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Periodontal diagnostic aids – An odyssey to remember

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Abstract

In the year 2000, the periodontal probe and radiographs were still, as they were in the year 1980, the basic diagnostic approaches for periodontitis. Although we envisaged periodontists employing new technologically advanced instruments for diagnosis in 2020, the periodontal diagnostic armamentarium seems to have not changed much over the years. This paper takes you for a walk down the history lane describing the advances in periodontal diagnostic aids that we witnessed in the past years.

Keyword: Aetiology, Periodontists

Introduction

Our understanding of the etiology and pathogenesis of periodontal disease has undergone major advances in recent decades. This increased understanding of the nature, aetiology and pathogenesis of this heterogenous disease grouping has demanded we modify our diagnostic strategies to more correctly fit our current disease concepts.

For decades, it was believed that once periodontal disease was initiated in an individual, it would slowly but continuously progress over time if treatment was not instituted (Russell 1967, Loe el al 1978). It was inferred that an individual would experience incessant destruction of periodontal attachment structures until they were lost. Later, this long held concept of continuous disease progression was challenged by observations suggesting a more dynamic disease process characterised by periods of disease progression, remission and exacerbation and by

perceived randomness with respect to teeth and patients. Socransky et al. (1982) suggested that periodontal disease progresses in recurrent acute episodes, "bursts of activity" which occur in short period of time in individual sites and are followed by relatively long periods of remission."

Although it was previously assumed that all gingivitis would ultimately lead to periodontitis, it is now realised that not all gingivitis progresses to periodontitis (Listgarten 1986). The view of natural progression of gingivitis into periodontitis is no longer held (Loe 1986) and the susceptibility varies between individuals and between sites in the same person (Page & Shroeder 1982, Kornman 1986). Cross sectional studies have shown that relatively few subjects in each age group suffer from advanced periodontal disease and these subjects account for most of the sites which are periodontally involved (Loe et al. 1986. Papapanou 1988)

Diagnosing periodontal disease involves several decision nodes or levels for clinicians (Page, 1992). At the simplest level, we should be able to diagnose periodontal health versus disease. At the next level, we need to differentiate gingivitis from periodontitis and classify the various types and severities of gingivitis and periodontitis. Lastly, we are faced with the decision as to whether the disease is active or whether it is arrested or in remission. The task of formulating a diagnosis at each of these levels can be tenuous for anyone using conventional methods. Hence, considerable measures have focused on better characterising the various diseases and developing new strategies. Discussion of the available diagnostic tools would help to identify the future directions.

Diagnoses in periodontics have responded to changes in technology as well as to new ways of understanding the pathophysiology of periodontitis Despite our expanding evidence base regarding periodontal disease, we continue to diagnose and classify a given patient primarily with traditional clinical assessment (Armitage 1995). To arrive at a diagnosis, we heavily depend on factors such as 1) presence and absence of clinically detectable inflammation, 2) extent and pattern of clinical attachment loss, 3) patient's age of onset. 4) rate of progression and 5) presence or absence of miscellaneous signs and symptoms including pain, ulceration and the amount of observable plaque and calculus (Caton 1989). The clinical signs and symptoms of periodontitis are broadly classified into those suggestive of a current inflammatory process and those associated with the historical attachment loss.

Assessment of gingival bleeding, recession, tooth drifting and changes in gingival colour has been a part of routine oral examination. Research evidence indicates that our traditional diagnostic criteria such as gingival oedema, redness, plaque, bleeding and exudate have fair specificity, but poor sensitivity in diagnosing sites or patients with active disease progression (Haffajee 1983).

Periodontal probing in the diagnosis of periodontitis

The measurement of true periodontal pockets has traditionally been used in the diagnosis of periodontal disease. Calibrated probes can be used to make three major types of measurements 1) probing depths 2) clinical attachment levels and 3) relative attachment levels. Probing depth is not necessarily a reliable measure of the extent of detachment of periodontal tissues from the root surfaces, since there can be wide fluctuations in the position of the gingival margin. Sequential measurement of either the clinical or relative attachment levels are useful when the clinician wants to longitudinally follow a site to determine whether further attachment gain or loss has occurred. Although measurements obtained with the periodontal probes are clinically useful approximations of damage to periodontal tissues, the periodontal probe has several sources of error that make it a somewhat imprecise

method of measurement. The accuracy of probing data has been questioned.

