signs and to mimic other important general diseases such as acute rheumatism, poliomyelitis, and meningitis. The element of mimicry is apt to cause confusion not only in such general manifestations but even in the local lesions, in which symptoms may be referred far afield from the actual focus. As an illustration I recall a case which though seen very many years ago has left a very vivid memory. A desperately ill child of about 10 was admitted to a medical ward with right-sided abdominal pain; the physician diagnosed appendicitis, but his surgical colleague regarded the case as one of pneumonia. The disease was of fulminating type, and the child died. The necropsy was dramatic: the pathologist, having ascertained that neither diagnosis was correct, then proceeded with his investigations. Eventually the heart muscle was incised to reveal multiple small abscesses which, as he said, "were almost certainly staphylococcal and therefore related to haematogenous osteomyelitis"; he then exposed the shaft of the right femur and proved himself right.

It should be recognized that there is great variety in the clinical pictures which osteomyelitis presents. Even with a single focus the manifestations may range from the relatively benign with few symptoms and signs to the really fulminating in which the child's distress is serious and his toxic state obvious. Pain may be so intense as to cause an inhibitory state of pseudo-paralytic type. The toxic condition may lead to coma, suggesting meningitis, but when less severe it can cause an apparent stupidity which may seem like mental deficiency. The following cases illustrate some of the difficulties.

Cases

A 12-year-old girl was admitted to an isolation hospital as a case of cerebrospinal meningitis. A lumbar puncture produced a normal fluid under increased pressure. She was restless, delirious, and semi-conscious, and later became unconscious. Penicillin was given, 2,500,000 units being spread over eight days. After 2,000,000 units had been given she became afebrile. Three days after the cessation of penicillin the temperature rose again and she was found to have a swelling over the lower third of the left thigh, extending into the popliteal fossa. She was then admitted to an orthopaedic hospital where a large subperiosteal abscess was opened, and further penicillin was given for three weeks, the child making an uninterrupted recovery. The early radiographic evidence of metaphysial infection completely resolved.

A boy aged 10 had not been well for three weeks following a superficial abrasion of the left ankle, with inguinal adenitis. He was treated with sulphonamides, but after a week began to have pain and swelling of the left knee. This was aspirated and penicillin was injected into the joint. He was also given 15,000 units of penicillin three-hourly. A high temperature continued and he became toxic. The day before admission to hospital a swelling appeared in the opposite knee. On admission he had a temperature of 102° F. (38.9° C.), a rapid pulse, and an enlarged heart. Both knees were swollen and he was thought to be suffering from rheumatic fever. Aspiration of the right knee produced a clear sterile fluid. His blood showed a leucocytosis of 20,000 (91% neutrophils). For three days sulphonamides were given and both legs were supported on Thomas splints. His temperature showed signs of subsiding, but on the third day there was pericardial friction and his temperature again rose. The next day both femora were exposed through postero-lateral incisions. There were large subperiosteal abscesses and pus under tension in both medullary cavities. After this the general condition rapidly subsided to normal. The wounds healed in less than a month and the two femora returned practically to normal radiologically in six months.

A girl aged 15 was admitted to an isolation hospital a week after some rough play with two boys and a fall off a bicycle, which was followed by pain in her right leg and a limp which did not prevent her from going to work. A day or two later her leg became weak. Three days before admission a general practitioner found no bruising or swelling of the leg and that the hip could be moved freely but with discomfort. The day before admission she lost her voice. On admission she looked very ill, was semi-delirious, had diminution of reflexes in the right lower extremity, incontinence of urine, and a normal cerebrospinal fluid. There was a foul vaginal discharge. At first she was thought to be suffering from acute anterior poliomyelitis, but the pyaemic

nature of her disease was soon recognized. The general manifestations were brought under control with massive doses of penicillin, but the response was slow because at first the full severity of the local disease was not recognized and because no surgical treatment was thought to be necessary. It is impossible in a few words adequately to convey the picture which this case presented: the gross involvement of the whole shaft of the right femur in an osteomyelitic process, massive sequestration, encrustation with new bone throughout the periosteal covering, and septic arthritis of the hip-joint, the only treatment for which was parenteral penicillin and immobilization of the hip and limb in plaster-of-Paris. It was some months before the patient was transferred to an orthopaedic unit.

