Periodontal and implant maintenance therapy: An essential component for optimal periodontal treatment

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Purpose: The aim of this paper is to review the importance of comprehensive periodontal/implant maintenance care in the preservation of teeth and implants in health, form and functions.

Materials and Methods: A critical assessment of science-based literature evaluating the effects of periodontal therapy and professional maintenance care on periodontal and peri-implant disease progression is included.

Results: Longitudinal studies have clearly demonstrated that the lack of periodontal therapy and regularly timed maintenance visits of susceptible patients results in a slow, progressive loss of periodontal attachment and tooth loss. Patients maintained with professional cleanings and effective home care regimens retain healthy peri-implant tissues, teeth and associated periodontium.

Conclusion: Periodontal and implant maintenance care is necessary for long-term success of periodontal and implant therapy. Patient compliance and individual risk factors should be utilized to devise a customized maintenance care regimen to tailor to each patients needs. **(Int Chin J Dent 2002; 2: 95-106.)**

Clinical Significance: Proper periodontal/implant maintenance is the essential component for the teeth and implants in health, form and functions.

Key words: dental implants, maintenance, periodontal therapy.

INTRODUCTION

Periodontal maintenance, formerly referred to as supportive periodontal therapy, is defined as an extension of active periodontal therapy. It is distinct from, but integrated with, active periodontal therapy. Periodontal maintenance care embodies the phase of periodontal therapy during which periodontal diseases and conditions are periodically monitored, and etiologic factors are controlled or eliminated. When disease progression is discovered, localized active therapy is performed. Typically, once active periodontal therapy has been completed, a dental hygienist is relied upon to perform the maintenance care. Recall appointments include an update of the medical and dental history, clinical examination, reinforcement of oral hygiene, and removal of microbial flora from sulcular and pocket areas via instrumentation and polishing of the teeth. As documented in the American Academy of Periodontology parameters of care, the

goals of periodontal maintenance therapy are: to minimize the recurrence and progression of periodontal disease in patients who have been previously treated for gingivitis and periodontitis, to reduce the incidence of tooth loss by monitoring the dentition and any existing prosthetic replacements of the natural teeth, and to increase the probability of locating and treating, in a timely manner, other diseases or conditions found within the oral cavity.[1] Therefore, the purpose of this paper is to discuss the intricate role of periodontal maintenance therapy in the preservation of patient's teeth and implants in health, form and function based upon past and current literature.

UNTREATED PERIODONTAL DISEASE

In 1952, Waerhaug reported that retained supragingival plaque developed an "advancing plaque front" that resulted in subgingival plaque formation.[2] In an earlier report, a cause-effect relationship between the accumulation of bacterial plaque on teeth and the development of gingivitis and periodontitis was demonstrated.[3,4] To better understand the cause and effect of microbial plaque in clinical practice, several longitudinal studies evaluating the effects of untreated periodontal disease were performed. These studies clearly illustrated that without effective removal of microbial plaque from the subgingival crevices of teeth, periodontal disease progression in susceptible individuals results in attachment loss, increased probing depths, alteration of the microflora, and ultimately tooth loss.[5-8]

A 15-year observational study performed by Loe and co-workers described the initiation, rate of progression and subsequent tooth loss in a population that never had access to any form of prophylactic or interventional dental care.[5] A total of 480 male tea plantation workers aged 14-31 years were initially examined. These individuals were re-evaluated every 3 years. After multiple examinations over a 15-year period, there were 161 individuals were available who had participated in the initial dental examinations. The findings were that generally each person exhibited large accumulations of plaque and calculus on their teeth; whereas, dental caries was an uncommon finding. Any tooth loss could then be attributed primarily to periodontal disease. Three subpopulations were recognized by the rate of disease progression: (1) 8% exhibiting a rapid progression (RP); (2) 81% displaying moderate progression (MP); (3) 11% with no disease progression (NP). The annual rate of periodontal destruction in the RP group varied between 0.1-1.0 mm, in the MP group 0.05-0.5 mm, and in the NP 0.05-0.09 mm.