Listgarten (1976) noted that probing depth seldom corresponds to pocket depth. The factors determining probe penetration included probing force, the degree of inflammation of the gingival tissues, the angulation of the probe, the contour of the tooth and root surface, pocket configuration type and location of calculus and degree of healing with a long junctional epithelium following treatment (Listgarten 1980). It was pointed out that errors of over and under estimation are possible. But he concluded that despite the uncertainties of interpreting probing depth measurements, the periodontal probe continues to provide the clinician with a simple and relatively reliable means of evaluating the relative periodontal status

In an attempt to overcome some of the variables associated with periodontal probing, several new types of probes have been invented. A newer generation of automated computer linked probes has emerged in the past decade including Florida probe, Birek probe, Jeffcoat probe Toronto probe. Foster-Miller (Alabama) probe and Inter probe. These probes have the advantage of controlled insertion forces an in vitro resolution of 0.1- 0.5 mm and direct data entry into the computer. The Alabama probe can automatically detect the cementoenamel junction and record the clinical attachment levels. But these automated probes have two main drawbacks - reduced tactile sensation and increased patient discomfort.

Based on generation of probe development, periodontal probes can be classified as follows (Gupta et al 2012):

• First generation: Mechanical probes like Marquis color-coded probe, UNC-15 probe, University of Michigan "O" probe, with William's markings, Michigan "O" probe, WHO probe, Goldman fox probe. Furcation areas can best be evaluated with the curved, blunt Nabers probe.

• Second generation: Pressure sensitive probes – Vine valle probe, Borodontic probes (NIDCR).They have standardized controlled insertion pressures. At forces up to 30 g, the tip of the probe seems to remain within the junctional epithelium, and forces of up to 50 g are necessary to diagnose periodontal osseous defects.

• Third generation: Computer aided probes or automated probe system like Florida probe, Interprobe System, Periprobe Systems, Foster-Miller probe, Toronto Automated probe.

• Fourth generation: Records sequential probe positions along gingival sulcus

• Fifth generation: Ultrasound probes

Radiographs in the diagnosis of periodontitis

Radiographs are an important tool in the diagnostic armamentarium of the dental clinician. They provide a permanent record which can be used for future examination providing the information on the extent of bone loss, root anatomy, proximity to adjacent teeth, sinuses and other anatomical structures. Severity of furcation involvements and periapical pathology may also be elucidated from radiographs. A variety of radiograph types assist in the development of periodontal treatment plans, particularly panoramic oral radiographs supplemented by selective intra-oral views. Although radiographs cannot reflect the buccal and lingual bony morphology, they provide useful information on the interproximal bone levels (Lang & Hill 1977). Furthermore, small changes in alveolar bone changes as in the initial stages and the exact topography of the defects are not disclosed by conventional radiographic examination (Ainamo & Tammisalo 1973). Full-mouth surveys of paralleling periapical radiographs have been considered to be a "gold standard" for periodontal diagnosis and treatment planning. Vertical bite-wings and

long cone parallel radiographs are used in conventional radiography for periodontal diagnosis.

The intraoral radiographs cannot disclose progressive periodontitis. The clinical and technical standardization of sequential x-rays and the methodology whereby small magnitudes of changes are measured are the most significant problems. Detection of minute changes is difficult with sequential radiographs. The standardization of the radiographic technique can be largely overcome with the use of intra-oral devices, fixing the relationship of the object and film to the x-ray source (Rosling et al. 1975).

Radiovisiography (RVG) is one of the direct digital imaging techniques that has become widely accepted as a substitute to film-based radiography because of its superior image quality, reduced time needed for processing and low radiation exposure (Ashwinirani et al. 2015). The use of RVG for visualizing alveolar bone changes in periodontal disease was found to be comparable to conventional radiographs and intrasurgical measurements (Sharma et al. 2019). In a review, Hausmann (2000) had optimistically predicted that linear radiographic measurements of digitized and computer managed images, rather than just visual inspection of radiographs, will soon be commonplace in the management of patients with periodontal diseases.

