Prompt Diagnosis of Suspected Osteomyelitis by Using Percutaneous Bone Culture

The authors describe a single technique of percutaneous bone culture, performed in the doctor's office or at the patient's bedside, in patients with suspected osteomyelitis. This technique provides for definitive documentation and verification of causative organisms when radiographic and scintigraphic studies are inconclusive, and it avoids the dangerous over-utilization of potentially dangerous radioisotopes and/or antibiotics, particularly in compromised individuals. Also described is a protocol to expedite the diagnosis and treatment of osteomyelitis in the hospital setting when diagnostic related groups (DRG's) are in effect.

Early diagnosis of osteomyelitis is essential to provide effective treatment, proper course of therapy, and avoidance of chronicity. This retrospective study involves 13 patients admitted to the Baptist Medical Center for suspected osteomyelitis, associated with pedal ulcerations. The majority of the patients were diabetic. No children were involved in the study. This study was undertaken because of the inadequacy and in accuracy of radiographic and scintigraphic studies, the lack of correlation between sinus tract and wound cultures with organisms present in the bone, the proper selection of antimicrobial drugs to avoid overuse of ineffective antibiotics and prolonged course of therapy, to discourage the use of toxic antibiotics in renal compromised patients, and to limit the length of hospital stay and unnecessary medical diagnostic tests.

Most patients in this study presented with active wound infection and radiographic changes in the underlying bone, suggestive of osteomyelitis. Early in acute osteomyelitis, radiographic findings are usually normal or demonstrate only soft tissue swelling (l - 4).After 7 to 10 days from onset, only one third of the patients present with radiographic changes. Radiographic abnormalities clearly present after 3 to 4 weeks from onset in over 90% of cases (l, 4, 5).

Twelve of 13 patients presented with a radiologist's report that read, "suggestive of osteomyelitis - recommend bone scan". It has been well documented that radiographs, without tomography or scintigraphy, are neither sensitive nor specific for the diagnosis of osteomyelitis (68). Technetium99m (" Tc) medronate and gallium citrate ('Ga) reportedly have been helpful in the early diagnosis of osteomyelitis, however, the radiologist's report usually reads, "should be compared with x-ray". In the authors' retrospective analysis, " Tcscans were performed on all but four patients, and they were interpreted as positive if increased uptake was seen at the area of suspected osteomyelitis (9). Sugarman etal. (7) have reported that these studies (" Tc and "Ga)may falsely suggest the presence of osteomyelitis, in the absence of histologic or bacteriologic evidence of bone infection (7).

It has also been documented that sinus tract and wound cultures have a low predictive value in isolating pathogens in the bone (10, 11). Staphylococcus aureus, however, was believed to have a more reliable correlation with bone and soft tissue (2, 4, 10, 11). The incidence of S. aureus associated osteomyelitis has decreased from 80 to 90% to as low as 46%, with marked increases in ûram negative and anaerobic bacteria (7,10). Therefore, one can no longer assume that S. aureus found in soft tissues will be the only pathogen isolated from the underlying bone (4).

Patients with a history of renal disease or azotemia on admission are more susceptible to the toxic effects of aminoglycoside therapy (12). Before challenging these individuals with the previously noted substances, or other renally excreted antibiotics, definitive isolation of bone pathogens should be made. Subjecting these patients to so called shot gun antibiosis may be interpreted as inappropriate and dangerous. "The selection of the appropriate antibiotic is dependent upon the identification of the organism causing the infection. Therefore, an adequate wound or bone culture must be obtained before therapy has begun" (3). Long term intravenous antibiotic therapy imposes on the patient's psychologic and physiologic burden as well as high medical expense (2, 3). Appropriate antibiosis combined with debridement of necrotic bone and soft tissue will expedite patients' recovery (4).

Methods

The percutaneous bone culture was performed on all patients utilizing an l 1gauge, 6inch Jamshidi' needle(Fig. 1). This instrument is one of many trephine needle designs utilized for bone marrow aspiration and biopsy(13). The Jamshiditype needle was chosen for our patients because of its simplicity, appropriate size forpedal structures, durability, and inexpensive cost. It consists of an outer cannula and handle with an innerneedle stylet for tissue penetration (Fig. 1).