Buckley and Crowley followed 1,016 textile workers over a 10-year time period.[6] In a follow-up examination, 82 subjects were identified who had no treatment for periodontal disease during the period of observation. In this untreated group, the average tooth loss over the 10-year period was 2.5 teeth per subject. The tooth loss was 2 to 12 times higher for the individuals untreated compared to the remainder of the treated group. Progression of periodontal disease was slow for teeth initially free of periodontal disease and with mild gingivitis for all age groups. However, where severe gingivitis existed, a more rapid destruction of the supporting tissues occurred in subjects over 35 years of age. Periodontal disease also displayed variation in the rate of progression, suggesting that periodontal disease progression is intermittent and episodes of progression occur over each period of time between examinations.

In a private practice setting, Becker et al. published a report of 30 patients that had undergone initial periodontal examination.[7] Evaluation revealed a diagnosis of moderate to advanced periodontal disease. For various reasons, these patients had no further treatment. In the most severe case, one patient lost 25 teeth during the observational period. Statistically, the annual mean tooth loss was calculated to be 0.36, with the mandibular and maxillary molars having the greatest chance of being lost. In addition to a high incidence of tooth loss, all patients completing the study displayed a progressive increase in pocket depth, ranging from 0.24-2.46 mm per year. The disto-lingual and mesio-lingual interproximal surfaces exhibited the greatest increases in pocket depths. All patients displayed progressive radiographic bone resorption, with the posterior regions of the mouth being the most susceptible.

Timmerman et al. authored a 7-year longitudinal study investigating the role of various putative clinical and microbiological risk markers in a young Indonesian population without access to regular dental care.[8] Plaque index, pocket depths, bleeding on probing, and attachment loss (AL) were scored at the approximal surfaces of all teeth and subgingival calculus on the approximal surfaces. All findings were recorded on teeth numbers 3, 9, 12, 19, 26 and 30 only. A pooled plaque sample of the deepest pocket in each quadrant, tongue dorsum, buccal gingiva, and saliva was evaluated using phase contrast microscopy and indirect immunofluorescence. At follow-up, all clinical parameters except probing depths were found to have increased. In addition, the prevalence of periodontopathic bacteria increased; specifically, increases of *Actinobacillus actinomycetemcomitans (Aa)* (40%), *Porphyromonas gingivalis (Pg)* (67%), *Prevotella intermedia* (66%), *Fusobacterium nucleatum* (79%), and *Bacteroides forsythus* (16%). No differences in clinical parameters were found between groups with or without these microorganisms. Logistic regression analysis showed three significant odds-ratios for patients who experienced progressive periodontitis: Plaque index (12.2), gender (3.4), and *Aa* and *Pg* (2.9). It was found that plaque is the most important parameter related to disease progression and the presence of periodontopathic bacteria (i.e., *Aa*) seems to be strongly associated with an increase of disease progression.

TREATMENT OF PERIODONTAL DISEASE

Several treatment modalities exist that have been shown to arrest or slow the progression of periodontal disease. The methods of therapy can be divided into non-surgical, surgical, and regenerative therapies. All therapies have been shown to reduce probing depths, decrease the incidence of bleeding upon probing, and to increase attachment levels.[9-12] Kaldahl et al., using a split mouth design, demonstrated that flap surgery with osseous recontouring, modified Widman flap surgery, and root planning all effectively increase attachment levels, reduces probing depths, and decreases bleeding upon probing and suppuration.[11] Sculean et al. reported significant gain in clinical attachment levels and probing depths using both guided tissue regeneration and enamel-matrix derived proteins regenerative procedures.[12] Even with effective treatment planning, case selection, and clinical precision, the long-term success of all these various treatment modalities are completely dependent upon thorough and effective subgingival plaque removal (maintenance therapy).