Subtraction radiography was introduced as a method of overcoming difficulties in detecting small changes in the bone levels (Gröndahl et al. 1983). In a study by Jeffcoat (1992). a strong relationship was shown between probing attachment loss detected using sequential measurement with an automated periodontal probe and bone loss detected with qualitative computerised digital subtraction radiography. The result indicates an important future role for modern subtraction radiography in longitudinal monitoring of periodontal patients. Even though these sophisticated techniques have been used as research tools to detect small changes in bone, at present these have little use in clinical practice. Experience has shown that digital subtraction radiography will probably remain a research tool without much clinical application.

Computer-Assisted Densitometric image Analysis System (CADIA) utilizes a video camera that measures the light transmitted through a radiograph, and the signals from the camera are converted into gray-scale images. An image processor and computer allow storage and mathematical manipulation of the images (Nirola et al. 2014).

Extraoral panoramic radiographs are still widely used for diagnosis of a wide array of oral abnormalities. In periodontics, they show the generalised pattern of bone destruction and help in periodontal diagnosis. When used along with periapical radiographs of localised sites, they provide adequate information for periodontal treatment planning. Extraoral radiography like computed tomography is also used especially for treatment planning of implants. Computed tomography (CT) has been used in some studies in relation to periodontal defects (Naito et al 1998, Pritorius et al. 2001). However, conventional CT does not offer any favourable cost-benefit, dose exposure or therapeutic yield advantage in periodontal practice and is unlikely to find a routine place.

The diagnosis of periodontal disease has relied on clinical and radiographic parameters for many years. The proper use of the periodontal probe and a panoramic radiograph or well-aligned and exposed bitewing and periapical radiographs provide the clinician with a measurement of the amount of mineralised and non-mineralised tissue destruction that has occurred in the past. These measures introduced more than 50 years ago continue today as the basis of periodontal diagnosis in clinical practice.

Limitations of traditional diagnostic techniques

Traditional diagnostic methods are suitable for most clinical situations but do suffer from a number of drawbacks as outlined below (Eley & Cox 1998).

Clinical and radiographic measurements of attachment loss are not accurate and if not carried out very carefully can be misleading. Full-mouth recording is necessary because of the site specific and episodic nature of periodontal progression.

Individual susceptibility to periodontitis varies both genetically and over time because of other conditions which may affect susceptibility. All clinical diagnostic techniques provide only retrospective information about the past disease and are unable to diagnose disease activity. If regular serial periodontal chartings are to be compared to monitor periodontal progression or if these measurements are required for research purpose then much more accurate diagnostic techniques are necessary.

The modification in the understanding of the nature of progression of disease has led to re-evaluation of how we diagnose patients. Based on this knowledge, Lamster 1995 concluded that patients can be assessed for both disease severity and their risk for disease activity. As standard clinical and radiographic measures of periodontal disease are poor predictors of the risk for future disease, the identification of risk relies on other parameters. Probing depth and radiographic bone loss measurements may undergo modification for improved accuracy and the ability to detect disease progress over time. A better approach to diagnosis of periodontal disease has been proposed that relies on the identification of the microbial challenge and the host response to that challenge. This conceptual change had its focus on the early detection of disease.

Other diagnostic tools

Microbiological diagnostic tests

Microbiological diagnosis can offer the clinician a laboratory measure of periodontal infection as an adjunct to the traditional clinical indices of periodontal disease, Microbial biomarkers have been studied extensively and some of them incorporated into commercially available diagnostic kits. But tests that measure periodontal pathogens do not measure periodontal disease. Bacterial pathogens can be present even in high quantities in periodontal pockets without causing loss of tissue attachment or bone loss. Therefore, assays for periodontal pathogens are not of themselves, diagnostic for periodontal disease (Zambon & Harazthy 1995). However, there is increasing evidence that subgingival infection with certain periodontal pathogens can increase a subject's risk for subsequent periodontal attachment loss (Beck et al 1992). Methods such as darkfield and phase contrast microscopy, bacterial culture, DNA probes, immunological assays, PCR, real-time PCR and microbial enzyme assays are being used.

