Pressure distribution of implant-supported removable partial dentures with stress-breaking attachments

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Introduction

The implant has been placed in the edentulous ridge to support and stabilize the removable partial denture (RPD) and minimize the rotational movement[1,2] (Fig.1). As a result, less bone resorption, fewer numbers of relining and minimum decrease of retentive force of precision attachments would be expected. There are remarkable differences between implant mobility and soft tissue displacement under occlusal force. Therefore, the implant might undergo excessive pressure with a conventional RPD during masticatory function. The stress-breaking attachment for implant has been developed to prevent the excessive and harmful occlusal forces.

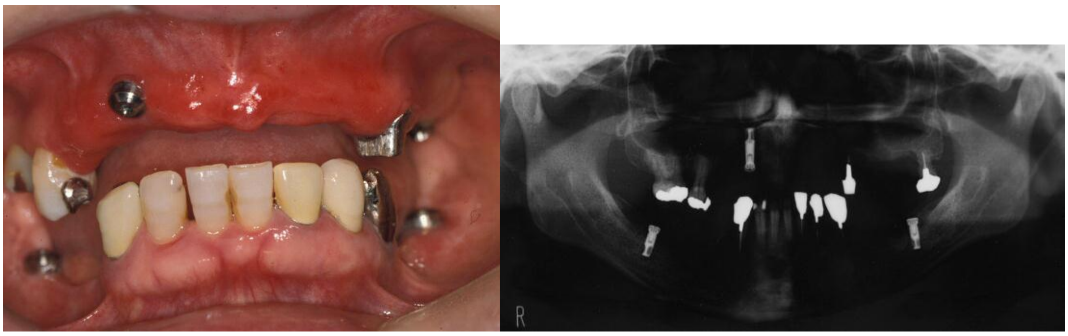


Fig.1 The implant has been placed in the edentulous ridge to support and stabilize the removable partial denture (RPD) and minimize the rotational movement

Objective

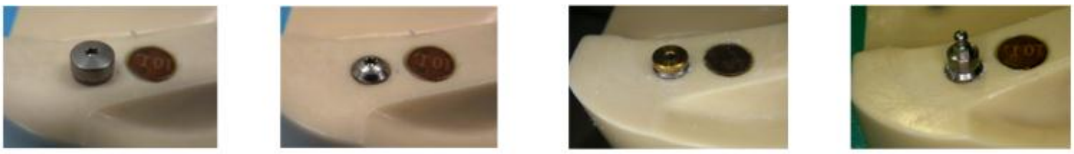
This study investigated the pressure distribution of the implant-supported RPDs with the stress breaking attachment under the occlusal force.

Materials and Methods

A model simulating a mandibular bilateral distal extension missing (#34 to #37 and #44 to #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. 2). Five small pressure sensors (4.2mm diameter, PS-10KA, PS-10KB, Kyowa, Tokyo, Japan) were attached near the left and right first molars, first premolars and medio-lingual alveolar crest (ML). The sensor at the median was positioned beneath the lingual bar when the RPD was set on the modified models. Five bilateral distal extension RPDs with a lingual bar and Akers clasps on both canines were designed and formed like an occlusion rim without any denture teeth. Co-Cr frameworks were conventionally cast, and then heat-cured denture base resin was packed and polymerized (Fig. 3). Two implants (SLA® implant, standard ϕ4.1mm 10mm, straumann japan, Osaka, Japan) were placed at the bilateral second molar regions (#37 and #47). Implant-supported RPDs, with the non stress-breaking connection (healing cap: HC) and the two stress-breaking connection (SBB attachment, GC, Tokyo: SBB, Magfit IPS, Aichi Steel Corp, Aichi: MG) were fabricated. For a conventional RPD (CRPD), healing screws were placed without being connected to the implants (Fig. 4,5). Loads up to 5kg were applied, and the pressure and displacement of the RPDs were simultaneously measured and analyzed using the Wilcoxen test (α=0.05).

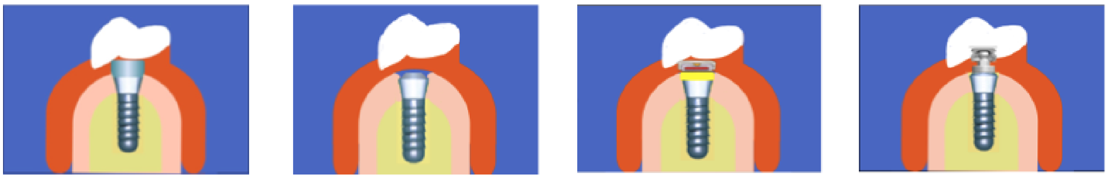
Fig. 2 Simulation model

Fig . 3 Simulation denture



Healing cap (HC) Healing screw (CRPD) Magnetic attachment (MG) SBB attachment (SBB)

