

Chronological grey scale changes in supporting alveolar bone by removable partial denture placement on patients with periodontal disease: A 6-month follow-up study using digital subtraction analysis

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ABSTRACT

Objectives: The purpose was to assess the early effects of removable partial denture (RPD) placement on abutment teeth in patients with periodontal disease.

Methods: Fifteen distal-extension RPDs and 19 abutment teeth were evaluated in 13 patients with moderate-to-severe periodontal diseases. Clinical periodontal records and grey level (GL) score based on digital subtraction radiography were measured on the day of denture placement (baseline) and at 1 day, 1 week, 1 month, 3 months, and 6 months after the placement. Occlusal force on total dentition (Ft) and abutment tooth (Fa) were recorded with (baseline) and without denture on the day of the placement, and with denture in the follow-up examinations.

Results: No statistically significant difference between a follow-up period and the baseline was found in the clinical periodontal and occlusal force records, except for Ft with denture on the day of the placement, which was significantly lower than the baseline ($p < 0.05$). The GL at distal crestal of the abutment was significantly higher at 1 week after the placement than at the baseline ($p < 0.05$), while the scores of following examinations returned to the baseline level.

Conclusions: The distal crestal bone of the abutment tooth transiently reacts to mechanical stress due to the denture placement, while this does not suggest a detrimental effect within the limitation of the study design with a short-term observation period.

Clinical significance: The RPDs can be safely used for patients with periodontal diseases for at least 6 months if they are properly placed and maintained by professional care.

1. Introduction

For partially edentulous patients with severe periodontal disease, prosthodontic reconstruction of dentition and occlusal rehabilitation, along with supportive periodontal therapy (SPT), is essential for prevention of further tooth loss. Potential restorative approaches may include fixed partial dentures and implant-supported prostheses, while the removable partial dentures (RPDs) are provided for reconstruction of the occlusal function and aesthetic appearance without extensive tooth preparations and/or surgical intervention [1]. RPDs are accepted as a prosthodontic measure that can cope with subsequent tooth loss by means of the addition of artificial teeth and denture base, suggesting it is highly adaptable to subsequent negative events, such as further tooth loss [2].

Despite the fact that carefully designed RPDs substantially restore the occlusal function of the patients [3,4], adverse effects of the RPD placement on retention of the abutment teeth have been reported in previous literature [5–7]. A previous study indicated that periodontally compromised teeth presented an increased risk of tooth loss if they were used as RPD abutments [6]. However, previous clinical studies on the prognosis of remaining teeth were often conducted without controlled conditions of the periodontal tissues [3,8] and the remaining teeth [4,6,7,9], and even without a systematic design and fabrication protocol for the RPDs [5,6]. Information on the topic is lacking, especially regarding the effects of denture placement on patients with moderate-to-severe periodontal diseases.

As one of the diagnostic measures used in those studies, radiographic examinations have been performed to evaluate the abutment

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teeth and the supporting alveolar bone based on the conventional morphometric concept [5,8]. The quantitative changes of the bone loss have often been indicated as the changes in the alveolar bone-height or crown-to-root ratio, while qualitative changes, such as alveolar bone density, have rarely been assessed. The digital subtraction technique can facilitate a qualitative visualization of minor density changes in the alveolar cortical bone using two radiographic images taken within certain intervals. The subtraction can be implemented by superposition of the images with a time difference using unchanged anatomic structures as fixed guides [10–12]. This method enables evaluations of bone changes in living bodies, and it has been used to assess the alveolar bone after immediate implant placement, periodontal surgery, and regenerative therapy [12–14].

The purpose of this nonrandomized prospective study was to evaluate a short-term chronological evaluation of the periodontal structures in the RPD wearers with moderate-to-severe periodontal disease. The clinical periodontal examinations were performed, and the maximum occlusal force at the occluding contacts was recorded to analyze the function of the periodontal structures throughout the follow-up periods. A digital subtraction technique using an original stationary observation device was applied to measure the qualitative changes of the periodontal structures. The hypothesis was that RPD placement causes changes in the grey scale level of the digital subtraction images of the alveolar bone surrounding the abutment teeth.

