Fixation of modified magnet assembly to denture base using alternative resins

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Introduction

Magnetic attachments have been widely used as stud attachments for root- and implant-retained overdenture rehabilitation. In general, 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 is 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. In this study, the magnetic assembly was modified to add several undercuts to improve mechanical retention.

Objective

The aim of this study has been to investigate the fixation strengths of magnetic assemblies to denture bases using alternative resins rather than conventional PMMA autopolymerized resin without housing.

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 three different undercut wings [wing diameter (undercut): 4.5 mm (0.5 mm), 4.8 mm (0.65 mm), and 5.5 mm (1.0 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).

The materials selected for the retaining magnet as fixation material, 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 used. Magnetic assemblies were bonded to the lower jig using a cyanoacrylate adhesive (ARON ALPHA, Toagosei Co., Ltd, Tokyo, Japan) for tensile testing. For 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 magnetic assembly using resins after repeated insertion/removal testing up to 10,000 cycles (Fig. 3, 4). The tensile strengths were measured using an autography 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 t-test (α=0.05).

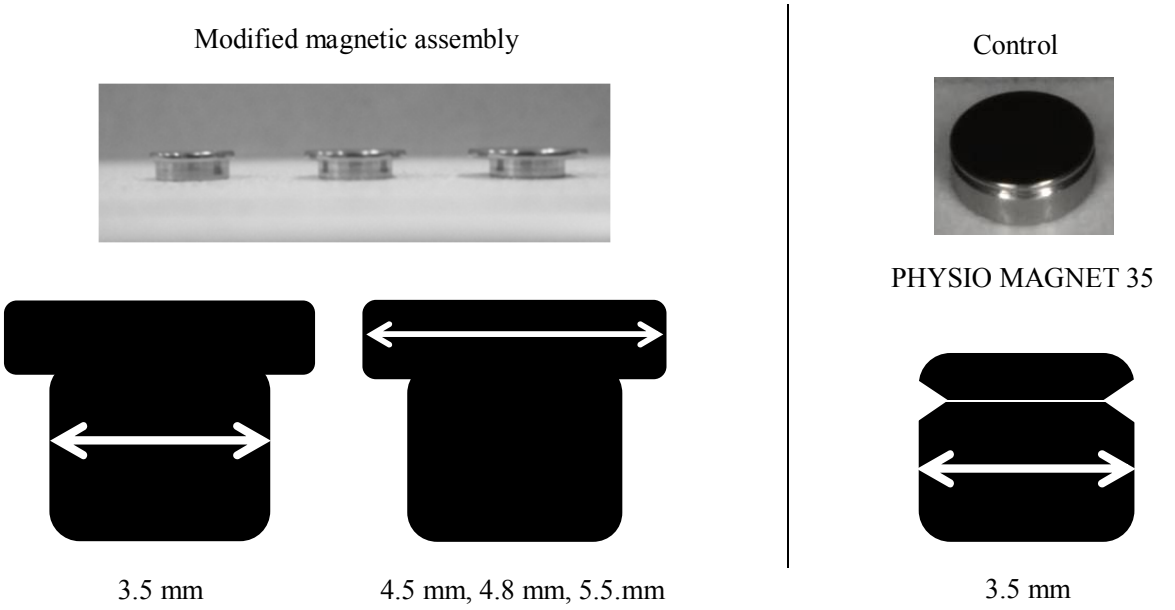

Fig. 1 Magnetic assemblies modified by adding three different undercut wings
[wing diameter (undercut): 4.5 mm (0.5 mm), 4.8 mm (0.65 mm), and 5.5 mm (1.0mm)]