These three cases illustrate difficulties in diagnosis. It is essential that osteomyelitis should be considered in the differential diagnosis in any child with an acute generalized infection, particularly if there are one or more of the following signs: pain and tenderness in a limb, particularly in relation to the long bones or in the neighbourhood of joints; swelling of or near joints; weakness and even paralysis of a limb; or muscle spasm or loss of movement in one or more joints. It should be remembered that symptoms may be referred far from the site of the disease, and that the general toxic state of the patient may by mimicry mask its real nature.

Anatomical Considerations

Recognition of the structural peculiarities of growing bone will explain much of the special morbid anatomy of osteomyelitis. To explain this a familiar diagram (Fig. 1) is used to show the relationship of epiphysis with epiphysial cartilage and the diaphysis with its metaphysial area of new-formed bone arising from the epiphysial cartilage. It illustrates the periosteum (a wavy line) and its attachment to the epiphysial disk, its continuity with the tendinous and ligamentous attachments of bone, and the relation of all these structures to synovial reflections and the neighbouring joint cavity. The importance of the relationships is well seen at the hip-joint (Fig. 2), which so commonly is involved secondarily to osteomyelitic lesions of the upper end of the femur.

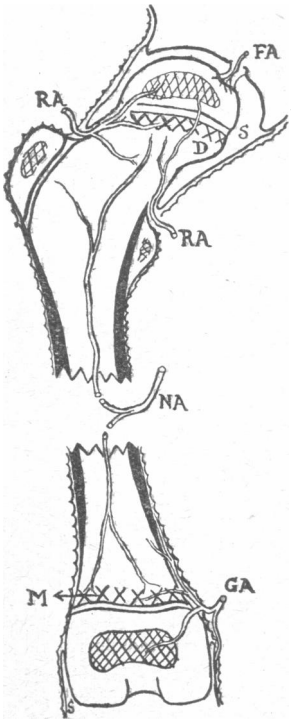

FIG. 1.—Diagrammatic representation of femoral metaphyses, their blood supply, and their relation to joint cavities. S=Synovial cavity. FA=Foveolar artery. RA=Retinacular arteries. NA=nutrient artery. GA=Geniculate arteries. M=Metaphysis. D=Diaphysial portion of caput femoralis (intra-articular).

Equally important to these main structural arrangements is the distribution of the vascular supply, which is from three sources: (1) the diaphysial nutrient vessel, which enters near the centre of the shaft and divides into two branches which pass upwards and downwards to the ends of the medullary cavity and supply its internal structure, and also help to do so for the metaphyses; (2) the surface supply of the cortex, through blood vessels within the periosteum; and (3) the arterial circle of Hunter, which surrounds the ends of the bones and supplies branches to the epiphysis and metaphysis through the neighbouring periosteum. At the upper end of the femur there is a further vascular supply to the epiphysis through the ligamentum teres. Anastomosis of the smaller branches of all these arteries takes place, but if there is occlusion of major radicles revascularization of the area affected is difficult and necrosis tends to occur.

In the past there has been controversy concerning the primary site of infection. There is little doubt that infection may reach the bone through any of the normal vascular channels, but British experience provides overwhelming support for stating that the metaphysial focus is the commonest.

The arrival of organisms in the vascular channels of the metaphysis may be by small emboli or by the infection of a pre-existing haematoma. Whatever the nature of the initial focus, there are two sequelae of widely destructive nature: (1) the production of an inflammatory exudate, which causes a rise of intra-osseous pressure and obstruction to the venous return; and (2) thrombosis of the veins completes the vascular interruption, and bone necrosis is its result. The extent of necrosis is dependent upon the severity of intra-osseous pressure and upon the extent to which the large blood vessels are obstructed. The natural relief of intra-osseous pressure occurs as the necrosis or bone absorption in the neighbourhood of the thinner cortex of the metaphysis permits pus to escape under the periosteum. This may occur early to such an extent as to limit considerably the diaphysial necrosis. In this event pus tracks along the shaft of the bone under its periosteum, lifting this away from the bone itself, and thus involves subsequent interference with the vascular supply of the superficial parts of the cortex, which may themselves then suffer necrosis and superficial flaky sequestration. These last-mentioned changes may occur by themselves owing to primary involvement of periosteal blood vessels without medullary or metaphysial involvement.