Darkfield and phase contrast microscopy provided a simple and good means of determining total bacterial counts and counts of bacteria with characteristic morphotypes. Since it does not differentiate between pathogens and non-pathogens with similar morphology, it had less value in the diagnosis of disease or monitoring of disease activity. Culturing is considered as the gold standard and has been used to diagnose different disease and to target and monitor therapy. But it was limited to those bacteria which can be cultivated and the availability of laboratory services for cultural microbiology were limited. The time and expense associated with culturing presently limits its use as a periodontal research diagnostic tool. Indirect methods for monitoring specific bacteria utilize nucleic acid (DNA of RNA probes), antibody and enzyme markers and have the advantage of not requiring live bacteria and therefore are amenable to in-office

testing or transport to distant sites. These approaches may be more sensitive than culturing, but these techniques are yet to be routinely utilized in clinical practice. The cost of these tests is a problem for the dentist as well as the patient.

Immunodiagnostic Methods such as the direct and indirect immunofluorescent microscopy assays (IFA), flow cytometry, enzyme-linked immunoabsorbent assay (ELISA), membrane assay, and latex agglutination employ antibodies that recognize specific bacterial antigens to detect target microorganisms. The microbial-enzymatic N-benzoyl-DL-arginine-2-napthylamide (BANA) test is one of the alternatives to bacterial cultures. It detects the presence of three periodontal pathogens in the subgingival plaque (Porphyromonas gingivalis, Treponema denticola and Tannerella forsythia), by measuring the activity of trypsin like enzyme.

Deoxyribonucleic Acid Probe Technology such as the nucleic Acid Probes contain segments of single-stranded nucleic acid, labelled with an enzyme or radioisotope which can locate and bind to their complementary nucleic acid sequences with low cross-reactivity to non-target organisms. Checkerboard DNA-DNA hybridization technology which was developed by Socransky et al. (2004) detects bacteria using whole genomic digoxigenin labeled DNA probes. Up to 40 bacteria can be detected using a single test.

Restriction Endonuclease Analysis uses restriction endonucleases to recognize and cleave double-stranded DNA at specific base pair sequences and these DNA fragment patterns constitute a specific "fingerprint" to characterize each strain. They help in studying the transmission patterns of putative periodontal pathogens among family members (Sanz and Newman 2002).

Polymerase Chain Reaction involves amplification of a region of DNA flanked by a selected primer specific for the target species which indicates presence of the target microorganism. The detection limits is as few as five to ten cells and shows no cross-reactivity under optimized amplification conditions and can detect multiple bacteria. (Sanz and Newman 2002). Most of the abovementioned methods are qualitative and indicate only the presence of certain species. Because periodontal pathogens exist not only in infected pockets but also in the healthy sulcus, qualitative detection is not suitable for the diagnosis of periodontitis. a quantitative detection system that uses real-time polymerase chain reaction (PCR) methodology (Yoshida et al., 2003a; Yoshida et al., 2003b).

Biosensors recognize various metabolites (e.g. volatile sulfur compounds) that are produced by periodontal pathogenic bacteria. .A sulfide sensor, Perio 2000, developed by Diamond General Corp. can measure levels of these compounds and report them as scores ranging from 0 to 5 in increments of 0.5 (Sanz and Newman 2002).

The best time for the detection of oral bacteria remains unclear. During periodontal treatment process, when should we use a diagnostic system? Can a quantitative detection test be used for the initial diagnosis of periodontitis? Furthermore, periodontitis is influenced by multiple factors such as genetic, environmental, and lifestyle-related factors that complicate the determination of a microbial cut-off value for disease onset. The use of microbiological detection for the initial diagnosis of periodontitis is thus likely to be of limited value. The most important application of microbiological examination in periodontal disease is in monitoring changes in bacterial numbers after periodontal treatment compared with before treatment, providing an assessment of the effectiveness of periodontal treatment. For this purpose, quantitative bacterial examinations are required.

Table 1: Representative microbiological examination methods in dental practice (From Yoshida & Ansai (2012)

Method	Principle	Advantages	Disadvantages	Comments
Culturing	Culturing of oral specimens on a medium Detection of viable bacteria	Antibiotic sensitivity. Unculturable bacteria.	Requires bacteriology skill.	Important for Antibiotic selection.
Enzymatic	Measurement of enzymatic activities produced by oral bacteria	Rapid and low-cost method.	Cannot identify bacterial species.	Commercial kits are available.
Immunological	Detection of specific bacteria using antibodies	Available for specific bacteria.	Cannot discriminate between living and dead cells.	Requires special techniques.
Conventional PCR	Detection of bacteria by DNA amplification	High sensitivity, qualitative analysis. Same as above.	Quantitative detection is not available.	Requires a thermal cycler.
Real-time PCR	Detection of bacteria by DNA amplification	High sensitivity, quantification	Cannot discriminate between living and dead cells.	Requires a thermal cycler
Loop-mediated isothermal amplification (LAMP)	Isothermal DNA amplification	High sensitivity, isothermal amplification, visual detection.	Same as conventional PCR.	Developed by Eiken Chemical Co., Ltd

