Current Concepts in Diagnosis and Treatment of Periodontitis

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This article describes some areas of periodontal research and current opinions regarding detection of disease progression, as well as risk indicators and risk factors associated with disease progression. Longitudinal probing of periodontal attachment level is considered the gold standard for detection of disease activity although there are problems with this concept. Digital subtraction radiography can assist in the detection of minor changes of alveolar bone height and density. Risk factors such as composition of subgingival plaque and gingival crevicular fluid, as well as the effect of smoking are discussed. Adjunctive treatment with both antibiotics and nonsteroidal anti-inflammatory drugs, systemic or local, seems to be helpful in some forms of disease. Immunization to prevent colonization of tooth surfaces and pockets by periodontal pathogens does not seem to be feasible in the near future. (Semin Orthod 1996;2:13-20.) Copyright © 1996 by W.B. Saunders Company

Longitudinal probing of periodontal attachment has been and still is the gold standard for the diagnosis of active disease or progression of disease. Interesting questions arise: How reproducible and exact are the measurements? Which measured differences are clinically significant?

Efforts have focused on the improvement of probing validity for earlier detection of disease progression. Gibbs et al 1 developed the Florida Probe system (Florida Probe Corporation, Gainesville, FL) that combines the advantages of constant probing force with precise electronic measurement and computer storage of the data. The Florida Probe eliminates the potential errors associated with visual reading. The system, which consists of a probe handpiece, a digital readout, a foot switch, computer interface, and computer, was studied by Magnusson et al 2 and correlated to standard probe measurements. It was concluded that the reproducibility of pocket depth measurements obtained with the electronic probe was superior to the reproducibility of those obtained with a standard probe. There was no difference in time consumption between the two methods; however, probing data from the electronic probe are entered into the computer automatically, eliminating the need for an assistant to record the measurements. A slightly different electronic probe using an optical encoder transduction element (Interprobe, Bausch & Lomb, Tucker, GA) was compared with conventional probing. 3 Reproducibility was somewhat higher with the Interprobe compared with conventional probing.

To detect progression of periodontal disease for a short period, Haffajee et al 4 recommended the tolerance method, in which the difference between replicate attachment level measurements is used to calculate a standard deviation for all the measurement pairs made in one individual. The subject threshold for attachment loss in an individual site is defined as three standard deviations of the mean differences between all the paired measurements. For 22 subjects, standard deviation values varied from ±0.52 to 1.30 mm, resulting in a mean subject threshold for detection of attachment

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loss of 2.46 mm (range: 1.56 to 3.90 mm), indicating that in some patients a considerable loss of attachment is needed to determine progression of disease with a high level of probability.

Magnusson et al also investigated the reproducibility of attachment level measurements using the Florida Probe. With the use of fixed reference points on custom-made acrylic stents, a high level of agreement was achieved for attachment level measurements made by different examiners (mean SD = ±0.28 mm) or by a single examiner during different visits (mean SD = ±0.33 mm). The highest agreement between attachment level measurements was achieved when the measurements were performed at the same visit, even though the measurements were performed by two different examiners. It is significant that by using the tolerance method, Magnusson et al established that the Florida Probe was more sensitive in detecting a true attachment loss than was the standard periodontal probe. For the 10 subjects, the SD varied from ±0.25 to 0.33 mm, with an average of ±0.28 mm. With the standard manual probe, Haffajee et al reported an average of ±0.82 mm, with a range of ±0.52 to 1.30 mm. Using three SD as a threshold for attachment loss, the average threshold in the Magnusson study would be 0.84 mm, compared with 2.46 mm for Haffajee et al. Thus, it seems that progressive periodontal disease could be detected earlier by the constant-force electronic probe.

Several reports indicate that measurements of deeper pockets are difficult. In the study by Haffajee et al subjects were classified as having advanced periodontal disease; the Magnusson study dealt with subjects having minimal-to-early disease. However, when the Florida Probe was used in subjects with severe periodontal disease, the SD was found to be of the same magnitude or lower in that group of subjects. Yang et al studied different probing designs to investigate the reproducibility of the Florida Probe. The maximum probing error was found to be approximately ±0.3 mm, which is considerably smaller than that found in most previous studies. The errors associated with the periodontal condition and probing effect were also estimated. The variance components obtained here can be used for determining the sample size in controlled clinical studies.

