OSTEITIS.

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The term osteitis as here employed is to be understood as meaning an acute or chronic infection of the bone tissue with one or other of the common pyogenic organisms and as including the conditions commonly known as osteomyelitis and periostitis. The usual site for the onset of an acute pyogenic infection is the metaphysis of one of the long bones, and for this reason the condition has always been known as acute osteomyelitis. It is rare, however, particularly in acute infection, for the inflammation to remain confined to one or other of the constituent parts of the bone and the term acute osteitis is perhaps a more proper designation.

Acute Osteitis.

Incidence. The incidence of the disease has not changed much since the present century began and the mortality has shown little or no tendency to diminish. In a recent series of 200 cases admitted to the wards of a children's hospital during the years 1933 to 1936, the mortality was 16.5 per cent. over all ages. Twenty-two of the children were aged one year and under, and the mortality of this age group was 32 per cent. Forty-six were aged 2 to 4 years inclusive, with a mortality of 15 per cent. The remaining hundred and thirty-two children aged 5 to 12 years gave a mortality of 14 per cent. Boys are more frequently affected than girls, the proportion in this series being 175 boys and 75 girls. The morbidity and permanent disablement which often follow in the train of this disease are not, however, reflected in the ordinary sources of statistics and they constitute a formidable challenge in the experience of individual surgeons and hospitals. It is true that here and there the incidence of the disease has seemed to lessen, and the mortality to diminish, but not more than could be accounted for by the improvement in the physique and general health of the community—and particularly of the children. Nevertheless, the challenge has not yet been met. Wherever we find the weakly child, of poor stock and of adverse environment, we have still to admit a high mortality, slow healing and continued morbidity.

A greater respect for the defence mechanism of the tissues is characteristic of present day surgery, and tends towards conservatism in dealing with pyogenic infections. It is not only reasonable to assume, as is indeed borne out by clinical experience, that time is required for the mobilization of tissue and blood defence, and that surgical interference at an early stage, or in too radical a fashion, may easily act adversely. If such an attitude be justified in dealing with the tissues of the adult, it is a thousand times more so when dealing with a young and growing organism. The power of the child's tissues to return to structural integrity after destructive lesions is remarkable. The most gross infection of bone and joint may clear up and leave scarcely a trace, with a functional and structural recovery well nigh complete. In dealing with children then the surgeon must remain, whatever he be in other spheres, a conservative. It is the health officer and the bio-chemist who must lead the attack in future. We might with profit cease our intensive culture of micro-organisms *in vitro et in vivo* and turn our attention to fertilisers and weed-killers for the soil is more important than the organism.

Ætiology. To explain the onset of an acute osteitis we postulate a latent symptomless septicæmia. There is no doubt that organisms can circulate in the blood and be excreted in the urine of apparently healthy children but that does not constitute a septicæmia. There must be some factor at work whereby the

organisms are made to turn upon their host and we are asked by the text-books to believe that injury is that factor. The mechanism involved is difficult to understand as the injury is often of such a nature that there is no local evidence whatever of its occurrence. The choice of the metaphysis as the favourite site for the local focus suggests that this may be associated with the anatomical arrangement of the blood vessels in that region. The effect of the injury, however, may be constitutional rather than local. The shock or fright of an injury undoubtedly causes a very real disturbance of metabolism—a disturbance more than sufficient to produce an environment favourable to the circulating micro-organism.

Whatever the mechanism of the onset, some source of infection there must be. It may be obvious; septic tonsils, nasal infection, carious teeth, umbilical sepsis, middle ear infection, gastro-enteritis, boils, impetigo, etc., but often a careful search fails to reveal any focus. The importance of a latent infection of the middle ear has not perhaps received sufficient recognition. In a series of 1,000 consecutive post-mortem examinations pus was found in the middle ear of 173 cases and in the majority there had been no clinical evidence of such infection. Undoubtedly, however, the most dangerous source of infection is the skin and a history of skin infection, e.g. boils, impetigo, septic blisters or recurrent paronychia often precedes the most fulminating and fatal form of acute osteitis.

Infection and Distribution. In the great majority of cases the staphylococcus is the infecting organism, but in infants up to eighteen months or two years of age the streptococcus may be responsible. It is of interest to note that in these infants the blood infection seems to dominate the clinical picture. The local damage seems less important and the local recovery surprisingly complete. The pneumococcus is not uncommonly found and this infection is probably the least virulent form, both local and general. It is unfortunate that the staphylococcal infection should thus predominate since the local damage characteristic of the staphylococcus is often severe and serum or vaccine therapy so far of little avail.

