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# An evaluation of the long-term wear of a distal extension-removable partial denture on abutment teeth that have undergone periodontal therapy

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**ABSTRACT**

Although the evidence is clear on the long-term effects of removable partial dentures (RPDs) on the periodontal health of abutment and non-abutment teeth, little work has been done on the periodontal outcomes of the remaining teeth previously treated with periodontal therapy. The aim of this study was to evaluate the effect of denture loading on teeth previously exposed to periodontal treatment with additional photo-disinfection. Twelve partially edentulous patients classified as having mandibular Kennedy Class I arches were included. In each quadrant of the mandibular arch, the terminal abutment was diagnosed to have untreated chronic periodontitis. Initially, all the affected abutments received a conservative periodontal treatment in form of scaling and conventional root debridement. Patients were randomly received additional treatment with photodynamic therapy in one of the mandibular quadrants (test group). After the periodontal treatment, a 4-week load-free period was planned. Mandibular distal extension RPDs was fabricated to restore the missing teeth. The clinical periodontal parameters including plaque index (PI), gingival index (GI), gingival recession (GR), probing pocket depth (PD), clinical attachment level (CAL) and tooth mobility (TM) were assessed at baseline, and then for two additional 6-month recall appointments over a period of twelve months after prosthetic treatment. In addition, the mean annual vertical bone loss was also assessed. Except for the PI, GR, and PD, values for the mean GI, CAL, and TM scores at the test group were significantly lower than those in the control group. Better annual vertical bone loss results were observed on the proximal sides of abutments treated with additional photodynamic therapy. The results of this study suggest that RPD abutments affected by chronic periodontitis may perform better as abutments for distal extension RPDs when treated with both conventional root debridement and additional antimicrobial photodynamic therapy.

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## INTRODUCTION

when economic, systemic or local conditions prevent the use of fixed partial dentures or implant-supported dentures, RPD fabrication can be an excellent treatment option to restore mastication, speech and aesthetics in partially edentulous patients. These prostheses are conservative options and offer a quick fix at a reasonable price. However, the use of RPD can pose a serious risk to the patient's remaining teeth. Long-term effects of RPDs on the periodontal health of abutment teeth have been demonstrated in the literature. (1-6). They are linked to increased gingivitis, periodontitis and abutment mobility. RPDs contribute to increased plaque accumulation not only on teeth in direct contact with the denture, but also on teeth in the opposite arch and in some cases on the buccal surfaces of the teeth. Most studies have also shown continued periodontal destruction in patients with RPD.

However, the detrimental effect of RPD wear on the periodontium can be minimized by anti-plaque programs and satisfactory denture design requirements. Literature reports also showed that RPDs supported by only a few remaining teeth or periodontally affected abutments showed lower success rates. Therefore, management of the periodontal condition of the abutment teeth before and after RPD fabrication is of primary importance (6-10).

When selecting a natural tooth as an abutment for RPD, the state of periodontitis must first be assessed. In addition to receiving direct retainers and additional stresses that can cause mobility, the abutments suffer even more adverse effects as they are subject to have more periodontal problems than other teeth because the direct retainers surrounding the abutment teeth promote the accumulation of plaque (7-13). A tooth that has periodontitis cannot function as an abutment if the disease has not been controlled with appropriate periodontal treatment. Periodontal disease is an inflammatory reaction of the tissues surrounding the tooth, usually due to the progression of gingivitis caused by plaque biofilms on the subgingival tooth surface. This inflammation can cause long-term loss of the junctional epithelium in the normal healthy periodontium, resulting in the formation of periodontal pockets. The result can be further loss of connective tissue attachment, the development of intraosseous lesions and eventually possible tooth loss. This multifactorial disease affects up to 30-50% of the adult population and is associated with both local and systemic symptoms. The chronic nature and associated complexity and alteration of subgingival bacterial biofilms results in many virulence factors and inflammatory markers characteristic of chronic periodontitis (14-17). Removal of biofilm and mineralized deposits from the tooth surface are essential aspects of periodontal therapy. However, the effectiveness of these procedures may be affected with increasing probing depth and furcation involvement. Thus, bacterial stocks can remain on the root surface and affect periodontal healing after treatment. Additional measures such as topical and systemic antibiotics or subgingival placement of chlorhexidine chips have been evaluated. Of the topically applied antimicrobial agents, tetracycline, azithromycin, minocycline, metronidazole and chlorhexidine showed the best effect. However, it is difficult to maintain these substances in a therapeutic concentration in the periodontal pocket, and the development of antibiotic resistance has increased (18-22).