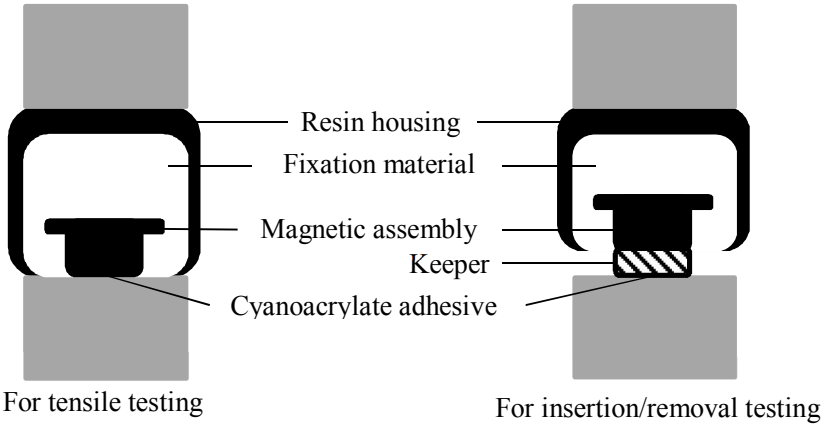

Fig. 2 Fixation of magnetic assembly for each test

Fig. 3 Autography used for tensile testing

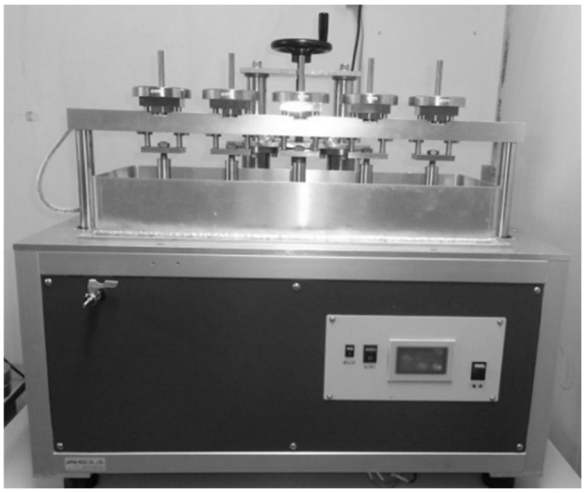

Fig. 4 Insertion/removal testing machine

Results

Figure 5 shows the fixation strengths of magnetic assemblies using permanent fixation material, both initially and after 10,000 cycles. The fixation strengths of a temporary filling resin (Dura Seal) with a 4.5-mm undercut wing and conventional PMMA resin could not be measured because the magnetic assembly was separated from the lower jig without failure between the magnetic assembly and the fixation resin.

Figures 6 and 7 show that the change in the attractive forces of the magnetic attachments when using fixation materials with and without the undercut wing, respectively. Without the undercut wing, the magnetic assembly was removed in one of 5 experimental resin specimens. There were no significant differences in the attractive forces with and without undercuts ($p>0.05$). Although the initial attractive force of the experimental resin was similar to the others both with and without the undercut wing, a remarkable decrease was shown at 1,000 cycles, keeping constant attractive forces at 2,000 cycles.