2. Materials and methods

2.1. Subjects

Subjects were recruited from patients who were diagnosed with moderate-to-severe periodontal diseases, based on the conditions of at least four periodontal probing sites with a depth ≥ 4 mm and radiographic evidence of $\geq 30\%$ bone loss (Fig. 1, recruitment). The inclusion criteria were also limited to those who had lost their posterior teeth but had not had them restored during initial periodontal treatment for one side of the maxillary or mandibular dental arch. The subjects were excluded from the study according to the criteria shown in Table 1. The subjects were provided oral hygiene instructions, non-surgical periodontal care, and surgical therapy when needed. They were enrolled as subjects of the study at the time when they were progressed to the SPT phase.

The subjects were informed of the study purpose on written descriptions of the protocol before they consented to participate. As a result, 13 subjects (8 females, 5 males; mean age 67.2 years; range: 37–80 years) qualified for participation. On the same day, partially edentulous dentition was examined and diagnosed for the RPD construction (Fig. 1, RPD diagnosis). The Ethics Committee of the University (authorization no. 1105) approved all the experimental procedures. The data were collected from December 2014 to September 2016 at the Tokyo Medical and Dental University Dental Hospital,

Table 1
Exclusion criteria.

Acute symptoms of oral and craniofacial diseases
Currently under dental treatment
Current use of a removable partial denture
Contraction of infectious disease or systemic disease(leukemia, HIV, etc.)
Having a smoking habit

Tokyo, Japan.

2.2. Provision and placement of the dentures

The dentures were fabricated with cobalt–chromium cast framework, heat-polymerizing denture base resin, and the artificial teeth. Clasp assemblies, with occlusal rests, proximal plates, and wrought wire clasp arms on the buccal side, were designed and engaged on the most distal remaining tooth of each edentulous area. Another occlusal rest was placed on the anterior part of the dentition as an indirect retainer. On the non-edentulous side, a clasp was placed on the premolar and/or molar teeth and connected to the denture base through a rigid major connector. All prostheses were designed by a prosthodontic specialist and fabricated by an experienced dental technician.

The subjects were instructed to wear a denture in daytime, but to keep it outside of the mouth during sleep at night. Each subject was given routine oral hygiene instructions, including tooth cleaning using a toothbrush after every meal and cleaning of the denture using a denture brush. Fifteen dentures, 5 maxillary and 10 mandibular, were inserted for 13 subjects, including 4 Kennedy Class I and 11 Kennedy Class II cases. In total, 19 abutment teeth, including an incisor, a canine, and 17 first premolar teeth, were subjected to evaluation (Table 2).

2.3. Post-placement examinations

Throughout the post-placement period, routine denture adjustment was performed by an examiner (C.W.) whenever it was necessary at the examinations. Data collection was performed on the day of denture placement (baseline), and at the 1-day, 1-week, 1-month, 3-month, and 6-month follow-up visits, all by the same examiner (Fig. 1, Ex.1–Ex.5). Each subject also periodically visited the periodontist once for each three month for continuous SPT. To ensure consistency of the measurement, the examiner was calibrated prior to data collection by repeating all clinical outcome measurements in patients who were not subjects.

2.3.1. Clinical periodontal examinations

Probing pocket depth (PPD), clinical attachment level (CAL), and bleeding on probing (BOP) were recorded at the mesial and distal sites of each abutment tooth using a manual probe (PCP-UNC15, Hu-Friedy Manufacturing Co., Chicago, IL). Tooth mobility (TM) was also judged for each abutment tooth according to Miller’s classification [15].

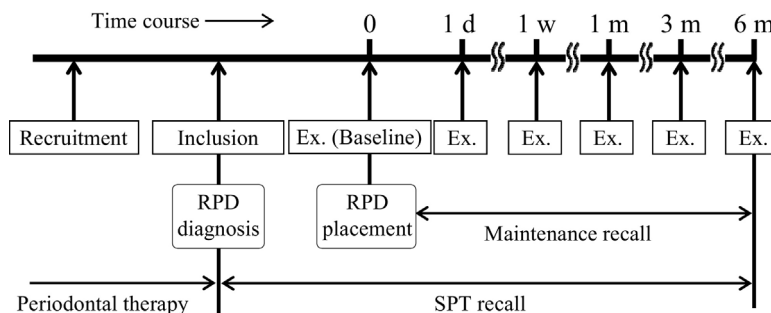


Fig. 1. Time course of the experiment. The total experimental schedule from the patient recruitment to the final examination 6 months after the denture placement is shown according to the time course from left to right. There were no data lost throughout the follow up periods of this study. Ex.: Examination, SPT: supportive periodontal therapy

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