Retentive forces and vertical displacements of stress breaking attachments for implant over dentures

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Introduction

Numerous studies with reliable results on attachment systems for implant overdentures in the mandible and maxilla have been published. Most attachments allow for rotational excusion, but cannot compensate for vertical displacement under the functional forces. There are extraordinary differences in setting under a chewing load between the implant and mucosa under the denture base. In addition, horizontal forces and rotational excusion are also applied to the implants depending on the occlusal contact, location, and numbers of implants in the dental arch. Therefore, excessive and harmful occlusal forces are applied to the implants. To protect implants from excessive forces, a few stress-breaking attachments have been manufactured.

Objective

This study evaluated the retentive forces and displacement of stress-breaking attachments after repeated loads simulating masticatory function.

Materials and Methods

Four types of stress-breaking attachments (Fig.1), namely, a self-adjustment type magnet attachment (Magfit SX, Aichi Steel), a cushion type magnet attachment (Magfit IPS, Aichi steel), a locator attachment(Locator, ZEST anchors), and three types of Stress-Breaking Ball (SBB) attachments (amount of displacement:0.3mm, 0.5mm, 0.7mm,GC corp.), were placed on the implants. The implants were embedded in a resin block using autopolymerized resin (Fig.2). To simulate the chewing cycles, a load of 5 kgf was repeatedly applied up to 50,000 using a loading apparatus (Fig.3). The retentive force was measured by means of tensile testing at a crosshead speed of 5 mm/min. The vertical displacement of each female was measured under 5 kgf. These measurements were repeated for 10,000 cycles. The mean values were analyzed using 1-way ANOVA followed by the Tukey’s test at a significance level of $\alpha=0.05$. The contact surface of attachment female were examined using a microscope (SZX, OLYMPUS).