Saliva and Gingival crevicular fluid (GCF)

As periodontal diseases are the result of the interaction of the periodontal microflora and the multifaceted host response to the infection, specific aspects of the host response in periodontal disease may be used in the evaluation of patients. Assessment of the host response refers to the study of mediators, by immunologic or biochemical methods, that are recognized as part of the individual's response to the periodontal infection. The sources of samples include saliva, gingival crevicular fluid (GCF), gingival crevicular cells, blood serum, blood cells, and urine.

Saliva helps in analysis due to the presence of various host mediators. Ease of sample collection and the large volume of fluid available for study make it a popular diagnostic aid. But it is derived from many sources, including salivary glands, serum (entering the oral cavity in saliva or gingival crevicular fluid), host factors in gingival crevicular fluid (epithelial cells, inflammatory cells and various mediators released from cells such as enzymes and arachidonic acids metabolites), subgingival and supragingival bacteria, sloughed oral epithelial cells and foreign substances introduced into the oral cavity such as food and oral hygiene products. And also, it is diluted due to large aqueous component. Diagnostic markers in saliva

include proteins and enzymes of host origin, phenotypic markers, host cells, hormones (cortisol), bacteria and bacterial products, volatile compounds, and ions.

Analysis of gingival crevicular fluid (GCF) represents the most practical approach for the biochemical analysis of the host response in periodontal disease (Cimasoni 1983). Determination of the volume of GCF collected represents an accurate assessment of the degree of inflammation and vascular permeability. GCF samples are obtained using paper strips, microcapillary tubes and micropipettes, micro-syringes or plastic strips. Periotron is an electronic device that measures the change in capacitance across the wetted strip, and this change is converted to a digital readout, which can be correlated to the volume of gingival crevicular fluid. But there is no data to support that GCF volume can predict future attachment loss.

Inflammatory mediators and products like cytokines that are present in GCF include tumor necrosis factor alpha (TNF- a), interleukin-1 alpha (IL-la), interleukin-1 beta (IL-1ß), interleukin-6 (IL-6), and interleukin 8 (IL-8). Host derived enzymes that are possible markers of active periodontal destruction are aspartate aminotransferase (AST), akaline phosphatase, ß-glucuronidase, elastase, cathepsins, and matrix metalloproteinases. A rapid chairside test kit or AST (Periogard) is available. It is unable to discriminate between sites with severe inflammation but with no attachment loss from sites that are losing attachment. Periocheck is another chairside kit that has been developed to detect proteases in GCF. Some host markers being considered for rapid diagnostic tests include PGE_2, host cytokines such as IL-1, IL-6 and IL-8, enzymes such as collagenase and elastase and lysosomal enzymes such as beta-glucuronidase and aspartate aminoglucoronidase (AST). The value of PGE_2, as a diagnostic aid has been examined in a longitudinal study (Offenbacher et al. 1986).

Although many potential host based markers exist, several features hamper our ability to declare them as diagnostic tests with proven utility (Kinane 1996). Firstly, the gold standard is elusive, Secondly, inflammation due to gingival confined lesions and periodontal inflammation which results in attachment loss are potential confounders in any proposed test. Despite much being written about the need for markers of current and future disease, which will prevent us from treating pockets that are not going to exhibit future attachment loss, the time, effort and cost involved in testing these sites has to be balanced against relative ease and speed of root planing deep pockets which bleed on probing Clearly, active disclosing tests are needed to prevent over and under treatment, but currently we are still some distance away from reliable chemical testing methods. Whether their use will change our treatment approach is also to be considered. In conclusion, host response based chemical tests are still at an early stage of development and much work remains to be performed to fully validate their utility such that they become an important and cost effective aspect of treatment planning, screening and patient monitoring.