The essential changes, then, are inflammatory exudation, rise of intra-osseous pressure, vascular interruption, and thrombosis. Upon the extent to which the blood vessels are obstructed and the tissues devitalized is dependent the failure or imperfections of antibiotic treatment. It should further be noted that in the early stages, when correct treatment is most important, radiographic examination is of no help. In fact there is *no* way of knowing precisely the extent or intensity of the vascular occlusion. These circumstances must influence judgment regarding the need for and type of surgical intervention.

Treatment

The aim should be to control the general constitutional disorder and to prevent the mechanical effects of vascular interruption and inflammatory exudation. This can only be achieved in the first few days of the disease by adequate maintenance of the penicillin level in the blood. The absorption of the toxic products into the general circulation is controlled by precise application of physiological rest. These two measures must be applied with the greatest efficiency from the onset. In those cases in which, after 48 hours, severe pain and tenderness continue and the temperature is not showing signs of falling, decompression of the affected bone must be carried out. The sensitivity to penicillin of the organism concerned should be checked, if possible by aspiration or by incising and opening the bone. After five days without satisfactory response to conservative measures surgery is essential.

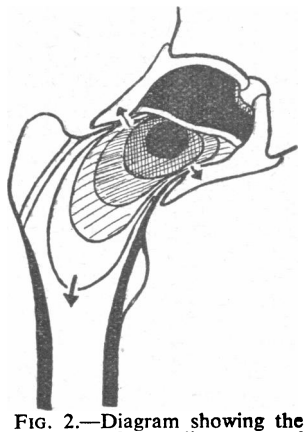

FIG. 2.—Diagram showing the influence of spreading zones of intra-osseous pressure arising from a central abscess (black circle). Arrows indicate penetration of metaphysial cortex into synovial cavity or diaphysial spread. Compared with Fig. 1 it will be noted that vascular obstruction by such an abscess may cause epiphysial necrosis (indicated in black).

Physiological Rest

By this is meant giving rest to a part of the body in the position most favourable for the biological processes of growth and repair, while safeguarding functional restoration. Its purpose is to promote healing by reducing the local physiological demands of the limb, by avoiding the aggravation of pathological processes and the spread of infection by movement, and by bringing to bear upon the lesion the whole general metabolic resources of the patient. The rest is graduated according to the activity of the disease and should readily permit progressive activity as infection becomes controlled. During the phase of acute inflammation perfect immobilization is required. For each limb and every joint there is a physiological position which is optimal for the average needs of the limb. This position is not a fixed one but varies, and is usually near the middle of the normal range of movement of the joint concerned. In the lower extremity joints are generally rested in positions rather more extended than the previous statement suggests. A list of suitable joint postures is given in the Table.

Optimal Positions for Physiological Control

Joint	Position	Joint	Position
Shoulder	Abduction 45°; flexion 30°; external rotation 15°	Hip	No abduction or adduction; rotation nil; flexion 20°
Elbow ..	Extended to about 100°	Knee	Flexion 15°
Forearm	Mid-prone-supine position	Ankle	Right angle or, in woman, a degree or so below
Wrist ..	Extension 15–20°		
Digits ..	All joints flexed about 25°. Thumb abducted and opposed moderately	Tarsal	Neutral as to inversion or eversion
		Toes	Maintain flexion of metatarsophalangeal joints and extension of interphalangeal joints
Spine ..	Normal curves maintained		

It is important to avoid makeshift appliances which do not fit comfortably or maintain perfectly the position required. For the lower extremity the Thomas splint cannot be improved upon. There is no contraindication to the use of plaster-of-Paris splints, provided they are split to enable adequate observation of the limb. In many cases these may be preferable because of the better immobilization and comfort which they provide.