Jeffcoat et al have designed an electronic periodontal probe that can automatically detect the cemento-enamel junction. The Jeffcoat probe provided highly reproducible measurements in 10 human subjects with attachment loss ranging between 0.5 and 7.5 mm who were measured 10 times for 2 weeks. The overall mean SD of the repeated measurements was ±0.17 mm.

Two other electronic probes, the Toronto Probe and the Florida Disk Probe have been designed to measure changes in attachment level using the occlusal surface or the incisal edge as a reference point. The Toronto Probe works on constant air pressure and measures attachment level from the occlusal surface. In a study of replicate measurements in nine subjects, it was found that 82% of the measurements were within 1 mm difference. The SD for all teeth was ±0.46. The Florida Disk Probe was used independently by Low et al and Osborn et al to assess reproducibility of repeated measurements. Both studies resulted in highly reproducible measurements with low standard deviations between replicate measurements (mean SD = ±0.26 and ±0.18 mm respectively). This probe does not require a prefabricated stent.

Gerlach et al described repeatability of controlled pressure relative attachment level measurements collected in a multicenter clinical trial setting. Relative attachment level measurements were recorded for 213 patients by five different examiners at three study centers. For each patient, measurements were recorded from four periodontally involved posterior teeth. Duplicate attachment level measurements were collected at baseline, and after 3 and 6 months from each selected site. A total of 2,453 duplicate measurements were collected during the study. Of these, 215 (8.8%) pairs differed by more than 1.0 mm. Overall, the mean SD of replicate measurements was ±0.29 mm. The repeatability shown in this study supports use of controlled pressure probing to evaluate changes in periodontitis in multicenter studies.

Electronic probes seem to be superior to manual probes. In the studies described previously, the range of overall SD for repeated measurements of individual sites in different subjects was ±0.17 to ±0.32 mm. Regarding the ability to detect significant attachment level changes, this is an improvement over earlier findings.
Probing attachment level is currently the gold standard for detecting active disease at a site, but changes in attachment level are not always easy to interpret because of the limitation of probing in assessing the histological attachment level. Short-time changes, both loss and gain, may only reflect fluctuation in collagen content accompanied by changes in inflammatory status and may not indicate real attachment changes. Watts suggested that it is also possible that despite our best efforts, these changes might also represent errors in probe placement or angulation. If attachment loss is confirmed at a later time, however, it probably represents a true loss, indicative of active and progressive periodontal disease.

**Computer-assisted Subtraction Radiography**

Over the past years the technique of subtraction radiography has been refined. More sensitive and objective methods for analyzing radiographs and perhaps a better opportunity to compare changes in attachment with changes in bone density are offered. Hausmann et al. monitored crestal interdental bone in 15 untreated patients with periodontitis for a 6-month period. Nine percent of the sites exhibited bone loss, whereas 4% exhibited bone gain. The investigators suggested that the findings were consistent with the theory of exacerbation and remission at crestal alveolar bone sites in untreated periodontitis patients. However, in this study there was no attempt to correlate the findings to changes in measurements of attachment level.

Few attempts have been made to correlate bone loss with changes in attachment. Deas et al. compared the frequency of attachment loss in 21 subjects with periodontitis at baseline and at 3, 6, and 9 months. They reported changes in bone density in 53% of sites at 3 months, 56% at 6 months, and 62% at 9 months. With 88% to 92% of attachment level measurements reproducible within 1.0 mm, the frequency of attachment level changes was 19% at 3 months, 25% at 6 months, and 32% at 9 months. Cogen et al. subtracted radiographs taken at baseline, 3 months, and 6 months and reported that of the sites examined, 23% were losing bone and 3% were gaining bone. This suggests that the prevalence of active bone loss reported using subtraction radiography is higher than that previously reported using periodontal probing, and that the proportion of sites losing bone is greater than the proportion gaining bone. However, the clinical significance of a change in bone density is not clear. We must keep in mind that changes in alveolar bone may not correlate with changes in the true attachment level or with measurements of the clinical attachment level. Nonetheless, in a periodontal patient, sites that show evidence of bone loss must be considered to have been active sites at some time during the time interval the radiographs were taken, especially when they correlate with loss of attachment.