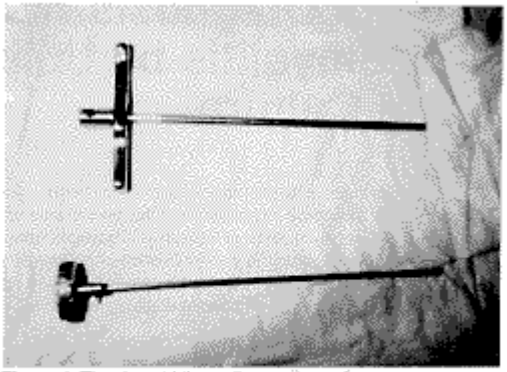

Figure 1. The Jamshidi needle consists of two parts: *upper*, the canula and handle; *lower*, the needle stylet that is inserted within the canula handle.

Materials Needed

Jamshidi needle *, sterile gloves,sterile drape, sterile disposable No. 15 blade and handle,povidone iodine solution, and culture tubes.

Before obtaining bone specimen, the vascular status of all 13 patients was evaluated clinically and documented by noninvasive arterial Doppler studies. All patients had ankle/arm index of 0.75 or greater. Informed consent was obtained before infiltration of 1 to3 ml. of 2% lidocaine plain (if necessary) proximal to the culture site.

The procedure was performed at beside by utilizing a septic technique. The foot was prepared with povidone iodine solution, followed by a single sterile drape. A stab incision, approximately 5 mm. in size, was made at a noninfected area away from the ulcer site (Fig. 2).The Jamshidi apparatus with needle stylet in place is inserted through the incision and directly advanced to the underlying bone (Fig. 3).

Figure 2. A single stab incision is made away from the ulcer site.

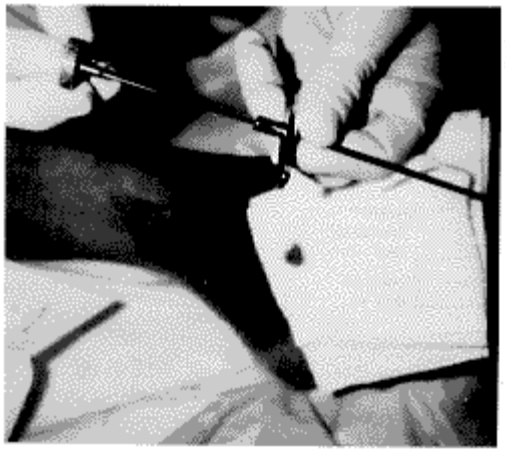

Figure 3. The Jamshidi apparatus is inserted through the stab incision. The stylet is now in place to facilitate tissue penetration.

After reaching osseous tissue, the stylet is removed and the cannula advanced by a twisting motion into the pathologic bone. A cylindrical core of biopsied bone is removed, placed into the culture medium, and forwarded for aerobic, anaerobic, and fungal cultures (Figs. 4 and 5). The stab incision is allowed to granulate or may be closed by sterile adhesive strip. The wound is then redressed.

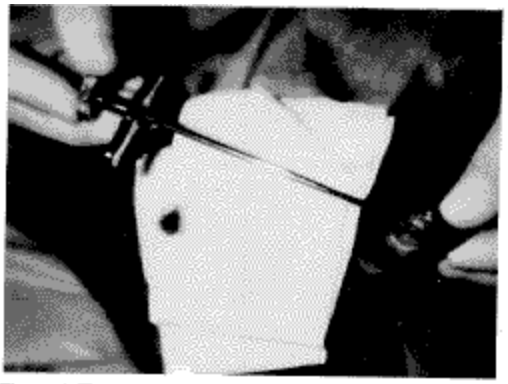

Figure 4. The needle stylet is removed and placed on the sterile field. The canula and handle are advanced via a twisting motion into the underlying bone.

