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Assessment Strategies to Improve the Diagnosis of Osteomyelitis in Diabetic Foot Using Radiography

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Abstract:

Background: Diabetes mellitus is a multi-system disease that affects people of both genders and any age or ethnic group. Foot wounds are common and can lead to loss of limb in cases of therapeutic failure.

Aim: The aim of this study was to correlate initial diagnoses of osteomyelitis by radiography with bacterial cultures and identify ways to improve the diagnosis using this method.

Method: In a prospective random clinical trial, the correlation between radiographs and bacterial cultures were evaluated in diabetic patients undergoing amputation of toes or part of the foot in Hospital de Base in the period from October 2010 to January 2012. Radiographs were considered suggestive of osteomyelitis if they identified an irregular bone surface, obliteration, bone reorption or periosteal resorption. The diagnostic impression rom imaging was compared to the results of a bacterial growth culture prepared using bone removed during surgery.

Results: An analysis of the radiographs identified 29 patients with results that were suggestive of osteomyelitis. Of these, the results of 27 bacterial cultures were positive. Eight of the 22 radiographs that were not suggestive of osteomyelitis were negative and 14 were positive.

Conclusion: The diagnosis of osteomyelitis in diabetic foot can be improved by stratifying the results, taking the positive results and creating a diagnostic window with another diagnostic evaluation in cases that are initially negative.

Key words: Osteomyelitis, radiography, diabetes, treatment, bacterial cultures

Introduction:

Diabetes mellitus is a multi-system disease that affects people of both genders and any age or ethnic group. Foot wounds are common and can lead to loss of limb in cases of therapeutic failure.[1] Neuropathy, vasculopathy and infection are the main factors to be addressed besides control of blood sugar. Neuropathy exposes the patient to foot lesions mainly due to a loss of sensation and changes in the points of support of the foot that favor the development of calluses.[2,3] The vasculopathy affects both micro- and macro-circulation and may lead to loss of limb in cases for which revascularization is impossible. Infection is a worsening of the injuries the requires quick control.[4,5]

Rapid diagnosis and control of infection are key to success in the approach of these patients. Empirical antibiotic therapy may fail and so the identification of bacteria is crucial to allow adequate antimicrobial therapy. However, diagnosis is not always accurate when there is involvement of the bone.[2,4]

Conventional radiography or simple x-rays is the most used method to assess bone infections. However, this test may give negative results during the early stages of osteomyelitis. Specific cases, such as in Charcot foot, can have bone lesions similar to osteomyelitis, thus results may be false positive. The aim of this study was to correlate initial diagnoses of osteomyelitis by radiography with bacterial cultures and identify ways to improve the diagnosis using this method.

Method:

In a prospective random clinical trial, the correlation between radiographs and bacterial cultures were evaluated in diabetic patients undergoing amputation of toes or part of the foot in Hospital de Base in the period from October 2010 to January 2012.

The inclusion criteria were diabetic patients with foot ulcers who were submitted to radiographs, bacterial cultures and antibiograms prior to surgery to amputate toes or part of the foot. The exclusion criteria were patients undergoing major amputation and those who were not diabetics. Fifty-one out of a total of 154 patients who filled t he inclusion criteria were included in the study.

Radiographs were considered suggestive of osteomyelitis if they identified an irregular bone surface, obliteration, bone resorption or periosteal resorption. The diagnostic impression from imaging was compared to the results of a bacterial growth culture prepared using bone removed during surgery. The assessment of the radiographs, the cultures and compilation of data were carried out independently by different specialists.

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The sensitivity, specificity, positive and negative predictive values, Likelihood Ratio (LR) for the positive and negative test and odds ratio were analyzed.

The study was approved by the Research Ethics Committee of the Medicine School in Sao Jose do Rio Preto (FAMERP)#350/2011. The study analyzed only radiographs and medical records, terms signed consent form was dispensed.

Results:

An analysis of the radiographs identified 29 patients with results that were suggestive of osteomyelitis. Of these, the results of 27 bacterial cultures were positive. Eight of the 22 radiographs that were not suggestive of osteomyelitis were negative and 14 were positive. Table 1 shows values comparing the two tests.

Discussion:

The present study shows that the use of radiographs to diagnose osteomyelitis in diabetic foot can fail, but a stratification of the results can improve the diagnosis and reduce operational costs. A total of 93% of the patients who had a positive diagnosis by radiography, had osteomyelitis confirmed by bacterial cultures, a result similar to that found in the literature for tests such as magnetic resonance imaging (MRI), nuclear medicine, probe to bone and 18-Fluoro-deoxyglucose*positron emission tomography* (*FDG*-PET).[2]

The remaining patients are in a diagnostic window that requires a novel laboratory evaluation technique. Examinations such as MRI, nuclear medicine or even repeat radiographs may help. In this group, 66% of the patients had positive bacterial cultures, so another diagnostic evaluation is essential. Services with fewer resources can follow up the patient clinically and repeat the radiograph after one to two weeks, awaiting a positive result or refer the patient to services with the necessary facilities to perform this diagnosis earlier.

In the initial phase, the osteomyelitis may not have evident bone changes making diagnosis difficult.[6,7] However in diabetic foot, infections of the skin and adjacent structures require quick antibiotic therapy. The type of bacteria and the time at treatment may not match the suggested investigation period for osteomyelitis. Therefore, this diagnostic window should warn about the possibility of therapeutic failure in this patient group.

Patients in this study were referred to this tertiary hospital from other centers and consequently had more advanced stages of the disease with the toes already in a very serious condition. These data show the severity of cases where osteomyelitis was diagnosed by bacterial cultures in 80.3% of the patients.

Conclusions:

The diagnosis of osteomyelitis in diabetic foot can be improved by stratifying the results, taking the positive results and creating a diagnostic window with another diagnostic evaluation in cases that are initially negative.

Competing interests:

The authors declare that they have no competing interests (political, personal, religious, ideological, academic, intellectual, commercial or any other) in relation to this manuscript.

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Table 1. Values related to the correlation between radiography and the bacterial culture in the diagnosis of osteomyelitis

Prevalence (pre-test likelihood of disease) 0.803922 (95% CI: 0.668843-0.901757); 80.39% (95% CI: 66.88-90.18%)
Predictive value of positive test (post-test likelihood of disease) 0.931034 (95% CI: 0.772338-0.991536); 93.1% (95% CI: 77.23-99.15%). {change = 13%}
Predictive values of negative test (post-test likelihood of no disease) 0.363636 (95% CI: 0.171979-0.593423); 36.36% (95% CI: 17.2-59.34%). {change = 16%} (post-test disease likelihood despite positive test) 0.636364 (95% CI: 0.406577-0.828021); 63.64% (95% CI: 40.66-82.8%). {change = -16%}
Sensitivity (true positive rate) 0.658537 (95% CI: 0.494053-0.799166); 65.85% (95% CI: 49.41-79.92%)
Specificity (true negative rate) 0.8 (95% CI: 0.443905-0.974789); 80.00% (95% CI: 44.39-97.48%)
Likelihood Ratio LR (positive test) = 3.292683 (95% CI: 1.236375-11.783962) LR (negative test) = 0.426829 (95% CI: 0.254767-0.783647)
Diagnostic Odds Ratio Odds ratio = 7.714286 (95% CI: 1.246775-80.698839)

95% CI: 95% confidence interval