**Microbiology**

Overwhelming data support the role of specific bacteria in the cause of periodontal diseases. A classical association is the one between localized juvenile periodontitis and *Actinobacillus actinomycetemcomitans*. Several other potential periodontal pathogens have been described primarily in association with adult chronic periodontal disease. Species of note include mainly gram-negative anaerobic bacteria: *Bacteroides forsythus*, *Campylobacter rectus*, *Eubacterium spp*, *Eikenella corrodens*, *Fusobacterium nucleatum*, *Peptostreptococcus micros*, *Porphyromonas gingivalis*, *Prevotella intermedia*, *Selenomonas spp* and spirochetes have been strongly associated with diseased sites. However, *Streptococcus intermedius* has also been identified in forms of refractory periodontal disease. This condition was described by the American Academy of Periodontology as a disease that continues to progress with loss of connective tissue attachment and bone despite appropriate periodontal therapy. Traditionally, bacteria have been cultured and identified on selective and nonselective media but also microscopic techniques have been used to identify morphotypes. Recently, DNA probes have been developed to detect the presence of putative pathogens. Several of these probes are commercially available and some can be used chair-side for rapid identification.

The presence of a potential pathogen must always be regarded as a risk factor and not as a disease indicator. Patients with refractory periodontal disease have often had previous antibiotic therapy resulting in the development of antibiotic resistance and in these cases it seems
advisable to base continued antibacterial therapy on microbial susceptibility.

**Antimicrobial Approach to the Treatment of Periodontal Diseases**

Conventional periodontal therapy, including scaling, root planing, and possibly periodontal surgery, is still the therapy of choice and is very successful provided that the patient adheres to a regular maintenance schedule. However, in some forms of disease, antimicrobial therapy is appropriate as an adjunct to conventional therapy (for review45,44). In patients with adult periodontitis administration of systemic antibiotics without mechanical treatment has shown little promise. The use of systemic tetracycline in the treatment of juvenile periodontitis is well documented and has been proven effective in suppressing subgingival *A. actinomyces*26. In patients with refractory periodontal disease subgingival plaque exhibits a high percentage of microorganisms with resistance, especially against tetracycline. Therefore, Magnusson et al30 selected antibiotics, based on susceptibility testing, as an adjunct to treat patients with refractory periodontal disease. The results were considerably better than those obtained in a placebo control group.

Recently, research has focused on local antibi-otic therapy to achieve a high local drug concentration and to avoid side effects observed with systemic administration. Favorable results have been described with the local delivery of tetracycline (25%) impregnated ethylene vinyl acetate fibers,45,46 the application of tetracycline (2%) in a lipid gel,47 and the application of metronida- zole (25%) in lipid gel.48

The use of lower-than-normal doses of tetracycline to treat periodontal disease has been investigated by Rifkin et al.49 They showed that the treatment was effective in preventing attachment loss in adult periodontitis patients. Low doses of tetracycline effectively inhibit pathologically excessive collagenase activity in gingival tissue.50

**Gingival Crevicular Fluid**

Analysis of GCF shows a number of enzymes, metabolic byproducts, serum proteins, and other substances related to the inflammatory process, tissue degradation, and cell death. Identification and quantification of these substances may provide better understanding of both the dynamics and metabolic stages of the periodontal tissues.

A number of enzymes reflecting tissue remodeling or destruction have been studied. These include collagenase, β-glucuronidase (β-G), aryl-sulphatase (AS), and L-aspartate aminotransferase (AST).

Villela et al51 studied collagenolytic activity in crevicular fluid from subjects with chronic adult periodontitis, localized juvenile periodontitis, gingivitis, and from healthy control subjects. Among subjects, collagenase activity increased with severity of disease. Among sites, significant correlation was found between crevicular fluid activity and pocket depth in chronic adult periodontitis and in localized juvenile periodontitis, but not in gingivitis.

Birkedal-Hansen et al52 reported that neither gingival crevicular fluid flow nor collagenolytic activity are good indicators or predictors of bone loss. On the other hand, Ciancio et al53 suggested that gingival crevicular fluid collagenolytic activity may be of diagnostic value in periodontal disease, however, they did not monitor attachment level changes. It is clear that further investigation is needed to establish if collagenase levels can be used as indicators of progressive periodontal disease.

