

Editorial

Management of Osteomyelitis

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Hematogenous pyogenic bone and joints infection is seldom seen in developed countries, but in developing countries it is still a major and common problem.^{3,7} New forms of acute fulminating osteomyelitis are likely to appear due to immunosuppression in the wake of the spread of HIV infection, AIDS, and the increased use of steroids, antibiotics and immune activators.⁵ Osteomyelitis due to candida and cryptococcus, which are not infectious in certain regions, are occasionally observed. Another form of osteomyelitis that is often encountered and resistant to treatment is associated with diabetes mellitus.⁵

Bone and joint infections are difficult to cure.^{1,2,4,6} This difficulty is related to the presence of bacteria adherent to dead bone and foreign material in many cases and also to drug resistance and limited distribution of antibiotics into infected bone.^{1,8,9} This presentation summarizes present knowledge of bone and joint infection and its management.

Pyrogenic hematogenous osteomyelitis varies in severity from a comparatively mild clinical form to an acute fulminating illness. Since 1944 in developed countries when antibiotics became available to treat osteomyelitis and surgical drainage has been carried out, the severely ill patient is seen less often, while the number of patients presenting with a mild or subacute form has increased. Recently, similar trends have been seen in developing countries.⁶

Today, new cases of hematogenous osteomyelitis of any form are rarely seen, but the number of non-hematogenous type cases complicated by open fracture

and surgeries including joint replacement and spinal instrumentation has increased.^{4,8,10,12} Many adult patients with pyogenic infections also have major associated diseases or conditions such as diabetes mellitus, malignancy, chronic alcoholism and drug addiction.

In adults, hematogenous osteoarticular infection may present as several different clinical syndromes. In children, the clinical presentation varies because the anatomy and blood supply to the bone vary at different ages. The difference is most marked in babies under one month, infants aged 24 to 30 months, and children aged 3 to 12 years.⁶

Prior to the availability of antibiotics, mortality from hematogenous osteoarticular infection approached 20% and morbidity 45% to 50%. Today in developed countries, children with acute osteomyelitis rarely die, but preventable morbidity remains. Reducing the morbidity depends on prompt diagnosis and initiation of appropriate treatment. Early diagnosis of acute osteomyelitis is only possible by isolating the microbe, which is difficult in practice. Early diagnosis may prevent progression to the chronic form. In joint replacement and instrumentation surgeries, preoperative lymphocyte counts of $<1,500 \text{ mm}^3$ and albumin levels of $<3.5 \text{ g/l}$ are associated with greater frequency of wound complications.

Diagnosis of post-operative infection can usually be readily made with evidence from the history and physical examination, confirmed by simple imaging and laboratory investigations. Ultrasonography is

useful to demonstrate the location of an infected hematoma or abscess and to guide diagnostic aspiration. The C-reactive protein level appears to have a higher predictive value for deep sepsis than does the ESR or WBC count.¹¹ The C-reactive protein level falls rapidly after the second postoperative day following uncomplicated joint arthroplasty; maintained high levels may indicate possible prosthetic infection. Scintigraphy presently has no important role in this clinical context. CT and MRI are also useful although not widely used routinely.

The management of bone infection should be based on an understanding of the underlying bone pathology and disease process. In the acute condition it is important to prevent progression to a chronic form, to prevent acute exacerbation of the infection, to restore normal anatomy and function particularly of the joint, and to minimise complications such as joint destruction, bony deformity and overgrowth, and amyloidosis. Treatment should be initiated the moment osteomyelitis is suspected.

In cases of articular skeletal infection, antibiotics and surgery are the mainstays of treatment. Antibiotics should be used prudently and the doctor should decide whether or not they are an adjunct to surgery. This is the critical point when the initial treatment may be successful or the disease may progress to the chronic form. Appropriate antibiotics should be selected. The most common causative organism in hematogenous osteomyelitis is *Staphylococcus aureus*, while gram-negative bacilli predominate in the non-hematogenous form. In general, doctors have depended too much on antibiotic treatment and have been too late with surgical intervention to prevent progression of early acute and subacute osteomyelitis to the chronic form.

Antibiotics kill bacteria and prevent their invasive spread, while surgery aims to drain pus, remove necrotic soft and bone tissues and bacterial slime, and restore blood supply. Surgical management of osteomyelitis can be very challenging. Debridement surgery is the foundation of osteomyelitis treatment, which should not be delayed if the clinical history and examination suggest infection. These two factors help improve the patient's general condition and avoid or minimise local recurrence of infection. Six to 12 weeks of therapy with high-dose parenteral antimicrobials directed at organisms isolated in the culture of the infected bone is usually recommended. The early results with quinolones and rifampin for prosthesis-related infection are encouraging.⁹ Overall, oral quinolones provide a new and frequently proportionate response to a disease that is difficult to treat.

In addition to these two basic modalities for early treatment of acute hematogenous osteomyelitis, acidic NSAIDs are also prescribed to inhibit osteolysis, which is induced by prostaglandins.

