Long-term fixation of a modified magnet assembly to the denture base using soft resins

S. Okayama, Y. Suzuki, H. Shimpo, C. Ohkubo

Department of Removable Prosthodontics, Tsurumi University School of Dental Medicine

Abstract

Introduction:

Special care must be taken during the fixation of magnetic assembly because the denture may become impossible to remove from the abutment teeth or implant due to the PMMA resin's hardening within the undercut around the keeper. The aim of this study was to investigate the durability of fixation strengths and attractive forces of magnetic assemblies to denture bases using soft resins for long term use.

Materials and Methods:

Magnetic assemblies with different undercut and three resins (experimental resin, temporary filling resin, and conventional PMMA resin) as fixation materials to magnetic assembly were prepared in this study. Tensile testing was performed to evaluate the durability of fixation strength and the attractive force of magnetic assembly after repeated insertion/removal fatigue testing. The data of fixation strengths and attractive forces were analyzed using a two-way ANOVA, Tukey's multiple comparison and t-test (α=0.05).

Results and Discussion:

Magnet assembly was detached using experimental resin during fatigue testing. Temporary filling resin and conventional PMMA resin demonstrated constant attractive forces without removing the magnetic assembly after repeated insertion/removal fatigue testing until 50,000 cycles. When PMMA resin and temporary filling resin integrated to modified magnet assembly, it might be suggested to less detachable from denture bases for long term.

Introduction

The magnetic assembly has been directly fixed to the denture base with autopolymerized polymethyl methacrylate (PMMA) resin using the brush-on technique after the magnetic assembly was placed on the keeper of the abutment tooth or implant. However, special care must be taken during the fixation because the denture may become impossible to remove from the abutment teeth or implant due to the PMMA resin's hardening within the undercut around the keeper. Modified magnetic assembly and new fixation materials for wearing magnetic assembly to the denture base have been investigated to resolve the serious problems. In this study, modified magnetic assembly and fixation materials were evaluated by fatigue testing for their durability.

Objective

The aim of this study was to investigate the durability of fixation strengths and attractive forces of magnetic assemblies to denture bases using many types of fixation materials.

Materials and Methods

To evaluate the effectiveness of mechanical retention in this study, a commercially available magnetic assembly (PHYSIO MAGNET 35, Neomax, Gunma, Japan; diameter: 3.5 mm; thickness: 0.8 mm; attractive force: approximately 5.5 N) was modified by adding undercut wing (wing diameter [undercut]: 4.5 mm [0.5 mm]). A conventional magnetic attachment (PHYSIO MAGNET 35, Neomax, Gunma, Japan) of the same size without undercut wings was compared as a control (Fig. 1).