The bones most commonly affected are the tibia and the femur with almost equal frequency. The humerus comes next, followed by the bones of the forearm and the fibula. The os calcis and metatarsals are affected with almost equal frequency and are followed by the innominate bone and the mandible. It has been said that the more central the site the more dangerous is the infection, but in a recent series the figures failed to support such a contention.

Pathology. The infection starts as a small limited focus in the cancellous bone of the metaphysis. Though the local focus may be thus limited a generalized septicæmia may yet be present at this stage. Thus a local excision, though possible surgically, may be useless therapeutically. The infection may spread distally towards the epiphysis, but the epiphyseal cartilage in the growing child is usually an effective barrier. In the infant before the cartilage proper is formed, and in the adult after it has disappeared, a rapid spread towards the joint surface is not uncommon. The most usual route is through the cortex towards the periosteum where a sub-periosteal abscess may form comparatively rapidly. Less rapid probably is the spread upwards to the medullary cavity. If an extensive spread takes place under the periosteum simultaneously with infection of the medulla, the blood supply of the bone is seriously interfered with and extensive destruction of the shaft results. In the absence of a gross medullary infection, however, even extensive stripping of the periosteum may not be followed by destruction of the shaft, and in infants particularly the shaft seems to have unusual powers of resistance. There seems to be no constant relationship between the development of this local condition and the degree of general toxæmia. If there

be one at all, it is rather in the nature of an inverse ratio, i.e. the more severe the local reaction the less severe the general toxæmia. In infants the infection usually starts in the epiphysis and the joint is early and frequently involved.

Clinical Features. The condition occurs most commonly in boys between the ages of 5 and 10 years. The child complains of pain near the end of one of the long bones—usually the tibia. The pain rapidly becomes severe and is accompanied by signs of toxæmia with fever, rapid pulse, dry tongue and general malaise. Local examination may reveal nothing except tenderness on pressure. This tenderness, however, is very characteristic, being localized to a small area and extremely acute, and is sufficient in itself to establish the diagnosis beyond a doubt. The pain and tenderness are such that the child will cry out at the merest suggestion that the leg is going to be touched. In many cases what may be termed “referred tenderness” can be elicited. Although the maximum tenderness is always felt when pressure is applied directly over the focus of infection, the child will still complain of pain at that site, even when the pressure is applied to the bone at some distance away.

Such is the clinical picture of the early stage of the disease, the stage at which the general practitioner will be called—the stage at which the diagnosis should be made and fortunately in most cases is made. In general practice a differential diagnosis may have to be made from

(a) *Greenstick fracture* in a young child of say 2—3 years. The child complains of pain in the leg after a fall and is unwilling to use it. There is an area of local tenderness and possibly a slight rise of temperature. The child, however, is not ill and fixation of the limb in a splint will relieve the pain, while a few hours' observation will equally relieve the mind of the doctor as to the presence of any acute inflammation.

(b) *Acute infective arthritis* may cause considerable difficulty in diagnosis, especially when it is remembered that a true bone infection is often accompanied by an effusion in the neighbouring joint. The maximum tenderness, however, is in the joint and not in the bone. If doubt persists, the joint should be explored with a needle before the bone is opened.

(c) *Acute rheumatism* is sometimes a source of confusion. A careful local examination will reveal the absence of true bone tenderness, and the child, though highly fevered and sweating, is not toxæmic. A true mono-articular rheumatism is extremely rare.

(d) An attack of *scurvy* may first present itself through local pain and marked tenderness in a limb. The child, usually an infant, is irritable and resents any handling of the limb. The bone is found to be thickened. There is, however, no toxæmia or high fever and the development of hæmorrhages elsewhere will suggest an enquiry into the dietetic history and reveal the diagnosis.

(e) Less common but occasionally a source of confusion is *acute anterior poliomyelitis*. A child is taken suddenly ill with high fever and complains of pain in a limb, accompanied by loss of function and tenderness on pressure. This tenderness, however, is not localized to the bone but is general throughout the muscles. Headache and other signs of meningeal irritation appear early and a lumbar puncture will confirm the diagnosis.

(f) *Cellulitis and erysipelas*, particularly in infants, are often accompanied by considerable fever and toxæmia and should always arouse suspicion of an underlying bone infection. The absence of acute bone tenderness may be the only sign to justify further observation. Where the less frequently affected bones are involved, the diagnosis may also present considerable difficulty. For example,

an acute infection of the innominate bone may be mistaken for an acute arthritis of the hip joint, for acute retro-peritoneal adenitis, or even for acute appendicitis. A careful examination should reveal the true seat of the tenderness.