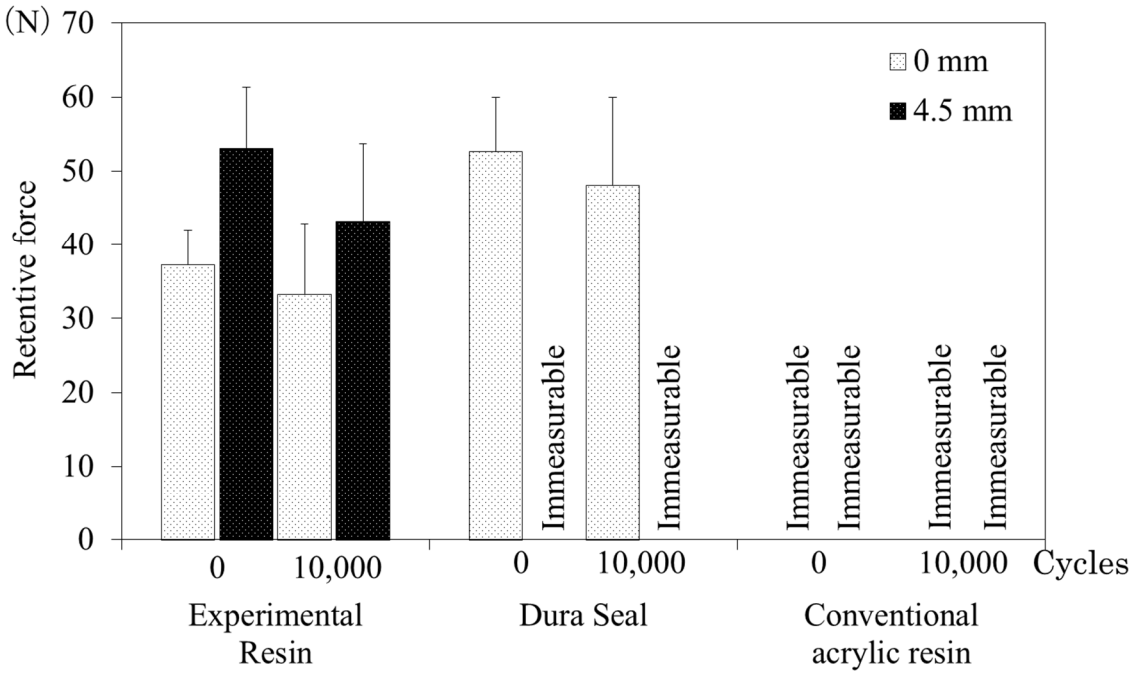

Fig. 5 Fixation strengths of magnetic assemblies using fixation materials

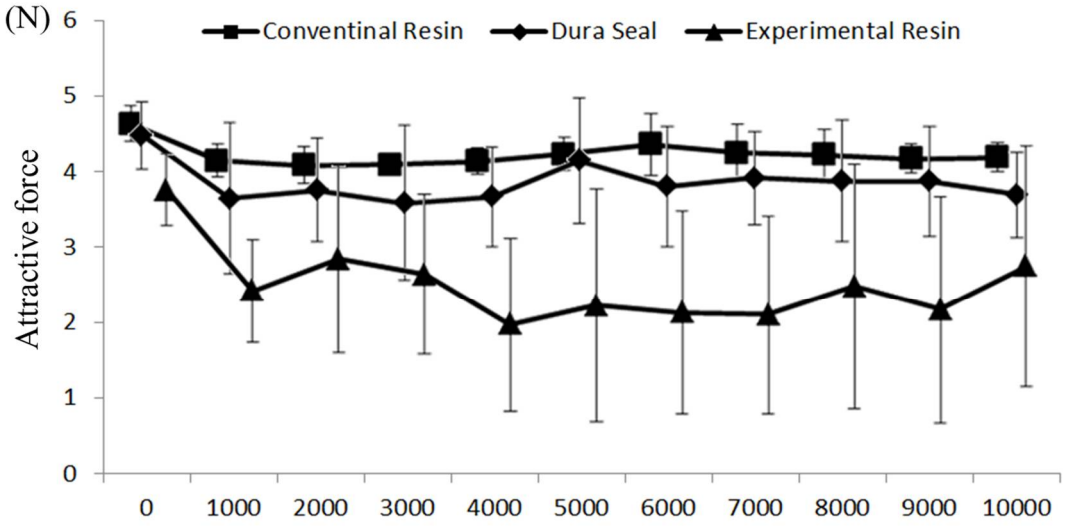

Fig. 6 The change of attractive forces to magnetic assembly without undercut using fixation materials

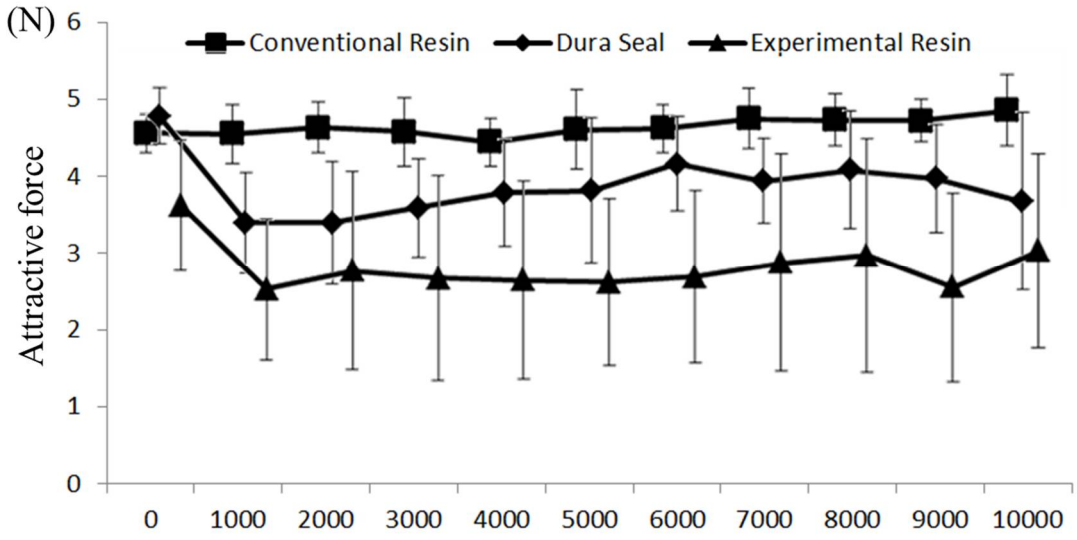

Fig. 7 The change of attractive forces to magnetic assembly with 4.5-mm undercut using fixation materials

Discussion

Regarding the experimental resin, polyethylene glycol (PEG) dimethacrylate 23G and polybuthylmethacrylate were prepared for flexibility and expanded the polymerization time. The magnetic assembly was removed from the housing in one of five specimens that used the experimental resin during insertion/removal cycles of up to 10,000. Thus, the mechanical property of the experimental resin should be improved for rigid fixation if the experimental resin is used as a permanent fixation material. The fixation strengths of magnetic assemblies using temporary filling resin, even without undercut, showed approximately 50 N even after 10,000 insertion/removal motions. Until 10,000 insertion/removal motions, temporary filling resin and conventional PMMA resin demonstrate a constant attractive force (approximately 4 to 5 N) without removing the magnetic assembly. In conclusion, using a temporary filling resin can be recommended as a permanent fixation material similar to conventional PMMA resin.

Conclusions

By adding undercut wings to the magnetic assembly, fixation strengths tended to be increased when fixation materials were used. Although the experimental resins demonstrated satisfactory fixation strengths, improving the mechanical strengths is necessary because the magnetic assembly was removed from the housing in one of five specimens. Temporary filling resin showed comparable fixation strengths to conventional resins; thus, they could be used as permanent fixation materials for magnetic attachments used in this study.