Lamster et al54 evaluated crevicular fluid for collagenase, β-G, and AST during development of experimental gingivitis in humans. They found that after 4 weeks the absolute amount of active collagenase had increased 550% in interproximal areas. For interproximal sites the increase in β-G activity was 180% and for AS 240%. Thus, these enzyme levels correlated positively with increased gingival inflammation, although increases in specific enzyme levels lagged slightly behind increases in gingival index. Harper et al55 evaluated lysosomal β-G and AS and cytoplasmic lactate dehydrogenase (LDH) enzyme activity and the composition of subgingival plaque flora in patients with adult periodontitis. β-G levels correlated significantly with populations of spirochetes, *P. intermedia*, *P. gingivalis*, and total lactose-negative black-pigmenting *Bacteroides (BPB)*. LDH activity showed a significant positive correlation with levels of *B. gingivalis* and total lactose-negative BPBs. AS levels correlated significantly with *B. gingivalis* only. In these studies no at-
Attempts were made to correlate increases in levels of these enzymes to changes in attachment.

AST is an intracellular enzyme that is released and can be detected in crevicular fluid as a result of cell death. Chambers et al. and Persson et al. have shown that AST measurements correlate with gingival inflammation and seem to differentiate sites with spontaneously occurring gingivitis in steady states, from sites with active gingival inflammation. In a longitudinal study, Crawford et al. showed that elevated levels of AST in gingival crevice samples exhibited a strong correlation with loss of attachment.

Prostaglandin E2 is reported to be a principal biochemical mediator of periodontal tissue destruction in humans. There is a clear association between the levels present within the periodontal tissues and crevicular fluid and the state of periodontal health. When considering gingivitis, adult periodontitis, and juvenile periodontitis, crevicular fluid levels are low or nondetectable in health, and are elevated markedly with increased disease severity. Extremely high levels of prostaglandin E2 are present at periodontal sites with active loss of attachment. In sites that are in remission or showing no loss, low concentrations are found. It can be concluded that high levels of prostaglandin E2 constitute a significant active disease indicator and that a diagnostic kit assessing concentration could be a valuable tool.

A number of soluble mediators are produced by inflammatory cells. The identification of interleukins and cytokines that could contribute to tissue destruction in periodontal diseases has increased interest in crevicular fluid levels of these mediators.

**Anti-inflammatory Approach to the Treatment of Periodontal Diseases**

Over the last years, considerable interest has been focused on the use of nonsteroid anti-inflammatory drugs to modulate the host response and research has shown that such compounds can retard bone loss. Controlled studies have noted this effect in adult and refractory periodontal disease using systemic flurbiprofen therapy and in rapidly progressive periodontal disease using naproxen or meclofenamate sodium therapy.

Because of the concern of side effects with the use of systemic therapy of these drugs, the concept of local therapy has been approached. In a 6-month controlled study, the effect on bone height was evaluated for three different regimens: ketorolac rinse (0.1%) with placebo capsule twice daily (BID); flurbiprofen capsule (50 mg) with placebo rinse BID; or placebo capsule and placebo rinse BID. Significant bone loss was observed in the placebo group but not in the flurbiprofen or ketorolac rinse groups. Data indicate that topical application of ketorolac may be beneficial in the treatment of adult periodontal disease.

**Smoking**

Smoking seems to be an important risk factor for periodontal diseases and for the refractory form in particular. Magnusson et al. and McFarlane et al. reported that in two groups of 21 and 31 refractory patients, 19 and 28, respectively had a history of smoking. Smoking has also been considered a major risk in adult chronic periodontal disease. Smoking has a negative impact on healing after both nonsurgical and surgical periodontal therapy. It has also been suggested that smoking is associated with increased risk of subgingival infection and that smoking may modulate the periodontal flora.

**Immunization**

Experiments using vaccination against specific periodontal pathogens have been performed by several research groups with the main goal of eliminating existing pathogens and preventing subsequent colonization and growth. McArthur et al. described the modulation of colonization by black-pigmented bacteria in squirrel monkeys by immunization with *P. gingivalis*. Ebersole et al. reported that *P. gingivalis* immunization significantly reduced the emergence of this species during disease progression in ligature-induced disease in *Macaca fascicularis*. However, immunization with *P. intermedia* had minimal effect on the subgingival plaque in this primate. Persson et al. reported that antibody titer and maximum percentage of *P. gingivalis* in *M. fascicularis* were inversely correlated, indicating that a humoral immune response may be effective in reducing *P. gingivalis* overgrowth. Although these animal experiments look promising, it is not reasonable
to assume that immunization in humans will be used in the foreseeable future.

References


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