Subgingival temperature

Indicators of local physical or metabolic changes such as increase in subgingival temperature have been used for predicting the metabolic events occurring in the periodontal tissues. A subgingival temperature probe has been developed for use in general population. Thermal probes measure gingival temperature (Kung et al. 1990). Periotemp probe detects pocket temperature differences of 0.1° C from a referenced subgingival temperature. Haffajee et al. (1992) used this probe to predict future attachment loss. But the use of this seems to be limited and there is insufficient evidence to prove the use of subgingival temperature as an indicator.

Nuclear medicine

Another diagnostic advancement involves the use of nuclear medicine to detect changes in bone metabolism that may precede or accompany architectural changes. This technique can detect active changes around teeth long before the loss or gain is perceived on radiographs Nuclear medicine techniques or bone scanning have been used in limited human patient settings to determine disease activity. Jeffcoat et al. (1986) found a highly significant association between high bone-seeking radiopharmaceutical uptake (BSRU) and active bone loss with an accuracy of 79%. Progress using nuclear medicine techniques for determining periodontal disease activity appears promising The limitation of adequate research and the added radiation risk in patients make it not currently applicable to clinical practice.

Genetic markers

Not all persons with similar amount of plaque and calculus develop periodontitis. The host susceptibility to periodontal pathogens is considered to play a significant role in the etiopathogenesis of periodontitis. The genetic factor is a major determinant of host susceptibility. There are contradictory results and varied results of the association of various genetic loci of different genes with periodontitis in different ethnic populations. .A genetic marker was identified by Komman et al. (1997). Their finding that a specific genotype in the IL-1 gene cluster correlated with severe periodontitis suggested a genetic mechanism by which some individuals, challenged by bacterial accumulation may have a more vigorous immuno-inflammatory response leading to more severe periodontitis. They found the IL-1α and IL-1β genotypes were an especially strong predictor of severe disease in non-smokers between ages 40-60, with an odds ratio of 18.9. But whether these results are applicable in other populations need to be examined. The usefulness of the composite genotype in Chinese has been questioned (Armitage et al. 2000). A plethora of research conducted in different ethnic races linking the association of composite genotype with periodontitis showed results that were contradictory in nature. Single nucleotide polymorphisms of various signaling factors, receptors, connective tissue components, enzymes involved in the host defense against the invading microbes have been reported by several researchers. Studies have been conducted to determine the role of genetics factors involving IL-1, IL-6, TNF - α, TGF-β, IFN-γ, MMPs and TIMPs and Vit D in periodontal disease (Karthikeyan and Meenakshi 2019). There is not much clarity in the genetic susceptibility to the disease since there are a multitude of etiological factors and epigenetic factors that contribute to the susceptibility as well as severity of periodontal disease.

From a brief overview of the available diagnostic tools, we may conclude that no diagnostic aid by itself would help in diagnosis and prediction of future progression of disease. None of the current methods can lead to an adequate definition of periodontal disease activity. It is suggested that the combination of either or both of clinical probing and radiographs with other clinical parameters such as occurrence of bleeding or suppuration on probing may permit a more representational definition of disease. The other techniques seem useful as an adjunct to clinical and radiographic assessment. More research may be required in order to have them in practice. The present cost and limited availability of facilities also seem to hinder the everyday use of these advanced techniques. So despite the drawbacks, the most simple, cost effective and useful diagnostic aids now available still remain the periodontal probe and radiographs

Future directions

Now that we have gone through what is currently available, let us try to predict what periodontists might employ in their diagnosis of periodontitis 20 years later. With still many things unresolved within the pathogenesis of periodontitis, we may expect that the renewed understanding of the disease would require more advanced diagnostic techniques as has occurred within the past decades.

Time might bring solid evidence for the effectiveness and utility of many current diagnostic aids. DNA testing which has been a hot topic for the past few years may be more conclusive with evidence of the susceptibility factor in various populations. It will be of interest to evaluate the role of other potential candidate genes as contributors to periodontitis. The completion of the Human Genome Project holds a promising future (or tour for periodontists). Then we might be able to identify the specific locus on the gene responsible for the increased disease susceptibility. Identification of these might help us to modify theme sequences and reduce the susceptibilty to periodontitis.