Over the past decade, extensive investigation has been extended away into the disinfectant action of photosensitizing agents and light as a sole or an adjunctive periodontal therapy. The antimicrobial photodynamic therapy is a treatment process that During the last decade, there has been extensive research on the disinfecting effect of light-sensitive agents and light as a basic or adjunctive periodontal treatment. Antimicrobial photodynamic therapy is a treatment process that uses light energy to activate a photosensitizer in the presence of oxygen. The principle of operation is that the photosensitizer undergoes a transition to a higher energy state, creating a highly reactive oxygen state. This singlet oxygen can have a toxic effect on microorganisms (23-27).

The use of lethal photosensitization as a tool for the treatment of periodontal disease was first suggested by Wilson (28). This tool besides the ease of use, and the ability to kill tissue-associated microorganisms, it may offer unique benefits in treating of periodontitis. This includes the lack of development of antibiotic resistance, the ability to treat the full depth of the pocket, and the inactivation of virulence factors associated with gram-negative bacteria (29, 30). Many studies (16, 30-32) have shown that in patients affected with chronic periodontitis, the clinical results of conventional subgingival cleaning can be improved by additional antimicrobial photodynamic therapy.

Although the literature is repleted with articles that evaluate the periodontal status of abutments that maintain, support and stabilize RPDs, clinical studies predicting periodontal outcomes of abutments previously treated with periodontal therapy are limited so far. The aim of this prospective study was to evaluate changes in periodontal status in patients with distal extension RPD supported by abutments previously treated with conventional root debridement with or without additional antimicrobial photodynamic therapy.

## MATERIALS AND METHODS

Twelve patients (8 women and 4 men) with a mean age of 55 years were selected from those referred through the screening clinic. Inclusion criteria included Class I mandibular Kennedy patients with at least one bicuspid terminal abutment and all anterior teeth intact. The arch of the opposite jaw was full (or almost so) of teeth. The terminal abutment in each quadrant of the mandibular arch was diagnosed as having untreated chronic periodontitis with a pocket depth not more than 6mm (33). Exclusion criteria included (1) pregnant or lactating women, (2) patients who had any periodontal instrumentation or antibiotic therapy in the previous 6 months, and (3) patients who had any systemic condition that might affect the course of the periodontal disease or treatment. Periodontal-related foci initially received non-surgical periodontal treatment in the form of scaling and routine root cleaning, and patients were encouraged to adopt a careful oral hygiene program. Patients were then randomized to receive additional treatment of periodontal abutments with photodynamic therapy in only one mandibular quadrant (test group).

The photosensitizing solution was applied directly to each affected pocket using a Dentsply (York, PA, USA) 23 gauge blunt-sided irrigation needle to allow complete irrigation to the apex of the pocket. A diode laser (Periowave™, Ondine Biopharma Corporation, Vancouver, BC, Canada) with a wavelength of 670 nm and a maximum power of 150 mW was used. A flexible fiber optic cable attached to a custom stainless-steel autoclavable handpiece was used. The handpiece contained a disposable light-scattering tip configured similar to a periodontal probe to allow access to the periodontal pocket. A uniform distribution of light was emitted from a distance of 7 mm distal to the tip for approximately 60 seconds per site. This allowed perfect light distribution throughout the periodontal pocket. The light scattering nozzle was gently moved around the pocket during the light cycle. Each patient underwent a four-week stress-free period after periodontal treatment.