After saucerization of osteomyelitic bone, muscle flap can be transpositioned to obliterate the bony defect,³ and antibiotic-impregnated acrylic beads are used to sterilize and temporarily maintain dead space.¹ The cement beads are usually removed within 2–4 weeks and replaced with a cancellous bone graft in certain cases. Antibiotic-impregnated cement has also proved effective for replacing infected prostheses. However, only heat-stable antibiotics which are released slowly from cement surrounding the tissue can be used because heat which is generated during the polymerization process makes heat-unstable antibiotics ineffective. The most commonly used antibiotics in beads are vancomycin, tobramycin and gentamicin.

In chronic osteomyelitis it is also important to treat the poor quality soft tissues. In chronic osteomyelitis and osteomyelitis associated with diabetes, hyperbaric oxygen therapy can be beneficial.⁵ As chronic osteomyelitis is a local ischemic condition, hyperbaric oxygen therapy promotes wound healing and is bacteriostatic. When there is damaged or ischemic soft tissue over the infected bony foci, hyperbaric oxygen therapy encourages wound healing.

Chronic osteomyelitis involving the entire long bone is very difficult to treat unless diaphysectomy is carried out. However, few bones can be completely excised. In most cases of chronic osteomyelitis, saucerization, not diaphysectomy, is the preferred method. After saucerization of the osteomyelitic area, closed continuous wound irrigation for 7 to 10 days with antibiotic solution containing mucolytic agents or 0.1–1.0% of diluted povidone-iodine solution is recommended. However, when the entire bone shaft is involved, saucerization alone cannot remove all the infected bone and surrounding scar tissue. The remaining bone remains ischemic and will not respond well to antibiotics.

Hyperbaric oxygen therapy is a useful adjunct to treatment. Such therapy has been shown to increase the oxygen tensions within infected bone, thereby augmenting the polymorphonuclear leucocyte and localized host immune response. When saucerized bone cannot be covered by soft tissue because of the soft tissue defect, the denuded bone should be covered with muscle or a musculocutaneous flap. Again, hyperbaric oxygen therapy should be instituted.

When chronic osteomyelitis is treated improperly, the patient will not only suffer from recurrence, but

also amyloidosis of the parenchymatous organ. A draining sinus untreated for over 10 years can develop into epidermoid carcinoma. Therefore, every patient who suffers from chronic osteomyelitis with a draining sinus should be regularly checked for epidermoid carcinoma.

Fractures that have been repaired with internal fixation devices and become infected are difficult to treat and will not respond well to antibiotics unless the fixation device (biomaterial) is removed.² The fracture must then be externally immobilized. This is because organisms stick to the biomaterials and are covered by glycocalyx biofilm that presents a barrier to the antibiotics, which are therefore unable to reach the bacteria. Infected pseudarthrosis with segmental osseous defects may also be treated by debridement and microvascular bone transfers. Vascular bone transfers in case of bone defects more than 3 cm in length can be placed after one month of inactive sepsis. It is speculated that bacterial drug resistance increases in parallel with the increased biofilm formation. It was reported that under identical experimental conditions the rate of infection with steel plates was significantly higher than that with titanium plates.

In early post-operative infection, surgical debridement and treatment with anti-microbial agents may allow the prosthesis and other implants to be preserved.^{1,4,8,10,12} In contrast, when infection is established and components are loose, radical surgical debridement is necessary to remove all prosthetic material and involved bone and soft tissue.^{10,12} Reconstruction by exchange arthroplasty has been highly successful. It was reported by some that for lower-grade infections, one-stage exchange arthroplasty had been successful but that this procedure had never been compared with the two-stage procedure. Therefore, in management direct comparative trials of one stage vs. two-stage exchange arthroplasty in established prosthetic infection are needed. The costs of managing a primary joint arthroplasty that becomes infected are 8–10 times those of a successful, uninfected arthroplasty.⁷ One-stage

exchange is clearly less expensive than two-stage exchange. Significant progress has been made in controlling the infected arthroplasty because of the increasing armamentarium of anti-microbial agents to treat infection. However, as yet difficulties and uncertainties in management remain.

Judicious treatment of any type of osteomyelitis is essential. Maintaining a high standard of asepsis in the operation room is vital to prevent post-operative infection. Prophylactic anti-microbial regimens are of proved effectiveness in reducing infection rates, and regimens administered for as short a period as 24 hours after surgery have been shown to be effective.^{2,8} To prevent late hematogenous infection of the prosthetic joint, prompt treatment of intercurrent bacterial infection is important. If any infection is suspected, treatment must be initiated immediately to minimize and prevent the potentially devastating sequelae.

In spite of the large number of successful treatment modalities, many questions still need to be answered, especially with regard to optimal therapies for bone and joint infections.⁷ It is thought that a better understanding of the pathophysiology of these biomaterial-centered infections, especially the role of a foreign body in promoting the infection and making it resistant to antibiotic therapy, the definition of the role of non-antibiotic treatment, and the selection of new diagnostic techniques are the key factors to solve the unanswered questions and to provide more successful treatment.

In summary, this editorial has highlighted the key points in prevention and management of bone and joint infections, either hematogenous or non-hematogenous. As yet, in some areas of the Asia-Pacific region, the incidence of osteoarticular infection is still relatively high, and the statistics emphasize the need to prepare for a resurgence of bone and joint infections due to the spread of the human immunodeficiency virus, other acquired immune suppression diseases and increased use of biomaterials in the human body in future.^{7,8}

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