Fortunately, as a general rule the diagnosis is beyond a doubt but the conditions referred to above have on occasion caused difficulty.

The further progress of the disease varies according to the predominance of the local or of the general symptoms. On the one hand the local focus may develop with the clinical manifestations of oedema, swelling of the limb, redness, and finally fluctuation, while the general condition shows little change or even some improvement. On the other hand, the general symptoms may rapidly become more severe with little or no change in the local condition and a fatal result follow within 36 or 48 hours. To forecast in the early stages which course a particular patient will follow seems impossible. The leucocyte count has been used both for diagnostic and prognostic purposes but the results on the whole have proved unreliable. The time required for a blood culture militates against its usefulness and the result is more of scientific interest than of clinical value. There seems to be no doubt that in the rapidly fatal cases death is due to a virulent septicæmia and treatment of the local focus has little if any effect in arresting the progress of the disease. Indeed, in many cases the effect of the local treatment has seemed to be harmful and to increase the septicæmia, but to hold one's hand in the presence of an acute osteitis requires long clinical experience and considerable moral courage. For the inexperienced immediate treatment of the local focus is the only safe guide.

Treatment. There is in fact, or should be, no such conception as "*the* surgical treatment of acute osteitis." A visitor to the surgical wards of a children's hospital was recently shown six cases of acute osteitis each of which had received different treatment. One had been left alone; one had had a sub-periosteal abscess opened; one had had the medulla opened with a small gutter; one had had an extensive gutter; one had had the entire diaphysis removed; and one, an infant, had had the knee joint opened as well as the lower end of the femur. This variation in treatment was an indication, not of uncertainty or lack of surgical principles on the part of the surgeon concerned, but of his endeavour to assess the condition of each patient individually and to apply such methods as seemed most suitable for that particular child. The only factor common to all the operations was that they were performed at the earliest opportunity after the diagnosis had been made. The real problem of the treatment of acute osteitis lies in the difficulty of assessing the relative importance of the local as compared with the general infection. If the surgeon is convinced that the condition is essentially a systemic infection, with the local focus as merely "a local manifestation of a generalized infection," then his treatment will tend to be conservative even to the extent of "non-intervention" in the local dispute. On the other hand, if he considers the local focus as the essential cause of the septicæmia, then he will favour more radical measures even to the extent of complete excision of the diaphysis. The aim of the immediate operation should be relief of tension for the twofold purpose of easing pain and lessening absorption. Incision of a sub-periosteal abscess may be all that is necessary or even, in view of the patient's condition, all that is advisable. In another case the medulla may require to be opened, sometimes extensively if it is widely infected. Justification for a primary diaphysectomy is sought in the fact that in many cases nature will provide a new shaft. This may happen in many cases, but not in all, and no surgeon who has had to wrestle with such cases in an endeavour to provide a new shaft by bone-grafting will lightly decide on a primary diaphysectomy. If the fibula alone is affected, then a partial or complete

diaphysectomy is the ideal treatment as a failure of growth is unimportant. In later stages also, where an X-ray film shows a reasonable growth of new bone round an extensively diseased shaft, removal of that shaft is the best course. In general, however, treatment should be conservative rather than radical. Extensive stripping of the periosteum must be avoided and a minimal interference with the bone attempted. The use of strong antiseptics is likely to do more harm than good and the wound should be packed lightly with gauze soaked in some oily preparation, and the limb enclosed in a plaster case. Any simple vegetable oil may be used and its function is purely mechanical to facilitate the escape of the discharge and to permit a painless removal of the gauze at the subsequent dressing. Various antiseptic emulsions have been given extensive trials but no consistently beneficial results have been obtained.

In many cases the local and general conditions at once improve and the limb may be left untouched for from four to six weeks. By this time the plaster may have become soiled and foul-smelling but the wound, when dressed, will be found clean and healing. In other cases, however, improvement is not immediate and either the local or the general condition will continue to cause anxiety and call for further intervention in the local focus. There comes a stage, as in most infections, when the patient has gained the upper hand and until that stage has been reached the surgeon must be prepared to intervene. Secondary metastatic abscesses may form in other bones or elsewhere in the body. An attempt should always be made to deal with these by aspiration and only if that method fails should resort be had to open incision. In all such operations or dressings it should be realized that a mixed infection of pyogenic organisms is almost as bad for the patient as a mixture of pyogenic organisms with the *Bacillus tuberculosis*. The strictest surgical technique should never be departed from. In spite of care, sequestra may form and delay healing in patients whose resistance is poor. These, if large, should be removed by open operation but if small can be left for nature to get rid of.