A simple fingerprick and DNA analysis might help to identify the susceptible individuals. This information would enable us to treat these individuals in order to prevent the severe outcome of periodontal disease. Now that the concept of universal susceptibility no longer exists, the main aim of the periodontist will be to distinguish the high-risk group of individuals and treat them as necessary. A screening test may be employed in the future to classify the individuals according to their risk of having periodontal disease or disease progression. The concept of risk assessment in periodontal practice has already been reinforced among periodontists. In terms of screening tests for diseases such as aggressive forms of periodontitis, much work based on systemic antibodies, luecocyte adhesion molecules and linkage analysis of the genetic make-up of these patients may enable such tests to become a reality. One could envisage chair side tests using blood from thumb pricks being capable of determining individual patient risk of developing disease at an early age and thus allowing for preventive strategies. In terms of self-screening tests for maintenance patients. occult blood and chemical tests of saliva may be used as motivational aids or to indicate to the patients that they need to visit their periodontists.

Aggressive forms of periodontal diseases which may cluster within families may be identified and treated in the family so as to prevent progression and further transmission of the disease. Prevention in the community level as well as in the individual level might become more popular with the advent of new, cheap screening tests. The same holds true in the case of the association with systemic diseases and high risk smokers.

At present, the use of microbial assays and commercially available chair side kits appear to show meagre utility and limited applicability in routine diagnosis nisk assessment and prognosis formulation. The microbiological methods now employed are too expensive and require high technology laboratories. We can expect the advent of cheap chair side kits that would help the periodontists in simple and quick monitoring of the required individuals. It may be possible in the future to combine the use of microbial assays together with other tests assessing environmental and host response components in order to enhance the clinician's diagnostic and prognostic potential. In the future, a test of specific antibody levels in patients prior to treatment might indicate their likely poor response to treatment and thus the need for adjunctive antibiotics. Tests of the host response are still at an early stage of development and much work remains be performed to fully validate their utility such that they become an

important and cost-effective aspect of treatment planning, screening and patient monitoring May be after 20 years, tests with host response factors may be researched and developed as more cost effective and simple diagnostic kits. Host response factors in GCF and saliva may become more useful..If research shows more promising results and cost effectiveness, bone scanning may help as a diagnostic aid, in addition to other diagnostic aids.

The Laser doppler probe has been developed which is capable of measuring the movement of red blood cells within connective tissue (Hinrichs et al. 1995). The first study demonstrated reproducibility of the measurements as well as sensitivity sufficient to detect trauma from probing But whether the laser Doppler probe will predict periodontal disease progression better than traditional diagnostic criteria is not known This may turn out to be one of the future diagnostic aids.

Penodontal probes will still have an important role in the years to come. The simplicity of use and low cost gives them a unique place among diagnostic aids. Their drawback including the variability of probing force has been overcome with various force-controlled probes. But these probes have their own disadvantages and they are cumbersome. May be in the future, there will be further advances in the technology of the probes with improved tactile sensation and probing force. May be a periodontal probe capable of identifying the disease activity, the microbial flora as well as the probing attachment levels all-in-one, on insertion into the pocket may be developed which would make life much easier for the periodontist. Radiographs will still play an important role in the future.

Conclusion

Our understanding of the nature, pathogenesis and progression of periodontal disease has changed in the last few decades. This has led to the development of new diagnostic aids. The diagnosis of periodontal disease has relied on traditional periodontal diagnostic aids such as clinical and radiographic parameters for many years. The further development of better diagnostic aids or modification of the existing ones may be the future.

In coming years, probably there will be more genetic susceptibility tests which may identify the susceptible individuals. This will help to formulate preventive strategies. Identification of the high-risk individuals and screening tests more at a community level might be the aim of the periodontist. As new assays are developed which can accurately detect subclinical infections, confirm disease or predict future disease progression, they might be integrated Into our diagnostic armamentarium. Despite the development of new expensive and sophisticated techniques, the clinical and radiographic diagnostic aids still remain the gold standard. The simplicity, ease of use and cost effectiveness cannot be overlooked. The authors believe that they will still be the basic diagnostic approaches even after 20 years, maybe with some modifications or along with adjunctive diagnostic aids. It should be remembered that before applying any test we have to consider what effects on treatment planning decisions, a positive or negative result will have and that any test which does not influence the treatment plan is redundant. Whether these new, complicated and expensive diagnostic tests will cause any change in the treatment plan is still an open question.

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