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Original article

Effect of implant support on mandibular distal extension removable partial dentures: Relationship between denture supporting area and stress distribution

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Abstract

Purpose: This study explored the relationship between implant support and the denture-supporting area by comparing the stability of an implant-supported distal extension removable partial denture and a conventional distal extension removable partial denture.
Methods: A model simulating a mandibular bilateral distal extension missing (#34–37 and #44–47) was fabricated using silicone impression material as soft tissue (2 mm thick) on an epoxy resin bone model. The denture base was reduced by 5 mm cutting part of both the retromolar pad and the lingual border. Loads of up to 5 kg were applied, and the pressure and displacement of the RPDs were simultaneously measured and analyzed using the Wilcoxon test ($\alpha < 0.05$).
Results: The pressure on the bilateral first molar and the middle areas of the implant-supported distal extension removable partial denture (ISRPD) was significantly less than on the conventional RPD (CRPD). As the supporting area of the denture base decreased, the pressure and the denture displacement of the CRPD were greater than for the ISRPD.
Conclusion: This study indicated that implant placement at the distal edentulous ridge can prevent denture displacement of the distal extension bases, regardless of the supporting area of the denture base.

Keywords: Implant denture; Edentulous patient; Pressure distribution; Denture displacement

1. Introduction

In general, clinical observation seems to indicate that the extraction of teeth and ridge resorption can occur after the long-term use of distal extension RPDs, particularly in cases of Eichner Classification C1 [1–4]. There are cases in which the maxillary and mandibular teeth remain across from each other, and there is no vertical occlusal stop preventing contact of the upper and lower teeth. Serious problems, such as ill-fitting retainers, occlusal disharmony and pain of the soft tissue under the connector or denture base, may occur from the displacement of distal extension RPDs. As a solution to this clinical problem, implants placed bilaterally at the distal extension of the denture base minimize the resultant denture displacement [5–8]. The main purpose for an implant located under the most posteriorly placed of the distal extension denture base is to stabilize the RPD vertically. Implants placed distally would effectively change the Kennedy Class I or II situation to that of the Class III. As a result, less bone resorption, less rebasing and less tension for precision attachments are expected. The ideal situation is that in which fewer implants are needed to achieve a successful distal extension RPD [9,10].

Partially edentulous patients with missing mandibular premolars and molars, especially the combination syndrome, have been rehabilitated successfully using the implant-supported distal extension removable partial denture (ISRPD) approach [11–14]. Suzuki et al. reported that mandibular implant-supported dentures were exceedingly reliable for

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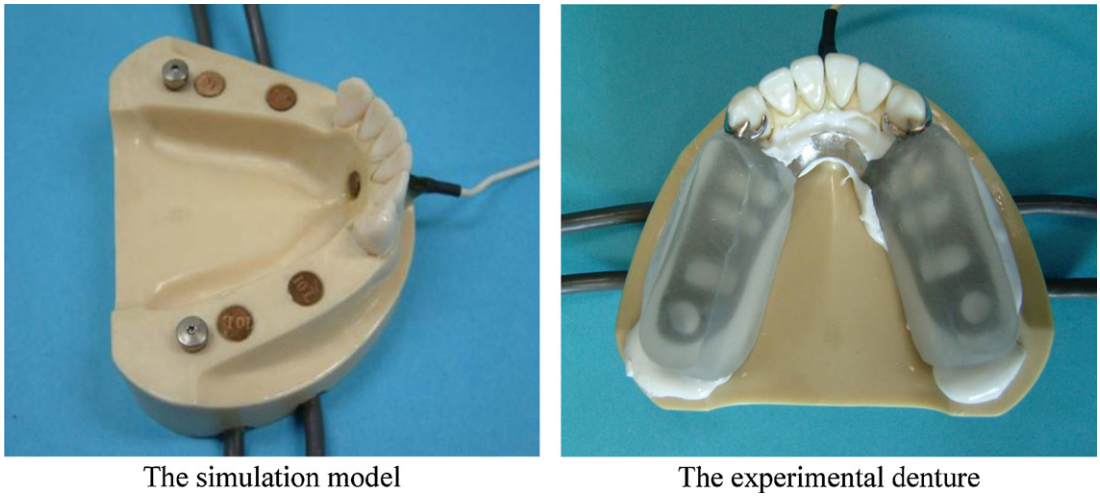

Fig. 1. The simulation model and the experimental denture.

rehabilitation with a high survival rate and showed a good prognosis [15].