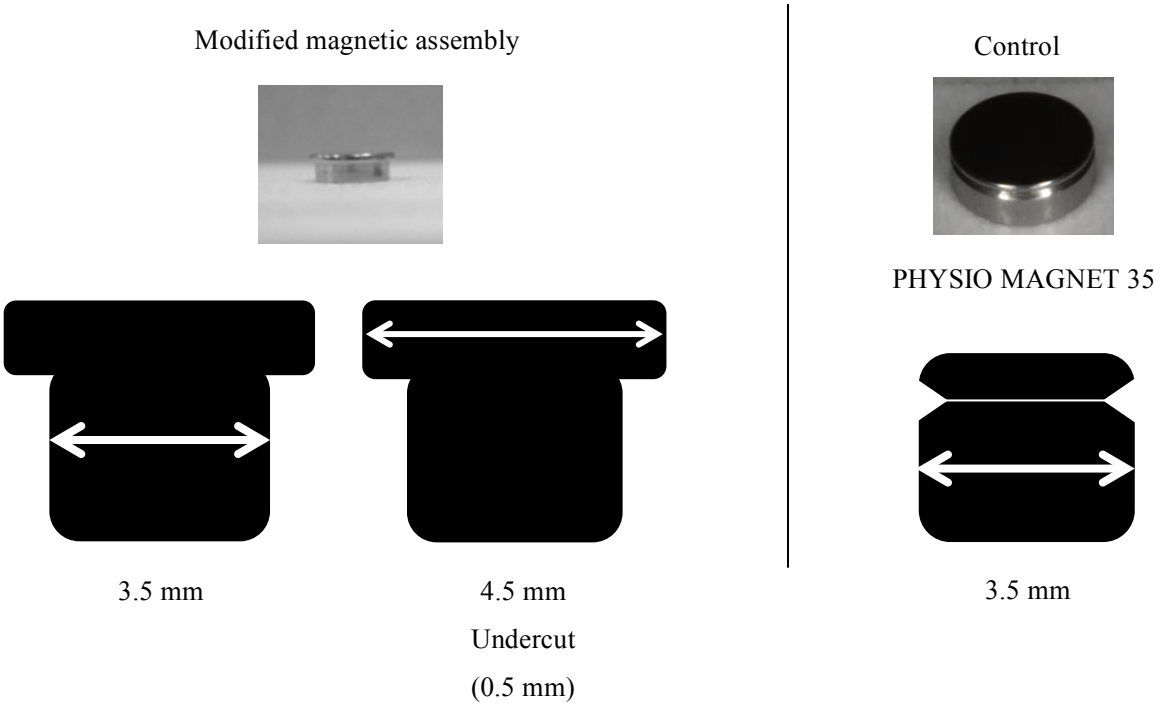

Fig. 1 Magnetic assemblies modified by adding undercut wing (wing diameter [undercut]: 4.5 mm [0.5 mm])

An experimental resin (70% polyethylene glycol dimethacrylate 23G and 30% MMA in the monomer, 20% polybuthylmethacrylate and 80% PMMA in the polymer), a temporary filling resin (Dura Seal, Reliance Dental Mfg. Co., Worth, IL, USA), and an autopolymerized PMMA resin (UNIFAST III, GC Corp., Ltd., Tokyo, Japan) were selected as fixation materials. Magnetic assemblies were bonded to the lower jig using a cyanoacrylate adhesive (ARON ALPHA, Toagosei Co., Ltd., Tokyo, Japan) for tensile testing (Fig. 2). For fatigue testing repeated insertion/removal, the keeper was mounted in the lower jig, and the magnetic assembly was placed on the keeper without a cyanoacrylate adhesive. After the polymers and monomers of the fixation materials were mixed, they were applied to the magnetic assembly and poured into the housing in the upper jig (Fig. 2). Tensile testing was performed to evaluate the fixation strength

and the attractive force of the magnetic assembly using resins after repeated insertion/removal fatigue testing up to 50,000 cycles (Figs. 3 and 4). Tensile strengths were measured by an autography (EZ-S 200N, Shimadzu, Kyoto, Japan) at a crosshead speed of 1.0 mm/min. The data of fixation strengths and attractive forces were analyzed using a two-way ANOVA, Tukey's multiple comparison, and a t-test (α=0.05).

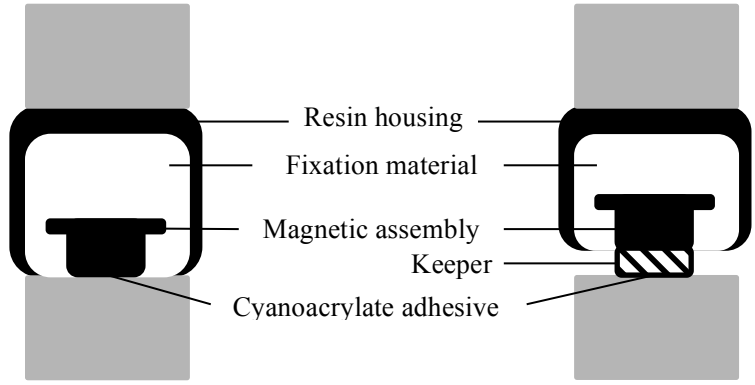

Fig. 2 Fixation of the magnetic assembly for each test

Fig. 3 Autography used for tensile testing

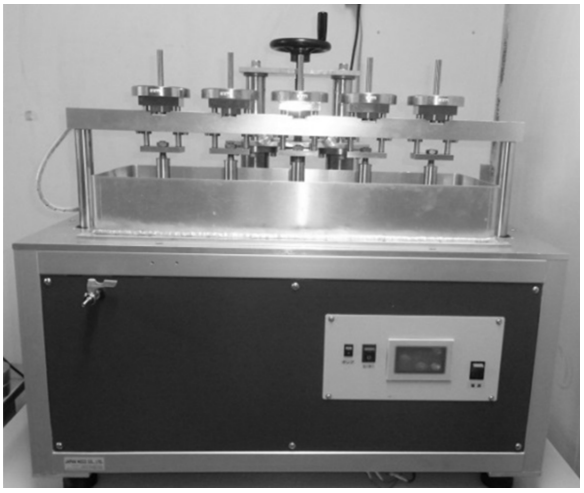

Fig. 4 Insertion/removal testing machine

Results

Figure 5 shows the fixation strengths of magnetic assemblies using three fixation materials, both initial and after 50,000 cycles. Fixation strength of temporary filling resin indicated appropriate potential with slight decrease. Modified magnetic assembly 4.5 mm was detached from lower jig and fixation strength data could not be measured.

Figures 6 and 7 show the changes in the attractive forces of the magnetic attachments when using fixation materials with and without the undercut wing, respectively. Experimental resins were detached

from magnet assembly during fatigue testing. With and without the undercut wing, attractive forces of both temporary filling resin and conventional PMMA resin showed the sufficient attractive forces (4-5 N) and there were no significant differences between control and 4.5 mm undercut after repeated insertion/removal fatigue testing until 50,000 cycles ($p>0.05$).

