Diagnosis of Periodontal Diseases

Committee on Research, Science and Therapy

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PREFACE

This paper was prepared by the Research, Science and Therapy Committee of The American Academy of Periodontology and is intended for the information of the dental profession. The purpose of the paper is to provide the reader with a general overview of important issues related to the diagnosis of periodontal diseases. It is not intended as a comprehensive review of the subject.

INTRODUCTION

It is currently believed that most periodontal diseases are mixed infections associated with relatively specific groups of indigenous oral bacteria.[1-17] Susceptibility to these diseases is highly variable and dependent on host responses to periodontal pathogens.[18-23] In addition, some forms of periodontitis appear to progress in brief, destructive bursts that may be associated with qualitative changes in the subgingival flora and host immune responses.[24-26]

TRADITIONAL APPROACH TO DIAGNOSIS

In spite of our increased understanding of the etiology and pathogenesis of periodontal infections, the diagnosis and classification of these diseases is still based almost entirely on traditional clinical assessments. To arrive at a periodontal diagnosis, the dentist must depend heavily on such factors as: 1) presence or absence of clinically detectable inflammation; 2) extent and pattern of clinical attachment loss; 3) patient's age at onset; 4) rate of progression; and 5) presence or absence of miscellaneous signs and symptoms, including pain, ulceration, and amount of observable plaque and calculus.[27] At the 1989 World Workshop on Clinical Periodontics, a reclassification of different forms of periodontitis was proposed as follows: I. Adult Periodontitis, II. Early-Onset Periodontitis, III. Periodontitis Associated with Systemic Disease, IV. Necrotizing Ulcerative Periodontitis, and V. Refractory Periodontitis.[28] Although it is probable that differences exist among some of these diseases with regards to the composition of the subgingival flora and abnormalities of leukocyte adherence and chemoattractant receptors, diagnosis of these diseases relies primarily on their clinical characteristics.

The above classification should not be confused with other classifications of periodontal diseases as suggested by the American Dental Association or The American Academy of Periodontology for purposes of third-party insurance payments. Current insurance classifications of periodontal diseases designated by the AAP include: Gingivitis (AAP Case Type I), Mild Periodontitis (AAP Case Type II), Moderate Periodontitis (AAP Case Type III), Advanced Periodontitis (AAP Case Type IV), and Refractory Periodontitis (AAP Case Type V).

There is considerable interest in screening dental patients to facilitate the detection of mild forms of periodontal diseases and to identify individuals who have previously undetected periodontitis. The American Academy of Periodontology and the American Dental Association support the use of the Periodontal Screening and Recording (PSR™) system. That system is based on the worst site per sextant. If one or more sextants show significant signs of disease, the clinician is advised to do a complete periodontal examination and charting. Evaluation of the effectiveness of this screening system in identifying patients with previously undetected periodontal disease will depend on the results of future clinical studies comparing PSR to a complete periodontal examination. However, PSR has the potential to be a rapid method of detecting disease, especially by the general practitioner.

DIAGNOSTIC INFORMATION

Periodontal diagnoses are determined by analyzing the information collected during a periodontal examination. A decision is then made regarding the disease category that is most closely associated with the patient's clinical status. The information routinely collected during a periodontal examination

includes demographic data (e.g., age, sex, etc.), medical history, history of previous and current periodontal problems, periodontal probe measurements (i.e., probing depths, clinical attachment loss, etc.), radiographic findings, and miscellaneous clinical features or observations (e.g., gingival inflammation, plaque/calculus, mobility, occlusal problems). In some situations, supplemental qualitative or quantitative assessments of the gingival crevicular fluid (GCF) and subgingival microflora are performed using newly developed and clinically practical tests. It should be emphasized that, at the present time, supplemental information on GCF and subgingival microflora is not commonly used by practitioners in arriving at a diagnosis. Furthermore, specific information of the probable causes of a patient's periodontitis, such as the presence of specific putative pathogens in the subgingival flora, is not routinely used in determining a periodontal diagnosis.

SCIENTIFIC EVALUATION OF DIAGNOSTIC TESTS

Statistical validation of a potentially useful diagnostic test routinely involves use of a two-by-two contingency table or decision matrix as shown in Table 1.[29-33] From such tables, the validity of a

Table 1. Decision Matrix for Diagnostic and Prognostic Tests

	Disease Present	Disease Absent
Test Positive	**A (true positive)**	**C (false-positive**
Test Negative	**B (false negative)**	**D (true-negative)**

$$\text{Sensitivity} = \frac{A}{A + B} \qquad \text{Specificity} = \frac{D}{C + D} \qquad \text{Odds Ratio} = \frac{AD}{BC}$$

$$\text{Positive Predictive Value} = \frac{A}{A + C} \qquad \text{Negative Predictive Value} = \frac{D}{B + D}$$

diagnostic or prognostic test can be determined.[27,27-33] A *diagnostic* device or test is intended to detect the presence of a specified disease. Data collection to evaluate a diagnostic test frequently employs a cross-sectional sampling scheme, and the validity of the test can be determined by calculating its