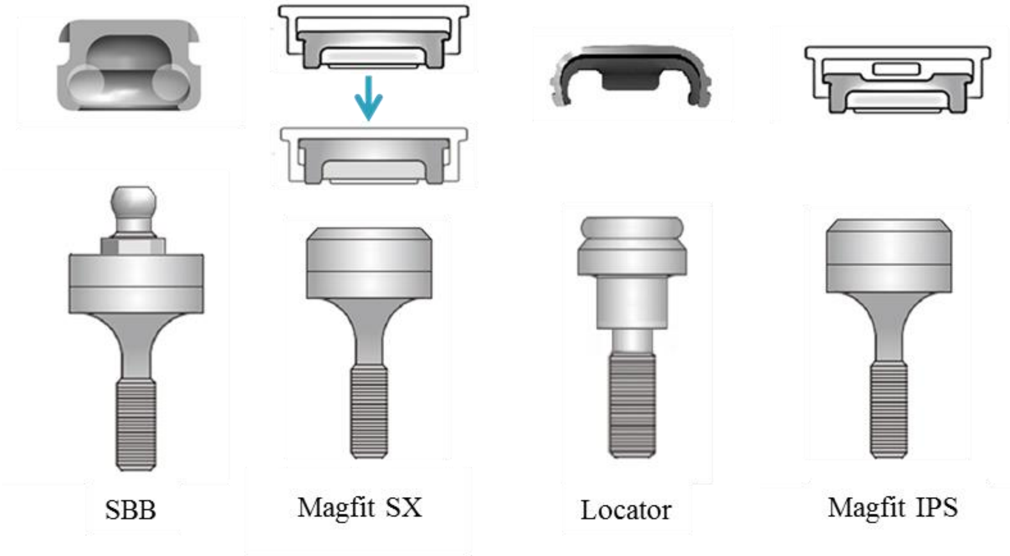


Fig. 1 Schema of stress breaking attachment

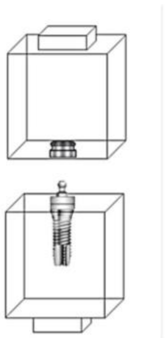


Fig. 2 Schematic drawing of Specimens

Fig. 3 Cyclic loading testing machine for tensile test

Results

The initial retentive force of the locater attachment was significantly greater than that of any other attachments tested ($P<0.05$). After 10,000 cycles, the retentive force of the locator attachment decreased to two-thirds of the initial one. There were no significant differences of the retentive forces of both magnet and SBB attachments before and after loading ($P<0.05$) (Fig4). The vertical displacement of MagfitSX and SBB attachments showed slight decrease after loading. On the other hand, there was little vertical displacement of the locator attachment irrespectively of the load applied. The vertical displacement of Magfit IPS was significantly decrease after 20,000 cycles, and there was little vertical displacement after 40,000 cycles (Fig.5). No crack and no deterioration were not observed in the O- ring rubber of the SBB attachment and these was no change of a diameter ratio compared between initial and 50,000cycles (Fig.6). Liner scratches to many directions were detected on the magnet and keeper surface of magnet attachments (Fig.7). The deformation was observed in the female silicone of the locator attachments (Fig.8). As for the Magfit IPS, built-in ball that made by silicon recognized the deformation. It caused displacement decrease. (Fig.9)

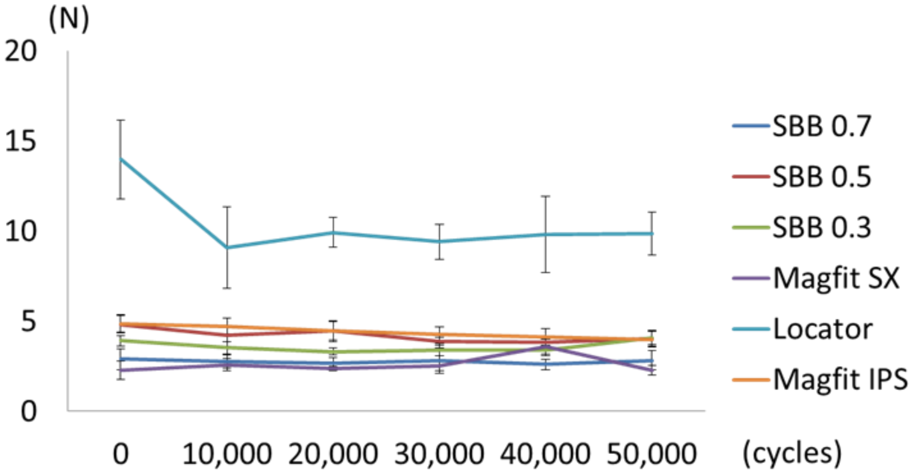


Fig. 4 Changes of retentive forces of each attachment

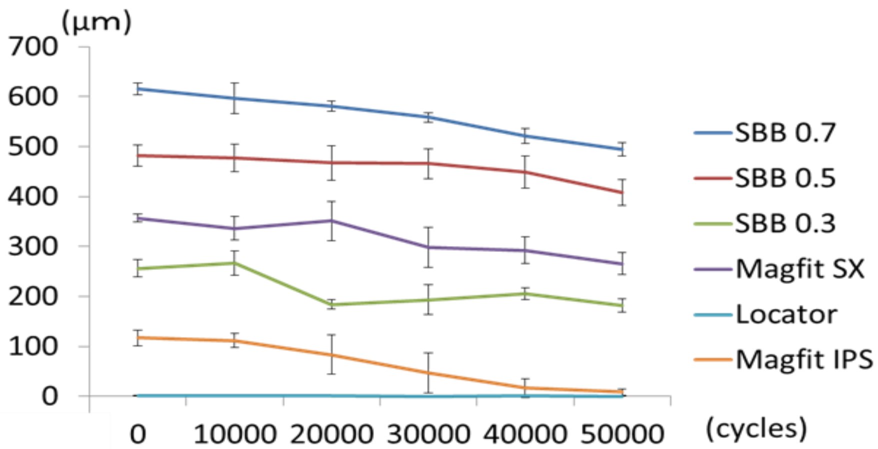
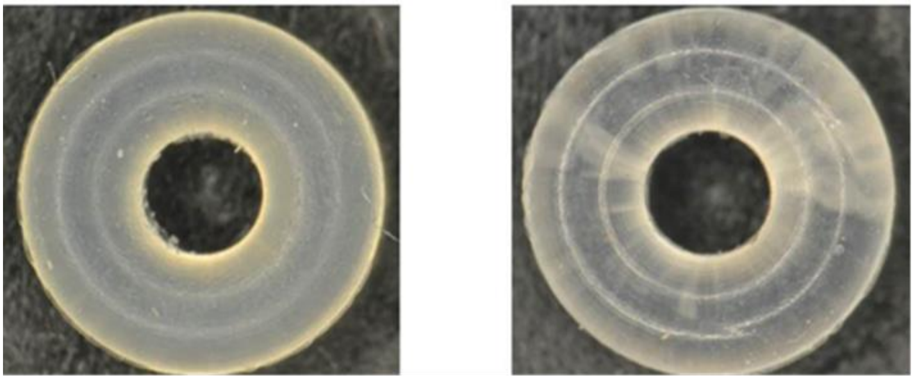
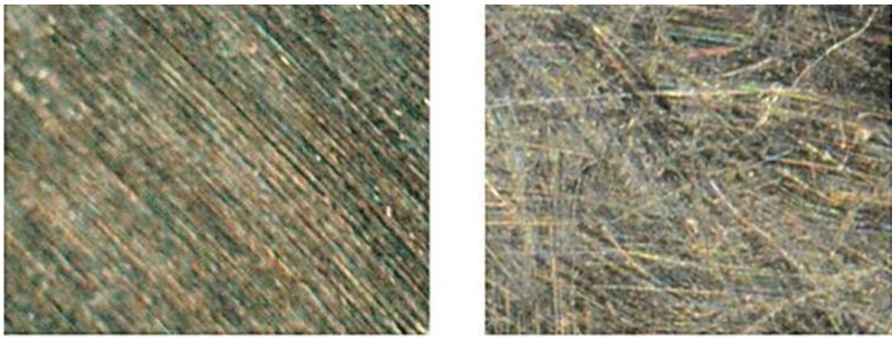