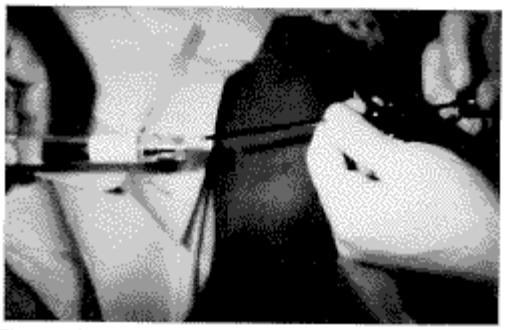

Figure 5. The canula is removed from the incision site. The bone culture is contained within the distal canula. The needle is now reinserted to push the cylindrical core of bone into the culture tubes.

Results

Retrospective analysis of 13 patients (Table 1) indicated that none of the wound or sinus tract cultures correlated identically with the bone pathogens' isolated. Eleven of 13 patients had prebiopsy radiographs "suggestive of osteomyelitis". Seven of 13 patients had positive " Tc scans, as evidenced by increased uptake at suspected sites. Two of 13 patients had negative bone scans with positive x-ray and bone cultures. One patient demonstrated positive bone scan and negative x-ray findings. As one can ascertain from these findings, it is difficult to interpret the diagnostic value of these tests.

Individual findings were of interest in this study. Patient M. L. revealed tissue cultures of Escherichia coli as the primary organism, with Pseudomonas, Enterococcus and Proteus species also present. Bone culture revealed only Enterococcus, an unusual finding as noted by De Benedictus *et al*. (14). This patient's therapy was changed to appropriate, specific agents, and success was achieved. Patient H. L., an insulin dependent diabetic with history of renal compromise, demonstrated Pseudomonas aeruginosa in tissue culture. minoglycoside therapy was not instituted because the one culture yielded Staphylococcus aureus. This patient was treated with specific non renal toxic antibiotics and responded well.

Patients H. L., A. W., A. C., and M. O. had positive x-ray findings followed immediately by percutaneous bone culture. Diagnosis of osteomyelitis was confirmed and "' Tc bone scan was canceled. Patient J. L. revealed Bacteroides fragilis, in addition to E. coli and Proteus species present in the bone. Based on these bone culture findings, appropriate antibiosis was added to cover anaerobic organisms.

M., C. M., and M. B. all had cultures indicating polymicrobial wound infection. Bone cultures produced no growth. These patients' hospital stays were dramatically shortened and the need for parenteral antibiosis was limited.

Patient S. M. was admitted for suspected osteomyelitis, however, x-rays were inconclusive and the radiologist recommended bone scan. The " Tc scan revealed increased uptake at the base of the fifth metatarsal. Bone culture of this area revealed no growth. The patient's diagnosis was changed to infected ulceration with underlying neuropathic bone changes. The patient was discharged and treated on an outpatient basis.

Patient M. B. presented 1 year after transmetatarsal amputation with a 2cm. x 2cm. ulceration at the distal aspect of the second metatarsal stump. Wound culture, x-rays, and '"""Tc bone scan were all positive, with increased uptake at the distal second metatarsal. Bone culture revealed no growth. The authors determined from these findings that the ulceration resulted from regeneration of the second metatarsal stump, causing an abnormal postoperative metatarsal parabola. The patient was brought to the operating room and the elongated second metatarsal was resected to reestablish a normal metatarsal parabola. The wound was closed primarily. The patient's hospital stay was brief and uncomplicated.

Patient C.D., and insulin-dependent diabetic, 1 year previously had a first metatarsal joint implant inserted. The patient presented 14 months later with an ulceration of the fifth digit of the same foot, with cellulitis of the entire forefoot. Radiographs revealed osseous changes of the first, second and third metatarsals and the fifth digit. Clinical impression was that of osteomyelitis of the fifth digit. The metatarsal changes were thought to be indicative of diabetic osteopathy exacerbated by implant surgery. Jamshidi needle technique was utilized at two separate sites: the second metatarsal shaft, and the base of the proximal phalanx of the fifth digit. The metatarsal culture revealed no growth whereas the bone culture at the base of the proximal phalanx, fifth digit indicated a streptococcus. The implant was not removed, and the patient underwent fifth digital amputation that healed uneventfully.