PERIODONTAL TREATMENT WITHOUT PERIODIC MAINTENANCE CARE

The effect of no periodontal maintenance care in patients treated for periodontal disease has been reported by a number of studies.[13-15] In susceptible individuals, the lack of an organized maintenance program results in pocket reinfection, progression of attachment loss, and ultimate tooth loss. Nyman and coworkers performed a 2-year longitudinal study evaluating patients who had undergone surgical procedures with no maintenance care.[13] In this study, twenty-five patients with advanced periodontal disease received either gingivectomy, apically-positioned flaps with and without osseous recontouring, or modified widman flap with and without osseous to reduce or eliminate pocketing. All patients were thoroughly instructed on proper home care, but no periodontal maintenance care was provided at the re-evaluation appointments. Their findings indicated significant continuing loss of periodontal attachment, regardless of the type of surgical intervention performed. They concluded that the success of periodontal surgery outcomes in patients without regular maintenance and inadequate oral hygiene efforts at home would be significantly compromised; ultimately, indicating that after any periodontal surgery, the outcomes will fail unless professional maintenance is performed.

A retrospective study performed by Becker et al., 44 patients treated for periodontal disease failed to return for the suggested maintenance visits.[14] The average time span between the initial visit and the re-evaluation examinations was 5.25 years. Their findings demonstrated that patients not maintained were two times more likely to lose teeth compared to maintained patients (0.22 vs. 0.11, respectively). In this study, the most commonly lost teeth in order of frequency were the mandibular second molars, maxillary second molars, and incisors. With regard to prognosis, at least one-third of the teeth initially diagnosed as questionable or poor were lost. Of the teeth that did not have furcation involvement at baseline, 31% presented with furcation attachment loss at follow-up. Whereas, 22% of the teeth that initially presented with furcation involvement displayed worsened conditions. In the maintained group, maintenance care had almost no effect on reducing initial probing depths greater than 7 mm.

Kocher et al. showed that patients who discontinued maintenance therapy demonstrated an increased number of lost teeth and increased interdental bone loss, compared to the maintained group.[15] Furthermore, this study concluded that systematic periodontal treatment arrests interdental bone loss and decreases the rate of tooth loss in most cases. Also noted was that periodontal surgery with regular follow-up care cannot always prevent further periodontal destruction, but can slow down the rate of destruction and tooth loss.

The retention of teeth with a “hopeless” prognosis without maintenance care have been shown to cause bony destruction of adjacent teeth.[16] Machtei et al. evaluated the radiographic alveolar bone changes adjacent to “hopeless” teeth over a period of at least two years. Results revealed significantly greater bone loss adjacent to teeth in close proximity to the “hopeless” teeth.[16]

PERIODONTAL TREATMENT WITH MAINTENANCE

In a number of longitudinal clinical studies evaluating the outcome of periodontal therapy, the vital role of maintenance in arresting disease progression has been documented.[17-22] Hirschfeld and Wasserman reviewed

well kept records of 600 patients maintained over an average period of 22 years following active periodontal therapy. The therapy included scaling/root planing, flap surgery, and hemisection.[18] After active treatment patients were placed on a 4-6 month maintenance recall interval, during which probing depths, mobility and furcation involvement were recorded. The patient's response to regular maintenance therapy as measured by tooth loss was grouped into three categories: The well-maintained patients lost 0-3 teeth (83% of all patients), the downhill patients lost 4-9 teeth (12.6%), and the extreme downhill patients lost 10-23 teeth (4.2%). Of the downhill and extreme downhill groups, 22.7% and 55.4% of the total number of teeth were lost, respectively. This translated into an average loss of 5.7 and 13.3 teeth per patient. The well-maintained group lost an average of 0.68 teeth per patient, while the downhill and extreme-downhill groups lost an average of 5.7 and 13.3 teeth per patient, respectively. The authors observed that bone loss due to periodontal disease is symmetrical. Maxillary molars were the most susceptible to bone loss, while the mandibular canines and first premolars were the most resistant teeth to bone loss over time.