sensitivity and specificity. These can only be determined in a cross-sectional study if the true disease status of the patient can be established from a single examination. This is the case for the presence or absence of periodontitis. The *sensitivity* of a diagnostic test refers to the probability of the test being positive when the disease is truly present. A perfect test would be able to detect the disease in all cases without registering a false-negative. The sensitivity of such a perfect test would be 1.00. The *specificity* of a diagnostic test refers to the probability of the test being negative when the disease is not present. A perfect test would be able to correctly identify all instances in which the disease was absent without registering a false-positive. The specificity of such a perfect test would be 1.00. However, in medicine and dentistry, perfect diagnostic tests do not exist. Therefore, a test's sensitivity and specificity will always be less than 1.00. Although precise values cannot be set to cover all situations, it is reasonable to expect that a clinically useful diagnostic test for periodontal diseases should have diagnostic test for periodontal diseases should have *both* sensitivity and specificity values of approximately 0.70 or greater. The predictive value of a diagnostic test is expressed as a function of the *prevalence* of the disease (i.e., the total number of cases of a disease in a given population at any point). The *positive predictive value* of a test refers to the probability that the disease is present when the test is positive. The *negative predictive value* refers to the probability that the disease is absent when the test is negative.

A *prognostic* device or test is intended to assess the risk of developing the disease at some point in the future. Data collection to evaluate a prognostic test employs a *longitudinal* sampling scheme which permits determination of the *incidence* of the disease (i.e., the total number of new cases of the disease that develop within a specified period of time). Calculations can be made by using the two-by-two contingency table (Fig. 1) to obtain the *odds ratio* which is a measure of the increased risk of developing the disease. For example, if a test that is designed to identify high-risk sites for developing additional bone loss has an odds ratio of 15, it simply means that sites with a positive test are at a 15-fold higher risk of developing additional bone loss within a specified time. In prospective studies, another statistic that is frequently used to characterize the strength of an association between a risk factor and disease development is the *relative risk.* The relative risk is the ratio of the risk of developing disease in individuals exposed to a risk factor to the risk in an unexposed group.

SUPPLEMENTAL DIAGNOSTIC TESTS

Supplemental diagnostic tests can be used to perform two basic tasks. The first is screening; i.e., to separate diseased from non-diseased patients. The second is to detect sites or patients at high risk for progressive disease. The second task is more demanding than the first. It is also of greater importance since the clinician can usually separate healthy from periodontitis patients based on customary clinical criteria. The clinical value of fully validated diagnostic tests is considerable in that they are potentially useful in identifying the presence of therapeutic targets (i.e., putative pathogens), monitoring the response to therapy, identifying sites at high risk for progression, and assisting the clinician in determining a patient-specific recall interval for supportive periodontal therapy. A large number of supplemental diagnostic tests are currently available or are under development. Most of them are designed to provide information presumably associated with progressing periodontal lesions.

Supplemental diagnostic tests fall into four general categories and can be used to detect the presence of: 1) substances associated with putative pathogens; 2) host-derived enzymes; 3) tissue breakdown

products; or 4) inflammatory mediators.

Several strategies have been developed to detect substances associated with putative periodontopathogens.[34] They include DNA analyses,[35-47] assessment of antigenic profiles,[48-56] and enzymatic activities[57-65] of certain members of the subgingival flora. The general aim of all of these approaches is to rapidly detect the presence of potentially pathogenic bacteria in subgingival plaque samples. They have the advantage of not requiring the collection and preservation of viable bacteria. Most of these tests can reliably identify sites that harbor certain putative pathogens and thereby provide information about potential therapeutic targets. For example, if recently treated sites continue to harbor high levels of pathogens, then it is reasonable to conclude that additional therapy may be required. In such instances, the tests could be used to monitor or assess the endpoint or effectiveness of therapy with the ideal result being a negative test for the putative pathogens. One problem with the existing rapid microbiologic tests is that they are designed to detect only a limited number of pathogens. Another drawback is their inability to provide any information about the antibiotic sensitivities of the infecting bacteria. The only known way to determine antibiotic susceptibilities of suspected pathogens is by cultural analysis of the subgingival flora.[66-69]

An array of enzymes, tissue breakdown products, and inflammatory mediators are released form host cells and tissues during the development and progression of periodontal infections. Some of these substances have been suggested as possible markers for the detection of active (i.e., progressing) periodontal lesions. A number of studies have been conducted with the general goal of devising rapid chairside assays for markers of disease activity in gingival crevicular fluid.[68] Host-derived enzymes that have received the most attention in this regard are: aspartate aminotransferase,[71-78] collagenase,[79-81] β-glucuronidase,[82,83] lactate dehydrogenase,[82,83] arylsulfatase,[82,83] elastase,[84-89] and alkaline phosphatase[90] Inflammatory mediators in GCF that might be associated with advancing periodontal lesions are: prostaglandin E_2[91,92] tumor necrosis factor-α,[93-95] and interleukin-1β.[95,96] Tissue breakdown products in GCF that have been suggested as possible markers for progressing periodontal lesions include hydroxyproline[97] and glycosaminoglycans.[98-101]

Further study and development of certain GCF-based diagnostic tests are warranted. It is quite possible that some of them might eventually have value in the clinical management and detection of active periodontitis. Such tests could conceivably be used to identify sites within periodontitis patients that may require additional treatment prior to the maintenance phase of therapy. They also might be of value in establishing recall intervals for previously treated patients. For example, patients with persistently positive tests may require more frequent recall visits. In addition, patients who are in the most urgent need of treatment might be more easily identified through the use of such tests.

