Changing Trends in Periodontal Diagnosis, Disease Recognition & Management
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Chapter 2

Current Trends in Periodontal Diagnosis & Disease Recognition in Malaysia

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Introduction

The ability to correctly diagnose and institute effective periodontal therapy is essential to the control of periodontal diseases (PD). Our increased understanding of the etiology and pathogenesis of PD have assisted in improving conventional diagnostic procedures such as visual examination, manual periodontal probing, exudate measurements and radiographic imaging to adapt to current periodontal disease concepts.

Traditional periodontal diagnostic procedures are not precise and only allow retrospective assessment of attachment loss. Considerable improvement and advances have been achieved in improving the accuracy of traditional clinical diagnostic procedures and in developing new diagnostic techniques. Continuing efforts have been directed to improving effectiveness of these diagnostic strategies, which in addition to diagnosis can be extremely useful in evaluating treatment outcomes and patient monitoring for disease recurrence.

Traditionally, periodontal diagnosis includes measurement of probing pocket depths (PPD), and attachment levels (AL) as well as recession with a graduated periodontal probe and visual assessment of patients' gingival tissue for signs of inflammation such as redness, swelling, presence of exudates and bleeding on probing (BOP). Assessment of tooth mobility and plaque levels are additional useful clinical parameters. Radiographic evaluation is vital to identify alveolar bone destruction and to determine disease severity. Additional information which involves demographic data such as age, gender, medical history, history of previous and current periodontal problems are used to tentatively assist in determining clinical form of the disease and possibly activity and prognosis of the disease.

In most cases, these traditional diagnostic methods are sufficient to allow development of an appropriate and effective treatment plan. However, the treatment outcome in a minority of clinical cases may not be as desired and research evidence indicates that conventional diagnostic criteria such as gingival oedema, redness, plaque, bleeding and exudates have fair specificity (71-97%) but poor sensitivity (3-42%) in diagnosing sites or patients with "active" progressive disease (Haffajee *et al* 1983).

Following increased understanding of the latest concepts of the nature, aetiology and pathogenesis of periodontal diseases, diagnostic strategies are being modified to correctly fit current disease concepts. Efforts are currently targetting the development of new diagnostic tests or procedures to relate pertinent information regarding a patient's particular periodontal disease, disease severity, progression, activity, predictions and response to treatment.

The new strategies in periodontal diagnosis and disease recognition have been categorized as follows:

1. Advances in traditional diagnostic methods:
   a) controlled-force, electronic probes
   b) computer-assisted digitalized subtraction radiography
   c) mobility measuring device e.g. Periotest

2. Detection of periodontopathic organisms
   a) bacteriologic DNA analysis
   b) immunologic-based tests for putative pathogens
   c) microbiologic enzyme assays
   d) Polymerase Chain Reaction (PCR)

3. Assessment of the susceptible host using markers in peripheral blood
   a) Polymorphonuclear leukocytes (PMNLs)
   b) Antibody titres
   c) Monocyte responsiveness to lipopolysaccharides (LPS)

4. Identification of host constituents in gingival crevicular fluid (GCF)
   a) Arachidonic acid metabolites
   b) Host cytokines
   c) Destructive host enzymes
   d) Other inflammatory host markers in GCF

5. Indicators of local physical/metabolic changes
   a) Subgingival temperature
   b) Nuclear medicine techniques (bone scanning)

Advances in traditional diagnostic methods

Controlled-force, electronic probes

The periodontal probe is the most widely used periodontal diagnostic tool for clinically assessing connective tissue destruction secondary to periodontitis. Progression of periodontitis is assessed using sequential examinations to determine attachment loss, indicated by periodontal pocket depth and periodontal attachment level measurements. These measurements are the benchmarks and most frequently used clinical parameters in the evaluation of the periodontal status.

Various types of periodontal probes have been used which include the manual probes like the Williams, North Carolina (Osborn *et al* 1992) and Michigan O probes (Osborn *et al* 1990); the pressure-controlled manual probes (Kalkwarf *et al* 1986, Perry *et al* 1994) and automated electronic probes such as the Florida Probe (Gibbs *et al* 1988, Perry *et al* 1994), Foster-Miller Probe (Jeffcoat *et al* 1986), the Peri-Probe (Vivadent, Schaan, Lichtenstein) and Audio-Probe (ESRO AG, Thalvil, Switzerland). Manual probing results in measurement errors usually associated with probing force (Van der Velden 1979, Mombelli *et al* 1992), probe angulation (Van der Weijden *et al* 1994), periodontal tissue status (Armitage *et al* 1977) and examiners' visual assessment (Magnusson *et al* 1988). To reduce some of these errors, the next generation of probes, automated electronic probes such as the Florida Probe (FP), have been developed.