Mandibular distal extension RPDs were then fabricated following standard procedures for restoration of the missing teeth, the design of which included a lingual plate major connector and combination clasps on the terminal abutments. All participants were then scheduled for regular recall assessment visits.

The clinical periodontal parameters including plaque index (PI) (34), gingival index (BI)(35), gingival recession (GR) 36, probing pocket depth (PD)(36), clinical attachment level (CAL) (37) and tooth mobility (TM) were assessed at baseline, and then for two additional 6-month recall appointments over a period of 12 months after prosthetic treatment. Tooth mobility was measured with a periotest device. The Periotest (Gulden-Medizintechnik, Germany) is an electronic device that measures the dampening characteristics of the periodontium. All measurements were made twice by the same operator and the average values were used in the calculations. A defined impact load was applied to the tooth crown and the mean contact time of the reproducible impacts is calculated and converted into a numeric scale ranging from −8 to +50. The scale was correlated with Miller's index (38), where periotest value (−8 to +9) being no movement distinguishable, (+10 to +19) first distinguishable sign of mobility, (+ 20 to +29) crown deviates within 1 mm of its normal position and (+30 to +50) mobility is easily noticeable (39).

In this study, the baseline assessment was conducted after 4 weeks of RPD delivery to ensure that patients had adapted to their new dentures regarding oral hygiene. In addition, measurement of the mean annual post prosthetic vertical bone loss was measured using Kodak Dental imaging software 6.12 on standardized digital periapical radiographs.

Data collected for both clinical and radiographic parameters were tabulated and statistically analyzed using SPSS software (SPSS Inc., Chicago, IL, USA). To test the significance of these data, comparisons were made within and between the control and experimental groups of the study using the Mann-Whitney and Wilcoxon method originally described (40).

## RESULTS

### Periodontal parameters

Statistically significant differences between the control and test groups (p < 0.05) were observed for GI, CAL and TM in all observation stages during the 1-year evaluation period (Table 1). The mean values of PI, GR and PD scores recorded in the test group did not significantly differ from those of the control group either at baseline, at 6-month intervals, or at the 12-month evaluation stages. In both groups, PI increased from baseline to the end of the 12-month observation period, but without a statistically significant difference between control and test groups (p>0.05). Also, no statistically significant difference in PI scores was observed within the groups between the initial observational study and the subsequent 6 and 12 months (p>0.05). In the control group, there was a gradual increase in GI score from baseline to 12 months. Conversely, GI values decreased in the experimental group from baseline to the end of the observation period with a statistically significant difference between groups (p0.05). In the control and test groups, this change in GI score was statistically insignificant (p>0.05).

Little change in GR values from baseline to 12 months was observed in both groups. No statistically significant difference was observed between or within the control and test groups (p>0.05). At the 12-month follow-up, there was little change in test pocket depth, but no statistical difference between or within the control and test groups (p>0.05). In addition, a statistically significant difference in CAL values was observed between and within the control and test groups (p<0.05) from the initial assessment to the 12-month follow-up phase. Tooth mobility decreased from baseline to 12 months with a statistically significant difference between control and test groups (p<0.05). However, this reduction in tooth mobility was statistically significant only in the test group between baseline and the 6 and 12 months later (p = 0.01) (p <0.05).

### Radiographic parameters

The mean annual bone loss on the proximal sides of abutment teeth after the first year of loading with distal-extension RPD was 0.072 ± 0.012 mm and 0.043 ± 0.052 mm in the control and test groups respectively. This difference between groups was not statistically significant (p=0.355) (p>.0.05).