Antibiotic Treatment

The importance of maintaining an adequate blood concentration of the appropriate antibiotic when indicated has been repeatedly stressed in this series of articles. If the response to antibiotic treatment is not adequate, either the organism is insensitive or surgery is needed. The move towards more exotic and more expensive antibiotic drugs should not be allowed to take the place of common-sense surgical judgment. In all cases in which the clinical signs (including the temperature chart and the white-blood-cell count) indicate an abscess or bone necrosis the bone should be opened as soon as possible.

The continued use of antibiotics over a long period because of the persistence of local activity and because of failure to operate at the right time may produce unresolved bone lesions of strange type which can even mimic radiologically such conditions as malignant bone tumours. Furthermore, these lesions, especially if in the central diaphysis, are vulnerable to stress and may cause pathological fractures.

Associated Lesions

Treatment of Suppurative Arthritis.—If a joint is involved secondarily to a neighbouring osteomyelitic lesion the proper surgical treatment for the latter is of first importance. Spread of infection from a neighbouring bone is the commonest way in which joints are infected in childhood. Aspiration of the joint in all types of septic arthritis is an important diagnostic procedure. Furthermore, aspiration readily permits the direct instillation of antibiotics; a method of treatment which is of special value. Penicillin, having a large molecule, is not readily removed from joints into the blood stream, and a high concentration remains long after the injection has been given. During the early period of treatment, however, it is necessary to maintain a high concentration in the blood in order to deal with the general systemic aspect of the infective lesion. The unsatisfactory nature of this treatment in the presence of a neighbouring bone focus should be stressed. If the purulent effusion is clearly associated with a local bone focus and is not responding to antibiotic therapy, the need for surgery is particularly indicated for the bone itself.

Osteomyelitis in the Newborn.—During the first few weeks of life osteomyelitis, generally of the femur, may occur secondarily to umbilical infection. Compared with osteomyelitis in older children, it is relatively more often due to streptococcal infection. At a few weeks of age a painful swelling of the femur, or of any other bone for that matter, raises an interesting point in diagnosis, but while infantile hyperostosis corticalis is a rarity, the practitioner would do well to keep in mind the possibility of scurvy and syphilitic epiphysitis. The *x*-ray picture of a well-established case of scurvy is strikingly similar to that of osteomyelitis affecting the whole shaft of a long bone.

Other Sequelae of Osteomyelitis.—Most of the sequelae are beyond the scope of this paper because they come under the heading of chronic osteomyelitis. These include sequestration, sinus formation, Brodie's abscess, pathological fractures, and amyloid disease, all of which should, under modern conditions, become rarities. Cases from the pre-penicillin era, however, still appear and occasionally, alas, even now cases occur as the result of imperfect early treatment. Septic arthritis has briefly been mentioned. It is at the hip-joint that special complications may arise—namely, pathological dislocation and separation, with or without necrosis, of the upper femoral epiphysis due to massive infection of the metaphysis. Necrosis, as elsewhere, is dependent upon the extent to which the blood supply has been obliterated. When apparent, these complications become major surgical emergencies.

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IMPRESSIONS OF A VISIT TO KOREA AND JAPAN

BY

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In January and February, 1952, I visited the British Commonwealth Forces in Japan and Korea by courtesy of the Commanding General, Far Eastern Command, and the General Officer Commanding, British Commonwealth Forces. Brigadier-General William E. Shambora, Chief Surgeon of Far Eastern Command, welcomed me and gave me every facility to visit all medical installations.

The first visit was made to the U.S. Army equivalent of a British Army base pathology laboratory, which was organized in seven sections, dealing with such subjects as bacteriology, epidemiology, blood transfusion, etc., and had a total staff of about 300. Here the problems being dealt with included the cause of epidemic haemorrhagic fever, research on infective hepatitis, and measures to render water safe from bilharzia.