The FP is aimed at increasing the probing measurement accuracy, reducing operator observational error and recorder error as well as improving standardization of reference points by utilizing the Florida Disk Probe for the measurement of relative attachment levels (RAL) with the occlusal surfaces or incisal

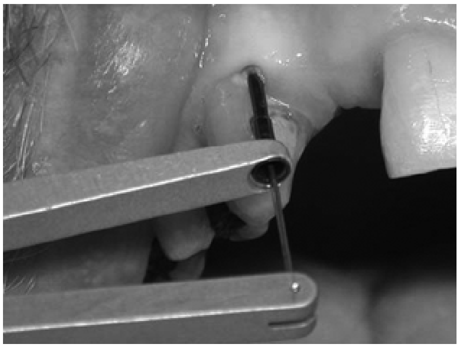

Figure 1. The Florida Pocket Probe in-situ in the periodontal pocket of a patient.

edges as the reference points.

The FP was one of the earliest automated, constant force electronic probes developed (Figure 1). It consists of an autoclavable probe handpiece, foot-switch and computer-interface (Figure 2), which stores captured data. A transducer is used to record the measurements which are transferred electronically to a computer (Figure 3), thereby eliminating transcription errors. Periodontal pocket depth (PPD) is measured with Florida Pocket Probe (FPP) and the Florida Disc Probe (FDP) measures relative periodontal attachment levels (RAL) (Figure 4).

In repeatability studies with manual probes, repeated measurements may vary by as much as 2 mm or more, although most measurements can be repeated to within 1 mm (Glavind and Loe 1967, Badersten *et al* 1981). Repeatability can also be expressed by the standard deviation (sd) of the difference between 2 measurements (Goodson *et al* 1982, Haffajee *et al* 1983, Badersten *et al* 1984). The Florida Probe has exhibited smaller standard deviations than the conventional probes (Magnusson *et al* 1988, Osborn *et al* 1990, Marks *et al* 1991, Yang *et al* 1992).

In a repeatability study of the FP by the author, the distributions of the differences in PPD and RAL measurements are depicted in Table 1 and Table 2 respectively. The differences between repeat PPD and RAL had mean values of -0.04 and -0.05 respectively. The Standard Deviations of the differences between the replicate readings were 0.68 mm for PPD and 0.80 mm for RAL with slightly better repeatability with FPP. It was observed that 88.4% of all PPD measurements and 85.1% of all RAL measurements differed within 1 mm. The distribution of the measurement errors of PPD and RAL measurements as expected had a typical bell-shaped distribution (normal curve).

The distributions of differences between repeat measurements for PPD and RAL for different sites in the dentition is depicted in Table 3 and 4. This was done to investigate if there were any differences on the repeatability outcome between anterior and posterior teeth. The distal surfaces of posterior teeth showed more variability in the repeated PPD measurements. In the case of repeated RAL measurements, greater variability was seen on the buccal and lingual surfaces of posterior and distal surfaces of anterior teeth.

Hence from this preliminary study, adequately repeatable data for clinical use was obtained with the Florida Probe which were comparable to those in other studies for a first-time user (Perry *et al* 1994, Reddy *et al* 1997, Osborn *et al* 1990, Badersten *et al* 1984, Janssen *et al* 1988, Kingsman *et al* 1991, Wang *et al* 1995).

Figure 2. The Florida Probe, consisting of a probe handpiece, computer interface which is connected to a computer laptop, power supply, foot controller and the probe handpiece.

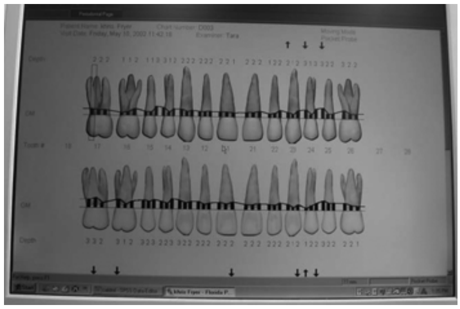

Figure 3. The periodontal measurements electronically recorded and displayed on the computer monitor.