These small sequestra are responsible for an occasional example of the so-called relapsing or recurrent osteitis where the wound breaks down after being healed for many weeks or even months. A small sequestrum is extruded and the wound again heals, only for the process to be repeated after a further interval. As a rule in such cases the general health of the patient remains unimpaired. Occasionally a patient is encountered who fails to respond to any treatment and the condition of the local focus remains so unsatisfactory that the surgeon is compelled to face the question of amputation as the only means of saving the patient's life. Fortunately such cases are extremely rare.

Even in patients who are making good progress a further difficulty arises in the prevention of deformity. Perhaps the gravest type of deformity is that already referred to, namely, the failure to form a new shaft. In the femur and the humerus the resulting loss of function is disastrous. In the forearm and leg the continued growth of the unaffected bone causes gross deformity and disability. The provision of a new shaft in such cases may prove extremely difficult. Scarcely less crippling are those cases where the epiphyseal cartilage has been injured by the infection. The consequent interference with growth gives rise to a persistent and increasing deformity during the growth period—most difficult to control. A third cause of deformity is involvement of the neighbouring joint. This is not uncommon, for example, when the bone focus is in the upper end of the femur. This site is within the joint capsule and the joint is frequently involved. Great and persistent care is required in such cases, to control the joint infection with its tendency to pathological dislocation and later contracture.

Chronic Osteitis.

Although acute osteitis is the most common manifestation of staphylococcal infection of bone less virulent forms are sometimes encountered. An abortive form of the acute infection may occur which subsides within thirty-six or forty-eight hours with or without surgical intervention. The attack is so transient that the diagnosis may be in doubt for a time and be verified only by the subsequent appearance in an X-ray film of periosteal thickening around an area of rarefaction in the metaphysis. Frequently in such cases there is little or no general reaction and the diagnosis is made on the local signs and symptoms. By way of contrast should be noted a type of sub-acute or chronic infection in which there is at first no evidence whatever of any local focus. The patient is admitted as a frank septicaemia with a high swinging temperature but little toxæmia. Improvement sets in gradually and only after a period of days or even of weeks is there any evidence of a local focus of infection. The patient may then complain of a little pain or discomfort in a limb but frequently the first evidence of anything local is the presence of a swelling somewhat tender to touch, and the appearance in an X-ray film of a well marked periosteal reaction of fairly diffuse distribution. This swelling soon becomes fluctuant and on aspiration a somewhat thick pus is obtained which on culture remains sterile. Similar foci may develop in other limbs although by this time the patient's general health may be almost normal. Such swellings should be treated by repeated aspiration but occasionally it may be necessary to make an incision and evacuate the contents. No attempt should be made to interfere with the bone unless a definite sequestrum can be seen in the X-ray film.

Perhaps the most common form of chronic pyogenic infection of bone is that known as a *Brodie's abscess*. This is a localized osteitis occurring without any acute phase. The child complains of recurring attacks of deep-seated boring pain situated towards the end of one of the long bones, usually the tibia. The pain is not extreme and is often felt more at night. Examination of the site of the pain may be negative but occasionally some thickening of the bone can be made out and there may be local tenderness. As a rule the general health is unimpaired apart from the effects of the pain. An X-ray film shows an irregular area of rarefaction surrounded by well marked sclerosis. The diagnosis of such a lesion is usually straightforward but it must be remembered that a similar focus may occasionally be caused by a tuberculous and by a syphilitic infection. A careful general examination is essential and the Mantoux and Wassermann tests may afford help while the X-ray appearances are often suggestive—the surrounding bone being rarefied and irregular in tuberculosis, densely sclerosed in syphilis. Rarely the question of bone cysts and tumours may have to be considered in the differential diagnosis. The treatment of a Brodie's abscess consists in incision and evacuation of the contents leaving the bone cavity widely open. The soft tissues should be closed, however, and any collection of fluid thereafter removed by aspiration. The final obliteration of the cavity may take many months to be complete.

Lastly there is a type of chronic osteitis, comparatively rare, in which the infection is not localized but diffuse. There is no acute phase but the patient complains of persistent boring pain with acute exacerbations. The bone is felt to be thickened and may be tender on palpation. An X-ray film shows a fusiform thickening of the cortex on both medullary and periosteal aspects. The infection is very chronic and there is rarely any fever or disturbance of the general health. It is advisable, however, before making a diagnosis to exclude syphilis, and hence a Wassermann reaction should never be omitted. No treatment is likely to arrest the progress of the infection but the pain may be relieved by opening the medulla.