**Table 1:** Comparative periodontal indices between and within the control and test groups

| Mann-Whitney U test (By groups) | | | | | | Wilcoxon signed ranks test (Within groups) | | |
|---|---|---|---|---|---|---|---|---|
| Periodontal index for one period | Control GP | | Test GP | | P value | Periodontal index for two periods | P value Control GP | P value Test GP |
| | mean | SD | mean | SD | | | | |
| PI : baseline | 1.072 | 0.341 | 0.876 | 0.671 | 0.755 | PI/0-6 months | 0.123 | 0.661 |
| PI : 6 months | 1.354 | 0.442 | 1.871 | 0.774 | 0.868 | PI/0-12 months | 0.334 | 0.445 |
| PI : 12 months | 1.990 | 0.774 | 1.221 | 0.861 | 0.445 | | | |
| GI : baseline | 1.133 | 0.662 | 0.543 | 0.753 | 0.003* | GI/0-6 months | 0.445 | 0.891 |
| GI : 6 months | 1.445 | 0.651 | 0.733 | 0.662 | 0.010* | GI/0-12 months | 0.211 | 0.453 |
| GI : 12 months | 1.342 | 0.691 | 0.542 | 0.781 | 0.031* | | | |
| GR : baseline | 4.651 | 0.771 | 4.231 | 0.772 | 0.664 | GR/0-6 months | 0.072 | 0.421 |
| GR : 6 months | 4.540 | 1.213 | 4.661 | 0.321 | 1.021 | GR/0-12 months | 0.047 | 0.741 |
| GR : 12 months | 4.445 | 0.831 | 4.762 | 0.891 | 0.442 | | | |
| PD : baseline | 5.761 | 0.334 | 5.871 | 0.663 | 1.011 | PD/0-6 months | 0.664 | 0.432 |
| PD : 6 months | 5.546 | 0.273 | 5.981 | 0.445 | 0.435 | PD/0-12 months | 0.861 | 0.981 |
| PD : 12 months | 5.546 | 0.132 | 5.070 | 0.795 | 0.900 | | | |
| CAL : baseline | 8.213 | 0.654 | 8.754 | 0.433 | 0.002* | CAL/0-6 months | 0.001* | 0.001* |
| CAL : 6 months | 8.654 | 0.674 | 8.880 | 0.431 | 0.003* | CAL/0-12 months | 0.000* | 0.000* |
| CAL : 12 months | 8.776 | 0.768 | 8.541 | 0.886 | 0.001* | | | |
| TM : baseline | 18.675 | 2.778 | 18.432 | 2.114 | 0.001* | TM/0-6 months | 0.166 | 0.001* |
| TM : 6 months | 18.543 | 2.221 | 17.543 | 1.881 | 0.000* | TM/0-12 months | 0.221 | 0.002* |
| TM : 12 months | 18.100 | 2.778 | 16.554 | 1.981 | 0.001* | | | |

*P> 0.05, PI (plaque index), GI (gingival index), GR (gingival recession), PD (pocket depth), CAL (clinical attachment loss), TM (tooth mobility)

## DISCUSSION

Analyzing the results of this study, it seems obvious that the test group had a better periodontal outcome than the control group. A statistically significant difference between the groups was observed in the analysis of the results of the gingival index, loss of clinical attachment and assessment of tooth mobility in all observation phases. These results can be attributed to the effective antimicrobial effect of the photodynamic application and the use of a properly designed RPD, which can ensure a uniform distribution of compressive forces, create a regular adaptation of the periodontal tissue, and a stabilizing effect on the rest of the teeth, especially if they are supplemented with strict oral hygiene and regular recall visits. In addition, the test group showed better results comparing the CAL and TM scores obtained after 6 months and 12 months with the initial observation phase, which can support the hypothesis that the application of photodynamic therapy in this group can be the reason for these results if all confounding variables are the same in both groups.

The periodontal tissue responses associated with RPD, such as inflammation, increased probing depth, tooth mobility, and marginal bone loss (2-11). Therefore, it is important to check the periodontal status of the abutment teeth before replacing missing teeth with RPDs. Periodontally affected teeth are not ideal abutments to support, maintain and stabilize RPDs unless the prognosis is improved by appropriate periodontal control. Periodontal treatment consists of non-surgical or surgical techniques aimed at reducing the burden of periodontal pathogens by removing plaque, calculus and root surface irregularities.