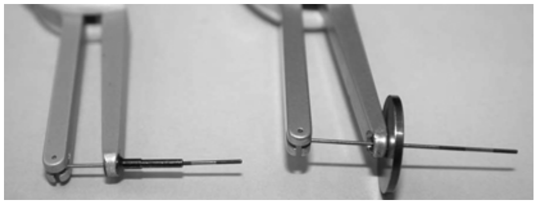

Figure 4. The Florida Pocket Probe (left) and the Florida Disk Probe (right).

Computer Assisted Digital Radiography (CADR)

The levels of alveolar bone are traditionally determined with the long-cone-paralleling technique or with an orthopantomograph. CADR such as subtraction radiography is an improved radiographic technique which is able to diagnose small losses or gains in alveolar bone which may allow immediate intervention of particular active sites. To detect loss of alveolar bone secondary to periodontitis, or gains after regenerative procedures, standardized views of radiographs of the sites separated in time are taken. Changes in as little as 1 – 5% mineral content, or as little as 0.5 mm bone loss along root surface or <1 mm^3 of bone loss (Jeffcoat 1990) can be assessed with consecutive digital images subtracted using developed software. These subtraction images, where bony changes occur, are contrasted or colour enhanced to heighten its readability.

Detection of Periodontal Pathogens

For over 20 years, bacterial culturing has been the primary method of identifying putative pathogens (Socransky and Haffajee 1992, Haffajee and Socransky 1994). However this technique is time consuming and costly, although it remains to be the gold standard for characterizing species and for antibiotic susceptibility testing.

Bacteriologic DNA Analysis

Nucleic acid probes rely on species specific

Mean Difference -0.04	Standard Deviation (SD) 0.68
Measurement Difference	Percentage of sites (%)
≤0.5 mm	58.80
≤1.0 mm	88.41
≤1.5 mm	95.65
≤2.0 mm	99.69
≤2.5 mm	99.90
≤3.0 mm	100.00

Table 1. Distribution of differences (mm) for PPD measurements (with FPP) between the 2 probing sessions for all sites in the dentition

Mean Difference -0.05	Standard Deviation (SD) 0.80
Measurement Difference	Percentage of sites (%)
≤0.5 mm	55.18
≤1.0 mm	85.09
≤1.5 mm	94.10
≤2.0 mm	98.86
≤2.5 mm	99.38
≤3.0 mm	99.69

Table 2. Distribution of differences (mm) for RAL measurements (with FDP) between the 2 probing sessions for all sites in the dentition

genomic sequences for microbial identification. Complimentary oligonucleotide probes are constructed and labeled (Dewhirst and Paster 1991). Subgingival plaque samples collected are enzymatically split into single stranded, denatured DNA fragments. These unknown fragments are then exposed to complimentary, labeled probes and allowed to hybridize to reflect the presence of selected species in the sample

Immunological assays

Specific immunological techniques such as immunoflorescence microscopy or enzyme-linked immunoassay (ELISA) can detect individual bacterial species by using specific labeled antibodies that bind to selected bacterial antigens.

Microbiological enzyme assay

An enzyme which is unique to one or more of selected bacterial species is identified by the detection of the trypsin–like protease produced mainly by *Porphyromonas gingivalis*, *Tanarella forsythensis* and *Treponema denticola* which hydrolyses benzyl arginine napthlamide (BANA) substrate (Loesche 1992, Loesche *et al* 1990).

Polymerase Chain Reaction (PCR)

PCR involves amplification of a region of DNA flanked by a selected primary pair specific for the target species. Primers to the

	# sites	≤0.5 mm	≤1 mm	≤1.5 mm	≤2 mm	≤2.5 mm	≤3 mm
Posterior							
Distal	178	48.9	84.4	91	98.9	99.4	100
Mesial	178	56.2	88.2	94.4	100		
Buccal	89	73	94.4	98.9	100		
Lingual	89	58.4≤	92.1	98.9	100		
Anterior							
Distal	144	66.7	86.8	97.2	100		
Mesial	144	59	89.6	97.9	100		
Buccal	72	55.6	83.3	91.7	100		
Lingual	72	59.7	93.1	98.6	100		