Using a similar patient classification as Hirschfield of well-maintained, downhill, and extreme downhill, McFall observed tooth loss rates in patients treated for periodontal disease.[19] On average, tooth loss per year was 0.13. It was found that during the period of maintenance care only 9.8% of teeth were lost due to periodontal disease. Generally, more than half of molars with furcation-involvement were lost. Well-maintained patients lost 27% of furcation involved teeth, while the downhill and extreme-downhill groups lost 69% and 92% of furcation involved teeth, respectively. Trends illustrate that with maintenance care, tooth loss is decreased. In contrast, the lack of periodontal treatment or maintenance care results in a higher incidence of tooth loss (Table 1).

Table 1. Tooth loss for untreated, maintained, and non-maintained patients.

Study	Years (mean)	Treatment status	Tooth loss per year
Hirschfeld (1978)[18]	22	Maintained	0.68
McFall (1982)[19]	19	Maintained	0.13
Lindhe (1984)[48]	14	Maintained	0.02
Becker (1984)[49]	3.72	Tx + maintained	0.11
Becker (1984)[14]	5	Tx + not maintained	0.22
Becker (1979)[7]	7	Untreated	0.36
Kocher (2000)[15]	7	Maintained	0.2
Kocher (2000)[15]	7	Not maintained	0.4
Kocher (2000)[15]	7	Untreated	0.5

To further assess the efficacy of a maintenance care program after periodontal treatment, Axelsson and

Lindhe designed a six-year longitudinal study.[20] Ninety susceptible patients with severe periodontal disease underwent oral hygiene instruction, scaling and root planning, and modified Widman flap surgery, as indicated. For the first two months following surgery, each patient received a professional cleaning and polishing every two weeks. The patients were then re-examined to establish post-treatment outcome data. One-third of the patients were referred back to the general dentist for maintenance care; whereas, the other two thirds of the participants remained in a well-controlled maintenance care program at the specialty clinic. The patients assigned to a well-organized maintenance program were able to preserve a healthy gingiva, stable attachment levels and excellent oral hygiene. The patients referred to the general dentist were more poorly supervised and less monitored, which resulted in recurrent periodontitis.

In 1991, Axelsson and co-workers reinforced their previous findings.[21] In addition, they established that frequent and effective maintenance care not only prevents recurrent clinical attachment loss, but also improves periodontal health as measured by gains in clinical attachment levels. Over a period of 15 years, an average gain of 0.3 mm in attachment was reported for 317 subjects.

The effect of adequate home care, in conjunction with periodontal maintenance, on the progression of periodontal disease has been also longitudinally evaluated. Ramfjord et al. observed the effect of plaque scores on probing depths and attachment levels.[22] Their findings indicated that patients with lower plaque scores and better oral hygiene tended to have significantly greater gains in attachment levels during the first year after active periodontal therapy. However, this trend lost its significance after four years of maintenance care. It was concluded that attachment levels and probing depths achieved one year after periodontal treatment could be maintained close to post-treatment levels through professional subgingival plaque removal every 3 months, regardless of the patient's plaque control variations.

The retention of periodontally treated teeth with a hopeless prognosis undergoing active maintenance care has been shown to not adversely effect the adjacent periodontium. Wojcik et al. found no significant difference in pocket depth, radiographic bone level, or width of the periodontal ligament of teeth adjacent to treated "hopeless" teeth.[23] These findings confirmed their original findings that retained hopeless teeth in treated and maintained periodontal patients do not affect the proximal periodontium of adjacent teeth.

IMPLANT MAINTENANCE

Within the past 40 years, studies have demonstrated the success of osseointegrated implants as a viable alternative to fixed or removable prosthodontic restorations.[24,25] Although, techniques and various materials have been developed which are capable of a high degree of clinical success, the ultimate long-term success of implants is dependent upon efforts from both the patient and the dentist in maintaining the health of the peri-implant tissues. Therefore, the goals of implant therapy should be to establish and maintain a healthy peri-implant soft tissue seal and high bony attachment levels.