Summary

Jamshidi percutaneous bone culture produced a definitive diagnosis in all patients of the preceding study. Conventional radiographs and scintigraphy have been shown to be inconclusive, costly, and, at times, inaccurate, whereas percutaneous bone culture is simple, diagnostic, and can save both the patient and hospital time and money. The authors, therefore propose the following protocol when osteomyelitis is suspected with an associated, infected wound (Fig. 6).

1. Complete history and physical examination.

2. Stat Gram stain followed by wound culture. Tissue cultures should include aerobic, anaerobic, and fungal studies.

3. Vascular studies that may include noninvasive arterial Doppler studies, if indicated by clinical findings, before any invasive procedure for documentation and indication of wound healing potential.

4. Radiographs are performed. If the radiographs are positive, percutaneous bone culture is performed at the suspected osteomyelitic site indicated by the radiographic findings. This must be done before instituting antibiotics. If bone culture is obtained at a later date, parenteral antibiosis should be discontinued 24 to 48hr. before taking the culture (13). If radiographs are negative or inconclusive, the patient should be started on antibiotics based upon the Gram stain and scheduled for appropriate radionucleotide scan.

5. If the scan is positive, as evidenced by increased uptake at the suspected site, discontinue antibiotics for24 hr. and take a percutaneous bone culture to verify the presence or absence of bone pathogens. The purpose of the bone scan in this instance is to reveal potential bone culture sites. If the scan is negative, treat the wound infection based upon clinical findings, and culture and sensitivity results from the soft tissue.

   Percutaneous bone culture provides for a rapid and accurate diagnosis of osteomyelitis with identification of causative organisms. After bone pathogens are known, the indiscriminate use of potentially dangerous antibiotics (*e.g.*, aminoglycosides) can be avoided or promptly instituted (12). Patients' hospital stays can be shortened by avoiding the overutilization of inconclusive testing, although producing the medical and legal documentation necessary for proper treatment.

   When radiographs are positive, this proposed protocol can be performed within a few hours after hospital admission, or in the doctor's office before admission. When diagnostic related groups are in effect, percutaneous bone culture provides definitive documentationof osteomyelitits either before or within 2 to 3 days after hospital admission.

Acknowledgments

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Comment: The paper by Caprioli et al., entitled "Prompt Diagnosis of Suspected Osteomyelitis Utilizing Percutaneous Bone Culture," is of real value in pointing out some fundamental principles of the problems encountered in dealing with the diagnosis of osteomyelitis. By utilizing a biopsy needle that allows direct cultures of bones suspected of being infected, In a number of circumstances, they were able to show specific bacteria and identify their antibiotic sensitivities. Although the treatment of osteomyelitis is multifactorial, the most crucial factor is making a correct diagnosis. Certainly, a direct biopsy of the supposedly infected site is the most essential and critical of all factors. Depending on the duration of time that an infection has been present, both conventional x-rays and bone scans can be either falsely negative or falsely positive. Although an x-ray is essential, a bone scan never rules in an infection and never rules out an infection. There are some words of caution in using any biopsy technique, including a needle biopsy. A biopsy is limited to one or several sites and it is easy to imagine that some or all of the organisms may not be cultured. Also, it is well known that inserting needles through skin can lead to contamination of the needle itself and subsequently to a false positive culture from a surface contaminant. Although this does occur, fortunately it occurs only on rare occasions. Last, although it is critical to treat the primary infection in the bone, one must not ignore the colonization of any sinuses or related soft tissue infection. These bacteria must be addressed by therapy in an appropriate way, which includes proper coverage by antibiotics. David J. Schurman, M.D.Editor's Note: Dr. Schurman is an Associate Professor of Orthopedic Surgery at Stanford University Medical Center in California. His field of expertise is infection. The editors appreciate his participation in providing this commentary.