The implant should be placed under the posterior molar of the distal extension base to prevent denture displacement. If there is insufficient bone in this area, the implant can be placed more medially although this is not an ideal position. However, there is a paucity of evidence-based research concerning the implant position and the supporting area of the denture base. Particularly, little is known about the effect of the decrease in pressure on the soft tissue under the denture base, denture displacement, and reduction of the supporting area of the denture base.

The purpose of this in vitro study was to analyze the relationship between implant support and the denture-supporting area on the stability of mandibular distal extension RPDs.

2. Materials and methods

A model simulating a mandibular bilateral distal extension missing (#34–37 and #44–47) was fabricated using silicone impression material (Fit Checker®, GC Corporation, Tokyo, Japan) as soft tissue (2.0 mm thick) on an epoxy resin bone model (Fig. 1). The six remaining anterior teeth (from right canine to left canine) had an artificial periodontal membrane made with silicone impression material (Fit-checker) [16,17].

Five small pressure sensors (4.2 mm diameter, PS-10KA, PS-10KB, Kyowa, Tokyo, Japan) were attached near the left and right first molars, first premolars and mesio-lingual alveolar ridge (ML). The sensor at the median was positioned beneath the lingual bar when the RPD was set on the modified models.

As soft tissue, silicone impression material (2.0 mm thick) was amply applied between the denture base and the sensor embedded in the resin bone.

Five bilateral distal extension RPDs with a lingual bar and Akers clasps on both canines were designed and formed an occlusion rim without any denture teeth. Co–Cr frameworks were conventionally cast, and then heat-cured denture base resin was packed and polymerized. Implants (ITI Strauman, RP 8 mm) were placed at the bilateral second molar areas (#37 and #47), and healing caps (4.5 mm high) were mounted. The denture base of the ISRPD was connected to the healing caps using autopolymerized resin according to the overdenture technique. The conventional RPD (CRPD) simulating a mandibular bilateral distal extension missing was mounted using a cover screw, and this screw was covered with a silicone impression material. Thus, the healing screws of the CRPD were placed without being connected to the implants. The measurement was carried out to decrease the denture base by 5 mm cutting part in following order: the retromolar pad, retromolar pad and the lingual border. After a brass plate for loading was attached on the occlusion rim of each RPD,

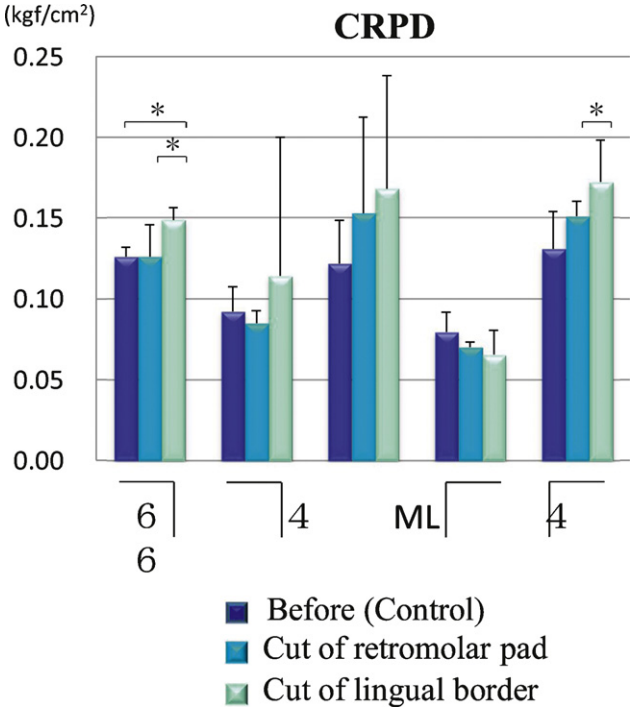

Fig. 2. Pressure distribution of CRPD.