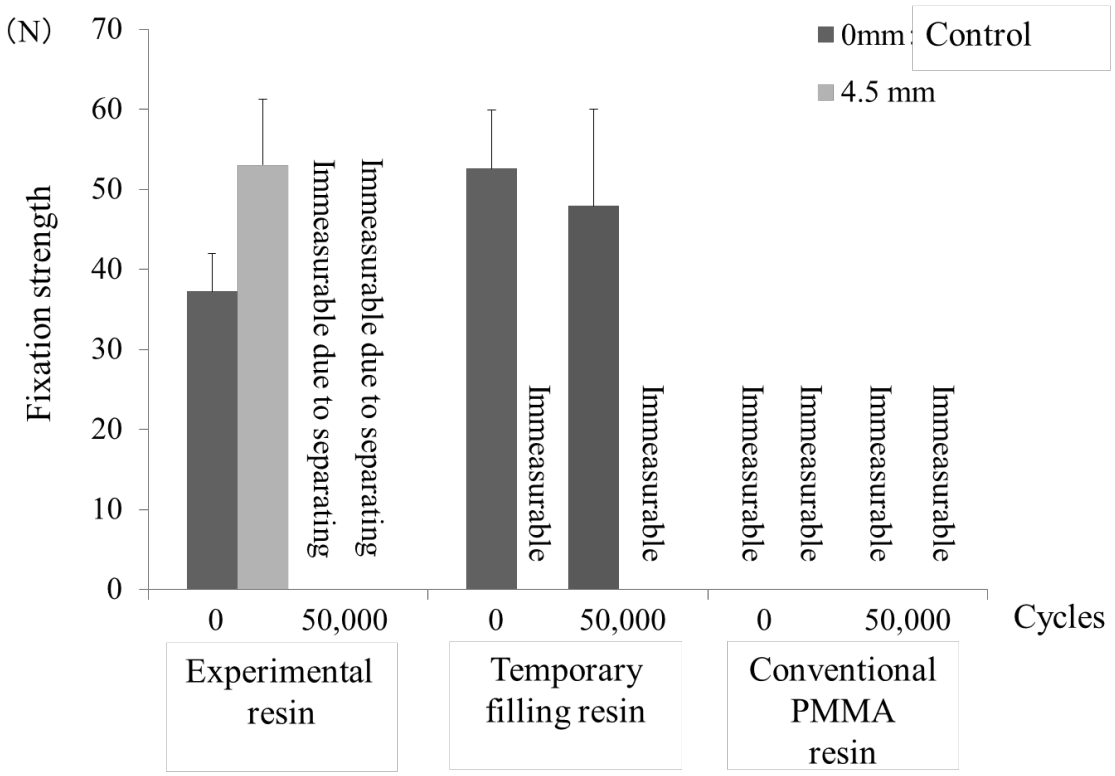

Fig. 5 Fixation strengths of magnetic assemblies using fixation materials

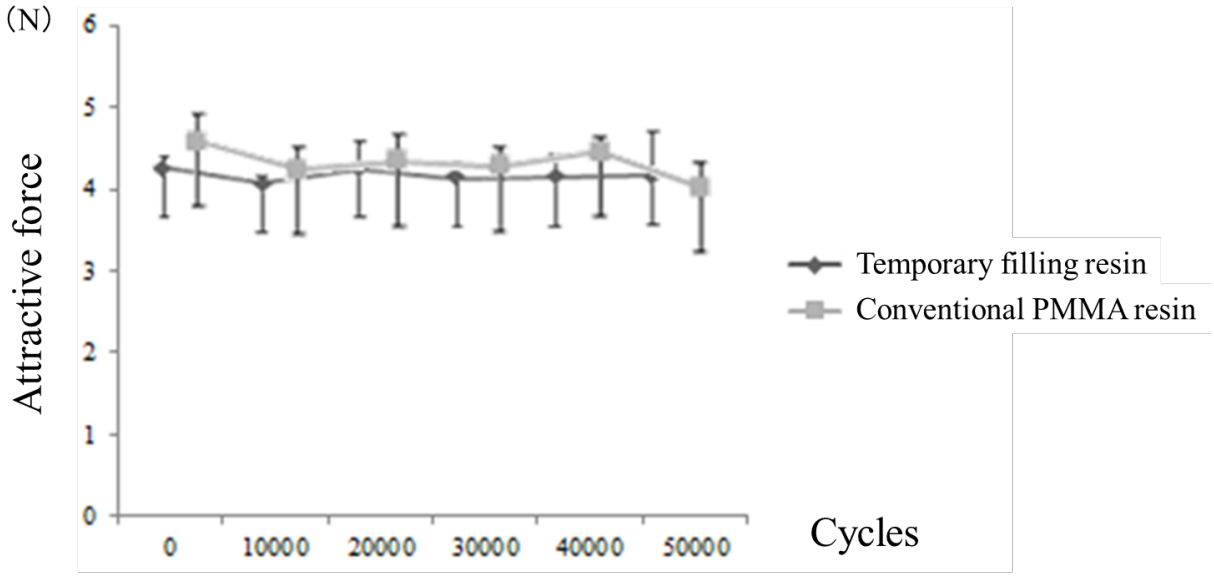

Fig. 6 Changes of attractive forces to the magnetic assembly without undercut (Control)

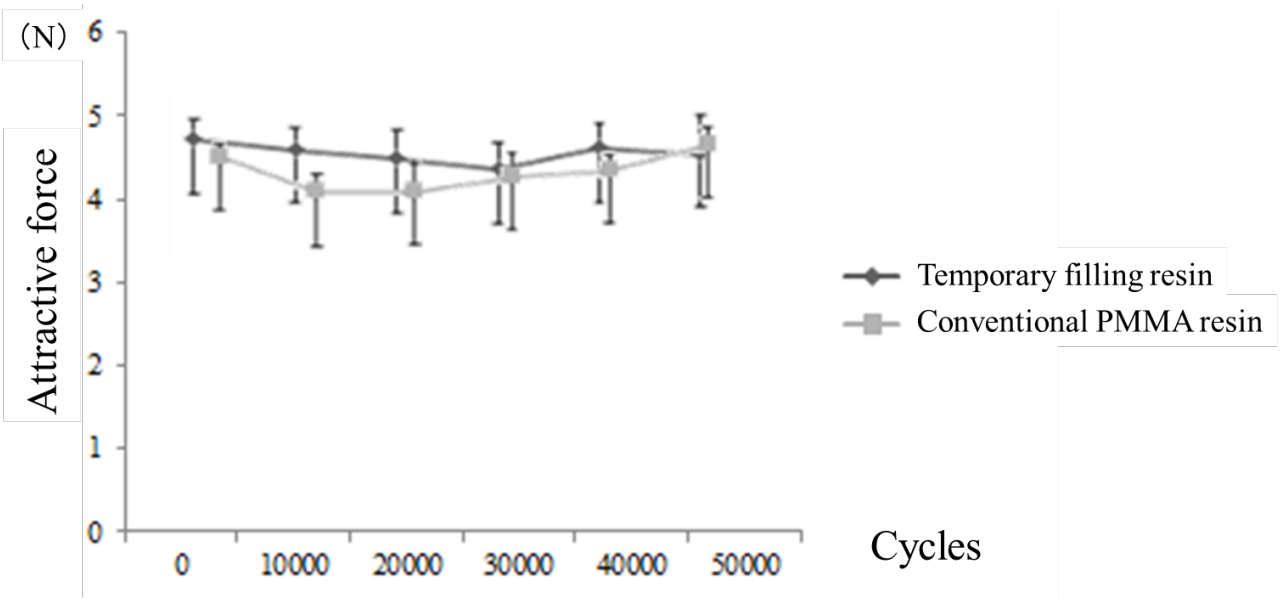

Fig. 7 Changes of attractive forces to the magnetic assembly with a 4.5-mm undercut

Discussion

Regarding the experimental resin, polyethylene glycol (PEG) dimethacrylate 23G and polybuthylmethacrylate were influenced for flexibility and expanded the polymerization time. All the magnetic assemblies were removed from the housing during up to 50,000 insertion/removal cycles. Thus, the mechanical property of the experimental resin should be improved for rigid fixation. The fixation strengths of magnetic assemblies using temporary filling resin without undercuts, showed approximately 50 N after 50,000 insertion/removal motions. Temporary filling resin and conventional PMMA resin demonstrated a constant attractive force (approximately 4 to 5 N) without removing the magnetic assembly. From the results of fatigue test, the try to use of temporary filling resin would be recommended as a permanent fixation material similar to conventional PMMA resin.

Conclusions

Using experimental resin, magnet assembly was detached during fatigue testing, its mechanical property should be improved. When temporary filling resin was integrated to the magnetic assembly with undercut, it might be suggested the less detachment from denture base for long term similar to using of conventional PMMA resin.

References

1. Okayama S, Suzuki Y, Shimpo H, Ohkubo C: Fixation of magnet assembly to denture base using

alternative resins, Dent Mater J, 34(3), 364-70, 2015.

2. S. Okayama, H. Shimpo, Y. Suzuki, C. Ohkubo: Fixation of a modified magnet assembly to denture base using alternative resins, J J Mag Dent, 24(2), 23-27, 2015.