Fig. 5 Vertical displacement of each attachment



Before loading After loading

Fig. 6 Magnification of O-ring rubber in the SBB attachment (×10)

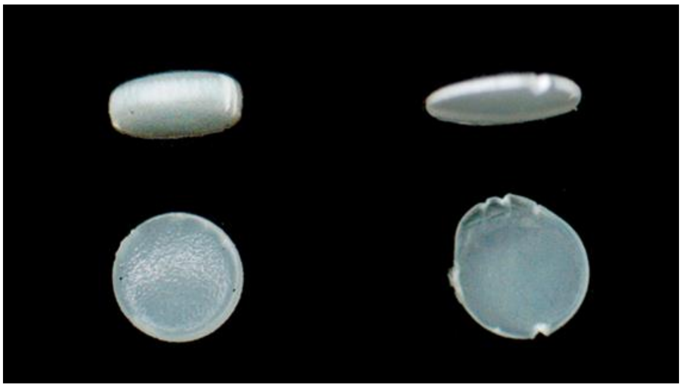


Before loading After loading

Fig. 7 Magnification of keeper surface of magnet attachment structure (×20)

Before loading After loading

Fig. 8 Magnification of female silicone in the locator attachment (×10)



Before loading After loading

Fig.9 Magnification of the deformation built-in cushion of magnet attachment (×10)

Discussions

It is very difficult to determine the amount of the most suitable retentive force as the attachment for overdentures. Generally, a single overdenture may require a retentive force of approximately 2 kg to withstand the chewing of sticky foods, and simultaneously, it should be easily removable by the wearers. One retainer may require retentive force of approximately 300~1,000 g. [1] After 10,000 cycles, the retentive force of the locator attachment decreased to two-thirds of the initial one. But the retentive force after 10,000 cycles was greater than the other attachments, the locator attachment would be effective to use the clinical application similar to the other attachments.

When a static load of axial direction were applied to the implant superstructure and the alveolar mucosa, the displacement was approximately less than 5μm[2)]and 300μm[3)], respectively. The stress-breaking attachment may compensate for this displacement difference in accuracy. The vertical displacement of Magfit SX and SBB attachments showed slight decrease after repeated loading. But these attachments may distribute the occlusal force equally between the alveolar ridge and the implant.

Conclusions

The initial retentive force of the locater attachment was significantly greater than the other attachments, but after 10,000 cycles, the retentive force of the locator attachment remarkably decreased. There were no significant differences of the retentive forces and vertical displacements of both magnet and SBB attachment before and after repeated loading.

References

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