Diagnostic techniques, such as probing depths, radiographic evaluation and microbial sampling have been used to measure the tissue health of dental implants. With the exception of the parallel connective tissue fiber orientation around implants, biologic width and the lack of periodontal ligament, peri-implant tissues have

been shown to be similar to that of the natural dentition.[26,27] In addition, microbial colonization of dental implant has been proven to be analogous to teeth.[28] Although the periodontal probe is a widely used instrument to evaluate peri-implant tissue health, the diagnostic value of probing around dental implants remains somewhat controversial. Ericsson and Lindhe reported that a 0.5 mm diameter probe tip penetrates apically through the junctional epithelium nearly to the crest of the alveolus.[29] Lang et al. demonstrated that the periodontal probe tip penetrates the coronal portion of the connective tissue and the depth of penetration of the tip increases with the amount of tissue inflammation.[30] Therefore, the true diagnostic value of probing around the peri-implant tissues has yet to be determined.

Radiographic procedures, either conventional or digital subtraction, are very effective in assessing crestal peri-implant bone heights. Vertical bone loss less than 1.5 mm during the first year and 0.2 mm each subsequent year has been offered as a criterion of clinical success.[31] The application of digital analysis in periodontal and implant radiography has increased the sensitivity in the detection of subtle bone density changes.

Optimal peri-implant health, like teeth, depends on (1) prevention of plaque formation, (2) inhibition of early plaque attachment, (3) elimination of existing plaque, and (4) interference with bacterial succession from non-pathogenic plaque.[32] In a dentate mouth, it has been shown that the microflora surrounding a dental implant is similar to that of adjacent teeth.[33] Therefore, the removal of plaque and calculus throughout the dentition is essential to maintain health of the soft tissue surrounding the dental implant.

Several techniques and systems have been proposed in an attempt to remove deposits from implant surfaces. The use of metallic instruments should be avoided. Stainless steel curettes have the potential to cause galvanic action and resultant corrosion. Metal ultrasonic tips may severely disrupt the titanium dioxide layer, resulting in plaque-retentive grooves and surfaces. Generally, rubber-cup polishing with non-abrasive paste appears to be adequate for plaque removal.[34]

Studies that test the effectiveness of adjunctive oral rinses to maintain soft tissue health around implants demonstrate mixed results. Lavigne et al. illustrated that no significant clinical or microbiological effects resulted from subgingival irrigation with chlorhexidine.[35] Ciancio et al. evaluated the effects of Listerine in the maintenance therapy of implant patients.[36] Listerine demonstrated a statistically significant reduction in plaque index, gingival index and bleeding index with no significant difference in probing depths or attachment levels. The general techniques for calculus and plaque removal from implants are similar to natural teeth with three differences. Implants require: (1) non-sharp instrumentation that will not scratch the implants, especially if used for calculus removal, (2) avoidance of prophylactic agents containing acidic fluoride and (3) the use of non-abrasive prophylaxis pastes.[37]

PATIENT COMPLIANCE WITH PERIODONTAL MAINTENANCE

Patient compliance with plaque removal has two components: effective home care and regular professional maintenance care. It is thought that patients do not comply because periodontal disease is a chronic condition which characteristically has little or no pain associated with disease progression.[38] Previously cited studies

have clearly shown that adequate oral hygiene efforts result in maintenance of healthy periodontal conditions.[1,22,39] The lack of pain and the classic signs and symptoms associated with periodontal disease creates, in the patient, a feeling that there is less need to keep recall appointments necessary to prevent periodontal disease progression.

Wilson et al. evaluated the records of 961 patients that had received periodontal therapy that had been followed for eight years. Most patients did no comply with suggested maintenance intervals. Only 16.4% of 961 patients complied with the recommended maintenance interval and 34.1% of the patients never returned for maintenance.[40] In a second study of the same patient population, Wilson observed that compliant patients never lost any teeth if they were compliant, while non-compliant patients tended to loss teeth at a rate ten-times more than the compliant patients.[41] In 1993, Wilson and co-workers attempted to increase the compliance rate by various methods, including accommodating patients schedules, follow-up phone calls, immediate next-visit scheduling, positive reinforcement and identifying non-compliers early.[42] Their efforts resulted in a two-fold increase in compliance rate and a significant decrease in non-compliance. The study also suggested that early recognition of non-compliance, professional diligence, and more effective methods of educating patients should result in the increased incidence of compliance.