Table 3. Distribution of differences (% of sites) for PPD measurements for different sites in the dentition

	# sites	≤0.5 mm	≤1 mm	≤1.5 mm	≤2 mm	≤2.5 mm	≤3 mm
Posterior							
Distal	178	59	86	94.4	99.4	99.4	100
Mesial	178	50.6	83.1	91	97.8	99.4	100
Buccal	89	61.8	86.5	94.4	97.8	97.8	98.9
Lingual	89	58.4	84.2	92.1	98.8	98.8	98.8
Anterior							
Distal	144	55.6	87.5	94.4	99.3	99.3	99.3
Mesial	144	47.9	81.9	96.5	98.6	100	
Buccal	72	58.3	86.1	95.8	100		
Lingual	72	55.6	87.5	95.8	100		

Table 4. Distribution of differences (% of sites) for RAL measurements for different sites in the dentition

16S-RNA signature sequences are used. PCR is based on the automated recycling of 3 reactions, namely DNA denaturation, DNA annealing and primary extension. Each reaction is quick and performed under similar conditions except for temperature. Completion of the procedure requires about 30 cycles and PCR displays the best detection limit identifying less than even 10 cells. In multiplex PCR, different bacterial species maybe determined simultaneously. Real-time or Quantitative PCR not only detects, but also quantifies, the target microorganisms.

Assessment of susceptible individuals using peripheral blood markers

Three constituents of peripheral blood have been investigated as markers for host susceptibility, which include polymorphonuclear leukocyte function, circulating antibody levels to bacterial antigens and monocyte responsiveness to bacterial endotoxins.

Polymorphonuclear leukocyte (PMNL)

Chemotactic and phagocytic defects in neutrophil function have been associated with severe forms of PD such as aggressive periodontitis and periodontitis associated with systemic diseases, Down Syndrome, Papillon-Lefevre Syndrome, insulin–dependent diabetes mellitus and cyclic neutropenia (Lavine *et al* 1976, Cianciola *et al* 1977, Clark *et al* 1977). Hence assessing neutrophil function may aid in screening high-risk individuals.

Antibody titers

An elevation in serum antibodies to suspected plaque periodontal pathogens in circulating peripheral blood is associated with increased severity of PD (Caton 1989).

Monocyte responsiveness to endotoxins

It has been hypothesized from results of a study that susceptibility to periodontal destruction could be related to increase host response to Gram-negative bacteria endotoxins (Garrison and Nichols 1989)

Assessment of host biomarkers in gingival crevicular fluid (GCF)

Mediators involved in the destructive host response and byproducts of host tissue metabolism, which may serve as markers of periodontal disease activity, pass into GCF.

These host markers include:

i) Metabolites of arachidonic acid e.g. PGE_2 (Goodson *et al* 1974)
ii) Cytokines e.g. 1L-1α , 1L-1β , 1L-6 (Masada *et al* 1990)
iii) Proteolytic and hydrolytic enzymes of inflammatory cell origin known as Matrix Metalloproteinases (MMP) e.g. Collagenases (Kowashi *et al* 1979), Cathepsins and neutral proteases e.g. elastases, trypsin and chymotrypsin (Lah *et al* 1986).
iv) Other inflammatory host factors e.g. β-Glucuronidase (Bang *et al* 1970), aspartate aminotransferase (Imrey *et al* 1991) and alkaline phosphatase (Ishikawa and Cimasoni 1970).

Many of these markers have a fairly high sensitivity and specificity and hence have potential in assisting prediction of PD progression. For some of these markers chairside assays have been developed and described.

Conclusion

Information obtained from any diagnostic test must be valid and precise for clinical use in patients. The validity of a test for periodontitis reflects its ability to correctly identify individual patients and/or sites with the disease and provide information related to disease classification, activity or susceptibility. The potential of these tests in predicting future periodontal destruction or stability in screening and diagnostics, as well as translating the results to clinical decision-making need to be verified further. Despite our present knowledge and expanding evidence regarding PD, there are setbacks in the use of these procedures or techniques as diagnostic adjuncts for PD. Although many of these revolutionary diagnostic tools hold promise, most are at present being used in research studies, not yet in day-to-day clinical practice.

In the future, the enormous focus in periodontal diagnostics is expected to further increase and existing techniques improved and refined so as to be easily accessible to virtually all investigators and clinicians.

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