Microbiological Evaluation of Diabetic Foot Osteomyelitis

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(See the article by Senneville et al. on pages 57–62)

Diabetic foot ulcers and osteomyelitis may limit health-related quality of life and contribute to mobility impairment, treatment morbidity, amputation, and death [1–6]. The ulcer may be caused by minor or repetitive trauma to the neuropathic foot, and bacterial seeding may result in a chronic draining sinus, osteomyelitis, and secondary bony deformity. Diagnosis of osteomyelitis in the diabetic foot is based on history, physical examination findings, radiographic and other imaging studies, probing the ulcer to bone, wound swab culture results, and deep-bone culture results. However, these studies have varied sensitivity and specificity [7–11]. Therefore, it would be helpful to have simple, reliable, and cost-effective techniques to establish the diagnosis and identify the causative microorganisms. Theoretically, this should facilitate appropriate treatment, including the type and duration of targeted antimicrobial therapy with or without surgical debridement, and should potentially minimize complications that may arise from treatment with broad-spectrum antibiotics.

Clinicians frequently obtain a wound swab for culture either from the ulcer base or the draining sinus and select antimicrobial therapy according to the microorganisms recovered. Although such wound swabs for culture may be reliable in determining the pathogens responsible for superficial infection [12], cultures of sinus tract swab specimens may be unreliable for chronic osteomyelitis [13]. Cultures of superficial swab samples from diabetic ulcers and sinus tracts may not adequately identify the true bacteriological characteristics of diabetic foot osteomyelitis because of bacterial colonization of the wound surfaces with microorganisms that are typically not considered to be pathogenic (such as the enterococci and coagulase-negative staphylococci). However, practitioners often accept swab cultures as an alternative to bone debridement or biopsy specimens because of the ease with which swab specimens can be obtained. Cultures of bone debrided from the base of the wound may also yield colonizing organisms that are usually considered to be nonpathogenic. In theory, cultures of bone specimens from deep within the osteomyelitic focus should be the most accurate method for identification of bacteria that are pathogenic and that can be eradicated by directed antimicrobial therapy; however, deep-bone cultures may be difficult to obtain because of limited technical expertise, time, and availability of surgical facilities.

In the study that appears in the current issue of *Clinical Infectious Diseases*, Senneville et al. [14] attempt to define the true concordance between cultures of swab samples and cultures of bone biopsy specimens obtained from areas of osteomyelitis in the diabetic foot. This well-conducted study nicely summarizes the complexity of establishing an appropriate microbiologic diagnosis in cases of diabetic foot osteomyelitis. It is important that patients who had received previous antimicrobial therapy in the antecedent 4 weeks were excluded from the study, so that culture specimens would be unaltered by recent antimicrobial therapy. It required almost 8 years to amass 76 patients with 81 episodes of diabetic foot osteomyelitis from a single diabetic foot clinic, presumably because many patients whose cases were initially evaluated had already received empirical antimicrobial therapy from their primary care physician or emergency medicine physician. The strength of this study is that the authors accrued this large cohort of patients with supporting microbiological data to correlate between cultures of superficial swab samples and of deep-bone samples.

The study shows that bone biopsy may clarify the causative organisms in cases of chronic diabetic foot osteomyelitis [14]. Pathogens identified from cultures of bone samples were identified from only 30% of the corresponding cultures of superficial swab specimens, and concordance varied...
...with different bacterial species. This is important, because it corroborates the clinical impression that swab cultures are inaccurate and unreliable indicators of the pathogenic organisms in chronic diabetic foot osteomyelitis. The only complication after the biopsy procedure was in 1 patient who developed acute Charcot arthropathy 1 month after the bone biopsy was performed.

There was poor concordance between the superficial swab culture and bone biopsy culture results for all microorganisms. Concordance was greater (but was still only 43%) for methicillin-susceptible and methicillin-resistant Staphylococcus aureus, presumably because of the intrinsic virulence of this species. It was surprising that microorganisms having little suspected virulence, such as coagulase-negative staphylococci and enterococci, were found more frequently in bone cultures than in swab cultures, but the importance of this is unclear because of the small number of these isolates and the absence of histological and treatment-response data. Nevertheless, this observation raises the question as to whether these microorganisms are true pathogens. Some authors have suggested that pathogens of limited virulence may cause infection in the diabetic foot [15], and others have considered these as potential pathogens in diabetic foot osteomyelitis only for subjects who had not improved with therapy targeted at traditional pathogens, such as S. aureus [16]. However, all of these hypotheses have only been supported with data from small studies.

Several features and limitations of the study should be emphasized, to limit overinterpretation of the results. Although many subjects were studied, the number of osteomyelitic episodes with a specific pathogen was small, limiting statistical conclusions about the true concordance between swab culture and bone culture results, which nevertheless appears to be small. The study patients had chronic osteomyelitis associated with ulcer, but acute osteomyelitis or osteomyelitis associated with abscess or sequestrum may necessitate broad-spectrum antimicrobial treatment and radical surgical debridement. Debridement was “required” for 11 patients, but the specific indications for debridement were unclear. As noted by Seneville et al. [14], sampling errors because of inaccurate needle placement may occur even with fluoroscopic guidance, and the needle tip unintentionally may be placed in the wound cavity or exit the bone at the base of the wound, resulting in the growth of colonizing bacteria from the bone biopsy culture. All 81 episodes of chronic osteomyelitis reported in the study were located at the metatarsal heads or toes, but more-proximal cases involving the metatarsal shafts, midfoot, or hindfoot were absent from the study population. Although reasons were not given, forefoot lesions may be more frequent and less complex than more-proximal episodes, and patients with midfoot and hindfoot osteomyelitis frequently will have been treated with antimicrobial agents within 4 weeks of presentation and may undergo radical debridement instead of biopsy. These patients may have complex microbial profiles, and their cases may be especially difficult to manage because of distorted anatomy and limited soft-tissue coverage. The prevalence of peripheral vascular disease was only 29%, which may be lower than that in other studies [17], but this may vary depending on the definition of peripheral vascular disease, which was unclear from the article [14].

Despite the usefulness of the study, several issues remain unresolved. Although the study demonstrates a difference in the rate of microbial growth from wound swab samples and bone biopsy specimens, it is unknown whether treatment based on the bone biopsy results will improve the clinical outcome and prognosis, compared with broad-spectrum empirical treatment or treatment based on swab culture results. The effect of previous empirical antimicrobial therapy on bone biopsy results may further confound the concept of whether treatment based on bone culture results will be as effective as broad-spectrum antimicrobial therapy alone. Furthermore, erythema, increased warmth, and swelling in the absence of a wound may occur in Charcot arthropathy, and in this situation, bone biopsy may be contraindicated, because of the potential risk of causing a deep infection at the biopsy site. The importance of debridement in promoting wound healing also should be considered in managing the diabetic foot with chronic osteomyelitis [18–21].

Acknowledgments


References

12. Slater RA, Lazarovitch T, Boldur I, et al. Swab cultures accurately identify bacterial patho-