In a research environment, neutrophil function assays and tests for cell-surface receptors can provide potentially useful diagnostic information. For example, neutrophils from some patients with localized juvenile periodontitis (LJP) exhibit faulty chemotaxis and abnormal bactericidal activity.[102,103] Molecular markers of LJP include an abnormally low number of chemoattractant receptors and an abnormal amount of another cell-surface glycoprotein designated GP-110.[104,105] On the other hand, patients with another form of early-onset periodontitis, termed rapidly progressive periodontitis or generalized juvenile periodontitis, have normal numbers of GP-110 receptors.[104,105] It is probable that tests of this type that are suitable for use in clinical situations will eventually be developed. However, at the present time such tests are not available for widespread clinical application.

ADVANCES IN TRADITIONAL DIAGNOSTIC METHODS

In the past decade a considerable amount of effort has been directed toward improving the resolution and accuracy of periodontal probing and radiographic methods of assessing damage to periodontal structures.[106] Computer-linked, controlled-force electronic periodontal probes are now either commercially available[107-110] or are in the prototype stages of development.[106,111,112] In addition to controlled insertion force, these electronic probes have a better resolution than standard manual probes. This feature is important since it makes it theoretically feasible to detect smaller changes in attachment level than is possible with manual probes.[106] For example, in one study, untreated adult periodontitis patients were examined over a 6-month period using a prototype of an automated probe which had an accuracy of 0.2 mm. It was found that if a threshold of 0.4 mm was used to indicate that a change in attachment level had occurred, the prevalence of active sites was 29% over the 6-month period. If a large threshold (i.e., 2.4 mm), comparable to that achievable with a manual probe was used, only 2% of the sites were determined to be active.ll3 At the present time, electronic periodontal probes are primarily used in research situations.

Advances in the radiographic assessment of the progression of periodontal disease are also occurring. In the past, sequentially taken radiographs, when examined by eye, have been able to detect changes in bone only after 30 to 50% of the bone mineral has been lost.[106] Furthermore, conventionally read radiographs underestimate the amount of bone loss.[106] It is now possible through advances in digital subtraction radiography techniques to detect very small changes in alveolar bone.[117-124] Many of the logistical problems initially associated with subtraction radiography are being overcome. Software programs have been developed to correct for subtle differences in contrast and other repeatability errors.[125,126] Standardization of film positioning and angulation can be easily achieved by using a cephalostat[127] or custom-made positioning devices.[128] Future development of these techniques promises to have a profound impact on our approach to the diagnosis of periodontal diseases. However, at the present time these new systems for analyzing radiographic images are primarily used in research situations. It remains to be determined if they can be further refined to be useful on a day-to-day basis in clinical practice.

It has long been observed that inflamed tissues anywhere in the body are warmer to the touch than non-inflamed tissues. Indeed, increased heat emanating from an inflamed site is regarded as a cardinal sign of inflammation. The increased amount of heat is believed to be due to the elevated metabolic rate of inflamed tissues and their high blood flow rates.[129,130]

A temperature-sensitive periodontal probe has been developed that rapidly measures differences between the core body temperature and that of the periodontal pocket.[131-133] Preliminary studies with this device indicate that pockets with elevated temperatures consistently bleed on probing, are clinically inflamed, and harbor elevated percentages of certain periodontal pathogens such as *Porphyromonas gingivalis, Actinobacillus actinomycetemcomitans*, and *Prevotella intermedial*[131,133] It has also been suggested that the presence of high subgingival temperature is a risk factor for the progression of periodontitis.[132] Further longitudinal studies of this device are needed in order to determine its clinical utility in the early detection of sites at risk for the progression of periodontitis.

SUMMARY

At the present time, the diagnosis and classification of periodontal diseases is almost entirely based on traditional clinical assessments. Supplemental quantitative and qualitative assessments of the gingival crevicular fluid and subgingival microflora can potentially provide useful information about the patient's periodontal disease. In certain situations, these supplemental tests may be particularly valuable in establishing the endpoint of therapy prior to placing patients on a periodontal maintenance program. Further development of these tests is warranted. In the past decade, major advances have been made in traditional diagnostic methods. Further development of computer-linked, controlled-force electronic periodontal probes with high resolution, accuracy, and repeatability should make it possible to detect very small changes in clinical attachment levels. As many of the logistical problems associated with subtraction radiography are overcome, this powerful diagnostic tool could come into widespread use. However, at the present time, electronic periodontal probes and subtraction radiography techniques are primarily research tools.

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