Antimicrobial therapy can further inhibit periodontal pathogens and enhance the effect of conventional mechanical therapy. However, systemic antimicrobial therapy can have some side effects, such as gastrointestinal disturbances, allergies, headache and dizziness. In addition, the repeated use of antibiotics can lead to the development of resistant microorganisms. In addition, a major disadvantage of systemic antibiotics in the treatment of periodontal disease is the insufficient concentration of the drug in the sulcular fluid and the presence of periodontal pathogens in the biofilm environment, which protects them against the effect of the antibiotic (18). Local administration of antimicrobial agents directly into periodontal pockets has been proposed as an alternative to systemic antibiotics to avoid some of these complications. However, this method can be technically difficult to apply in patients with generalized periodontitis and multiple deep pockets (21).

Photodynamic therapy has been used to successfully treat periodontal infection. It provides a broad-spectrum antimicrobial effect without local or systemic side effects. Recently, photodynamic therapy has been used as an adjunct to conventional periodontal therapy and has shown promising results (16,22-25). However, nothing has been reported about the effect of photodynamic therapy on the periodontal status of future RPD abutments. Therefore, this study can demonstrate the clinical and radiographic results of prosthetic abutments treated with additional photodynamic therapy.

This randomized controlled trial is the best method in the treatment-evidence hierarchy because it limits potential bias by randomly assigning one group of teeth to be treated with photodynamic therapy in addition to conventional root cleaning and another group of teeth to receive conventional root therapy. debridement without intervention with photodynamic therapy. This reduces the chance that the prevalence of confounding variables differs between the two groups.

When RPD is chosen as a treatment option for partially edentulous patients, the adverse effects of RPD wear on teeth and periodontium can be minimized by satisfactory denture designing (12, 40-41). In this study, each patient received a mandibular distal extension RPD using a lingual plate connector and combination direct retainers. In cases where most of the posterior teeth have been lost, such as bilateral distally extended arches, additional indirect retention is required. Although the lingual plate itself is not indirect retention, it contributes to indirect retention when supported by abutments at each end of anterior teeth (42). The continuous bar, which is the upper edge of the lingual plate without the gingival apron, can also be used as the main mandibular connector for the same purpose. Although it offers the same stabilization and other advantages as a lingual plate, it is often more repulsive to the patient's tongue and is certainly more of a food trap than a molded apron (43). A properly designed lingual plate uses the rest of the teeth to resist horizontal rotation. Although lingual loading with a lingual plate is less effective than a fixed splint, it is considered of considerable value when used with definite rests on adjacent teeth (44).

The RPDs used in the present study were retained with combination clasps as direct retainers to achieve the most favorable load distribution on abutment teeth. A combination direct retainer involves a cast reciprocal element and a wrought wire retentive arm which is more flexible than a conventional circumferential clasp due to its cross-sectional shape and internal structure. The circular cross section of wrought wire allows it to bend in any plane, whereas a conventional cast clasp bends primarily in one plane. Because of its flexure, a wrought wire retentive arm can equalize stresses effectively and can create the least torque on abutment teeth (45).

In this study, although wearing of the RPD negatively affected the prevailing ecologic status in terms of increased PI and GI, however, the slight increased plaque accumulation did not result in any periodontal destruction, which might be due to regular recall visits for professional plaque control.

Despite the non-significant decrease of GR, the decrease of mean TM values was still dependent on time. This finding may indicate reorganization of the supra-alveolar connective tissue (42, 46-48). In addition, the estimated mean bone loss at the proximal sides of the abutment teeth was less than 0.1 mm annually after the first year of loading with RPD with distal extension, with a greater effect in the experimental group. Although this difference between groups was not statistically significant, it can support the clinical results of this study favoring the test group over the control group.

## CONCLUSIONS

Within the limitations of this study, the results of this one year randomized clinical trial showed that the remaining teeth of patients with chronic periodontitis can be good abutments for

RPDs when treated with additional antimicrobial photodynamic therapy in addition to conventional scaling and root planning.

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## CONFLICT OF INTEREST

The authors confirm that there is no conflict of interest.

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