Attempts to develop a profile for patients identified as possible high-risk for non-compliant behavior has been undertaken. Mendoza et al. reported that there was no difference in compliance rates between males and females.[43] Older individuals and patients that had periodontal surgery tended to be more compliant. Smokers and non-insured patients also tended to be non-compliant. Novaes and Novaes found that male patients that were treated non-surgically proved to be the least compliant group, with a non-compliance rate of 80%, if the patient was less that 20 years old; 37.5% compliant between ages 41-50 years old, and 50% compliant for those over 51.[44] The compliance rate tended to increase with the age of the patient.

Table 2. Degree of non-compliance.

Study	Length of study (years)	Number of patients	Non-compliance (%)
Ramfjord (1975)[50]	6-12	64	22.0
Lindhe (1975)[4]	8	48	36.0
Knowles (1979)[10]	8	43	44.9
Wilson (1984)[40]	8	961	34.1 (absolute) 49.4 (erratic)
Mendoza (1991)[43]	3-7	637	63.7
Novaes (1999)[44]	5	874	46.8

RISK ASSESSMENT AND ESTABLISHIMENT OF MAINTENANCE INTERVALS

Several studies have been done to determine the best time interval between maintenance visits to maintain optimal periodontal health. Study time periods range from 2 weeks,[4] 3 months[22] to 4-6 months.[18] Periodontal maintenance intervals should be selected to meet each individuals needs based on an individual's risk for disease recurrence.[45] Both risk factors and risk indicators should be considered, including diabetes, smoking, history of periodontal disease, bleeding upon probing, pocket depths, stress and oral hygiene effectiveness.

Ainamo and Ainamo reported factors such as poorly-controlled diabetics, calculus, compliance rates and advanced attachment loss in adolescence indicate high risks for disease recurrence.46

Page et al. devised a computer-based risk assessment tool. His group reviewed clinical records and radiographs of 523 subjects enrolled in the Veterans Affairs Dental Longitudinal Study to evaluate the validity of risk prediction using a computer-based tool.[47] Variables describing the amount of radiographic bone loss, furcation involvement, tooth loss, and calculus obtained at baseline were entered into the risk calculation. Other factors such as the patient's age, smoking activity, diabetic status, and periodontal history were used. A risk score on a scale from 1 (lowest risk) to 5 (highest risk) was calculated for each subject to predict future periodontal deterioration. Actual periodontal status in terms of alveolar bone loss (determined from digitized radiographs) and tooth loss (determined from clinical records) was assessed at years 3, 9 and 15. The results indicated that the risk scores were strong predictors of periodontal status, as measured by alveolar bone loss and loss of periodontally affected teeth. They also concluded that predictions of future periodontal deterioration could be fabricated using traditional periodontal examinations methods and the periodontal risk calculator software.

During maintenance visits, several treatment elements to comprehensively administer care should be considered.[1] Foremost, both medical and dental histories should be reviewed and updated. Clinical assessment should include an extraoral, dental, periodontal, peri-implant, and radiographic examination. Implant stability, occlusal schemes, and implant prosthetic abutments and fixtures should be carefully assessed. The indicated treatment modality will be guided by clinical and radiographic findings, as compared to baseline. As a result, treatment may range from behavior modification to surgical treatment of recurrent disease. Lastly, it is imperative that each patient be continually reminded of their periodontal stability, areas of concern and any necessary alterations in home care.

CONCLUSIONS

Periodontal and implant maintenance care is necessary for the overall success after periodontal therapy. It affords clinicians an opportunity, over time, to continuously diagnose, modify treatment, re-evaluate potential pathogenic disease or identify disease recurrence. Using patient compliance and individual risk factors, a customized maintenance care regimen should exist for each patient tailored to meet their needs. With professional maintenance care and effective home care habits, post-treatment periodontal and peri-implant health can be maintained for an undetermined period of time.

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