Fig. 4 Implant supported situation



Healing cap (HC) Healing screw (CRPD) Magnetic attachment (MG) SBB attachment (SBB)

Fig. 5 Schematic of implant-supported RPDs

Results

The pressure on #36 and #46 of HC and MG was significantly less than SBB and CRPD ($p<0.05$). In contrast, the pressure on #34 and #44 of SBB and the MG were slightly greater than HC and CRPD. The pressure of CRPD indicated approximately one half times to three times at ML, compared with HC and MG, SBB (Fig.6). The amount of total pressure of HC and MG was significantly less than for SBB and CRPD ($p<0.05$) (Fig.7). The denture displacement of HC and

MG tended to be less than for CRPD and SBB. There were approximately 20-40μm differences among HC, MG and CRPD ($p<0.05$) (Fig.8).

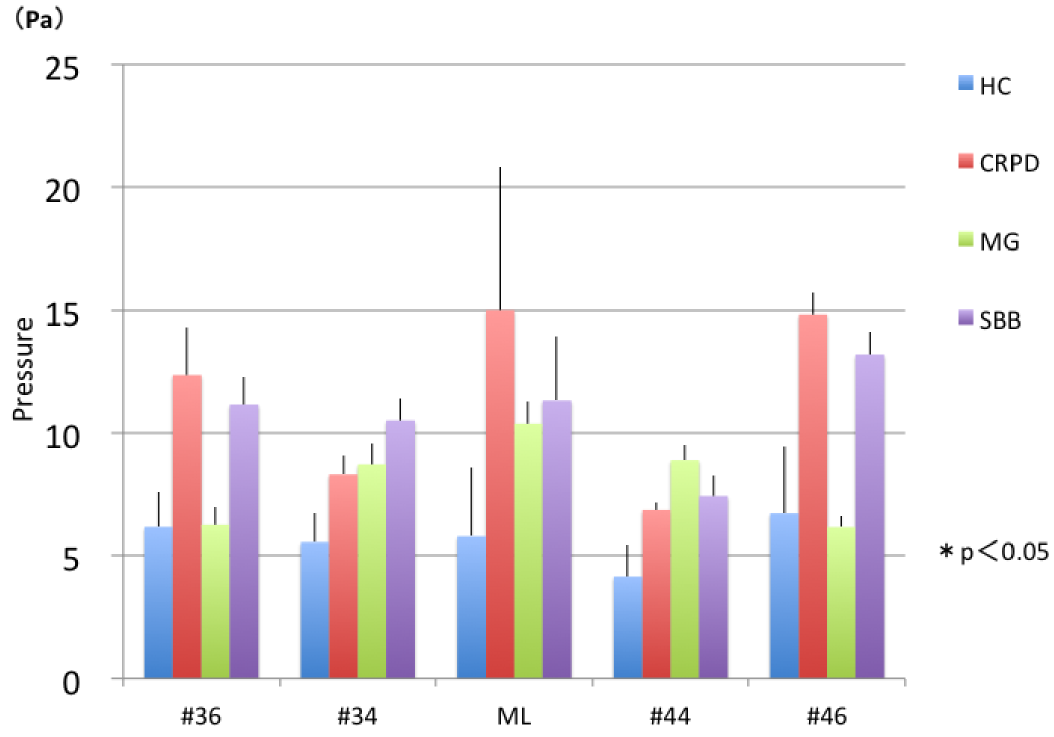


Fig. 6 Pressure distribution

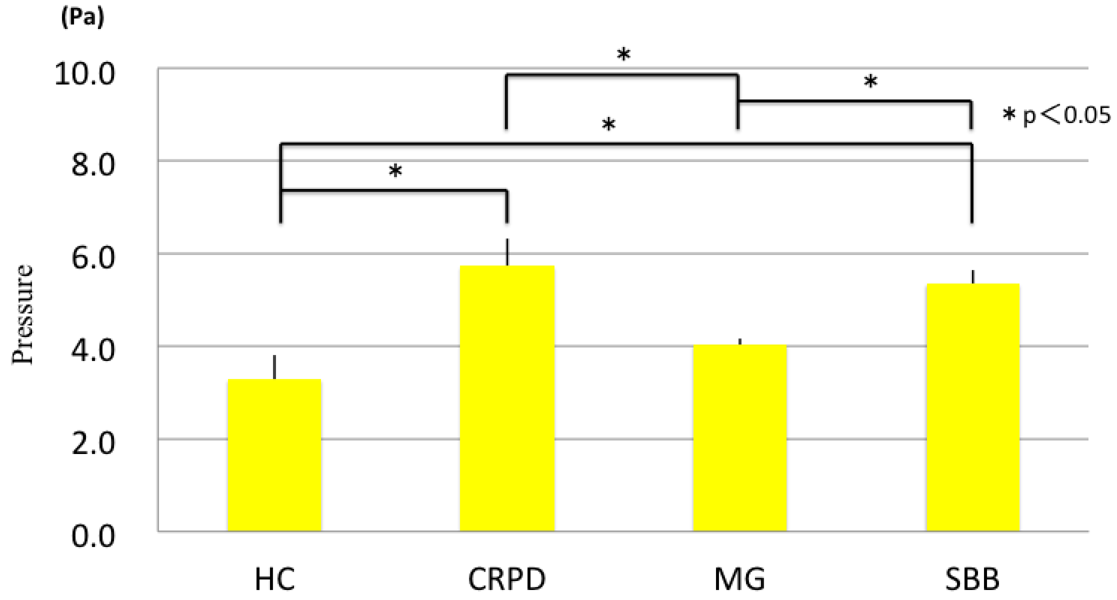


Fig.7 Amount of total pressure

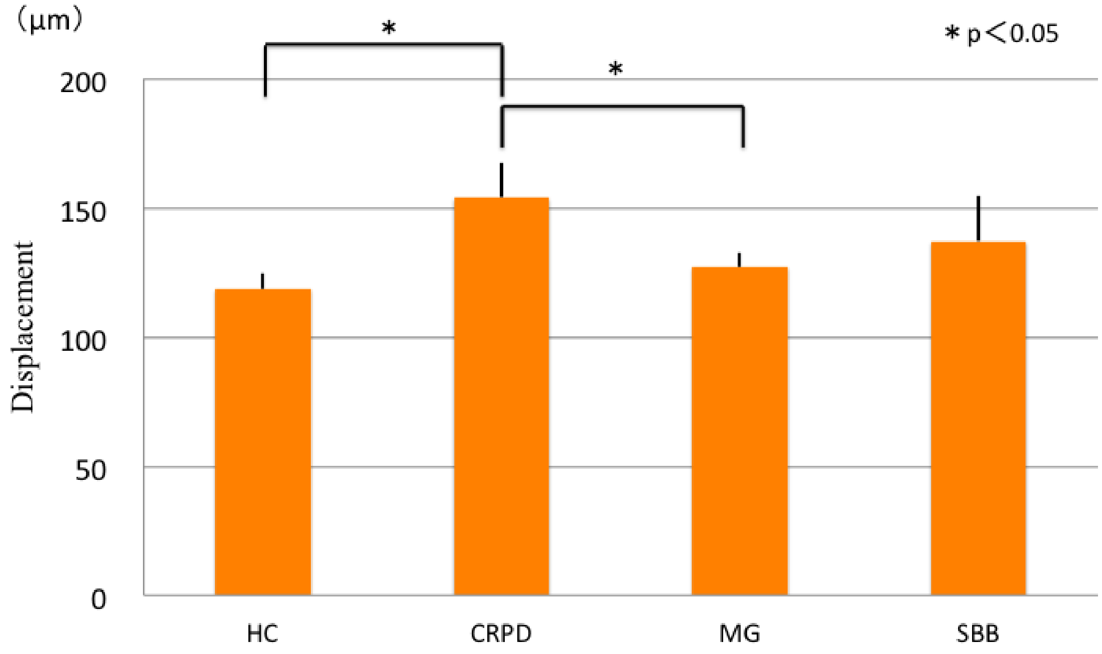


Fig. 8 Denture displacement

Discussion

The results of this study indicated that implant placement at the distal edentulous ridge can prevent the denture displacement of the distal extension bases. Note that the pressure at the distal regions (#36 and #46) decreased compared with the mesial regions (#34 and #44) by implant support. The pressure differences of the alveolar ridge, the SBB attachment tended to be greater than Healing cap and magnetic attachment. The buffer action of magnetic attachment was less than SBB attachment in vertical direction. Because the SBB attachment is stress breaking attachment until the denture displacement was 0.3mm. The selection of SBB attachment should be considered so that the occlusal force can be equally distributed between alveolar ridge and implants.

Conclusion

Within the in vitro limitations, precise denture settlements and pressure distribution under the denture base could be controlled using a SBB attachment. SBB attachment might be able to protect the implant from harmful force.

References

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2. Ohkubo C, Effect of implant support on distal-extension removable partial dentures: in vivo assessment, Int J Oral Maxillofac Implants 23(6):1095-1101, 2008.