Retentive forces and displacement of new stress breaking magnet attachment

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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 excursion, but cannot compensate for vertical displacement under the functional forces. There are extraordinary differences in settling under a chewing load between the implant and mucosa under the denture base. In addition, horizontal forces and rotational excursion 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 would be 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

Schema of Stress-Breaking Magnetic (SBM)attachment is shown in Fig. 1. The SBM attachment consists of housing unit including the steel spring (SUS304: height 2 mm) and magnetic assembly (Hyper Slim 3513, NOMAX, diameter: 4 mm undercut: 1 mm), can provide the displacement of 0.5 mm.

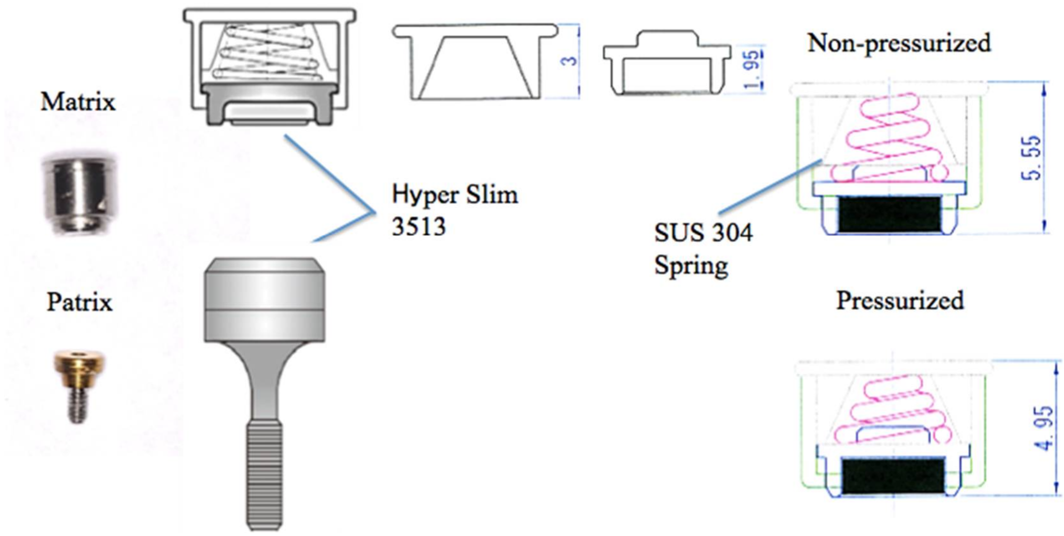

Fig. 1 Schema of SBM attachent

Four stress-breaking attachments (Fig. 2), namely, a self-adjustment type magnetic attachment (Magfit SX, Aichi Steel), a cushion type magnetic attachment (Magfit IPS, Aichi steel), a locator attachment (Locator, ZEST anchors), three types of stress breaking ball (SBB) attachments (amount of displacement: 0.3 mm, 0.5 mm, 0.7 mm, GC corp.), were placed on the implants. The implants were embedded in a resin block using autopolymerized resin (Fig. 3). To simulate the chewing cycles, a load of 5 kgf was repeatedly applied up to 50,000 cycles using a loading apparatus (Fig. 4). 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 vertical load of 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 α =0.05.

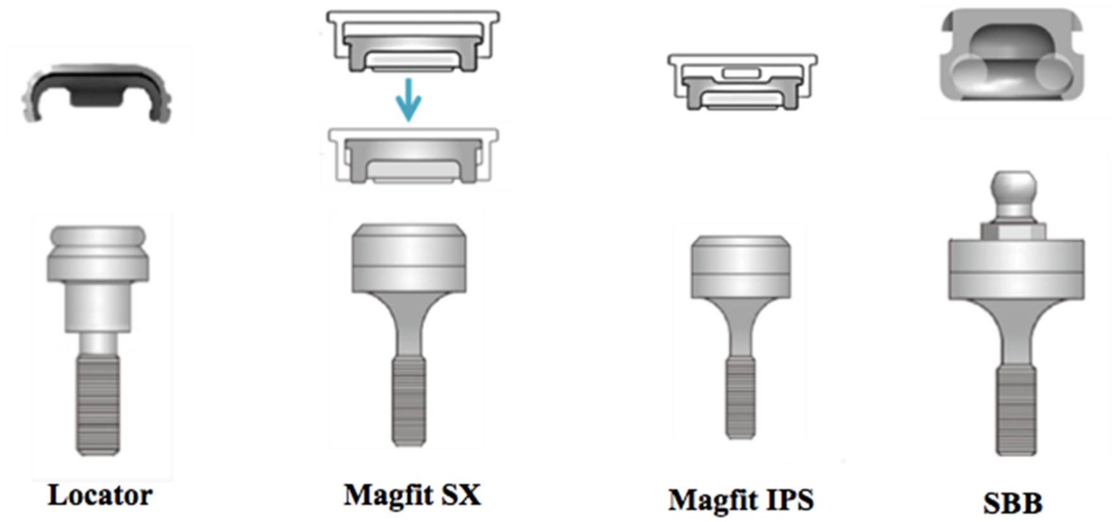

Fig. 2 Schema of four stress breaking attachments

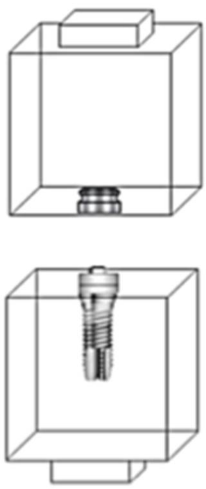

Fig. 3 Schematic drawing of specimen

Fig. 4 Cyclic loading testing machine for tensile test

Results

The initial retentive force of the locater attachment was significantly greater than those of the 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 two magnetic attachments, SBB and SBM attachments between before and after loading (P<0.05) (Fig. 5).

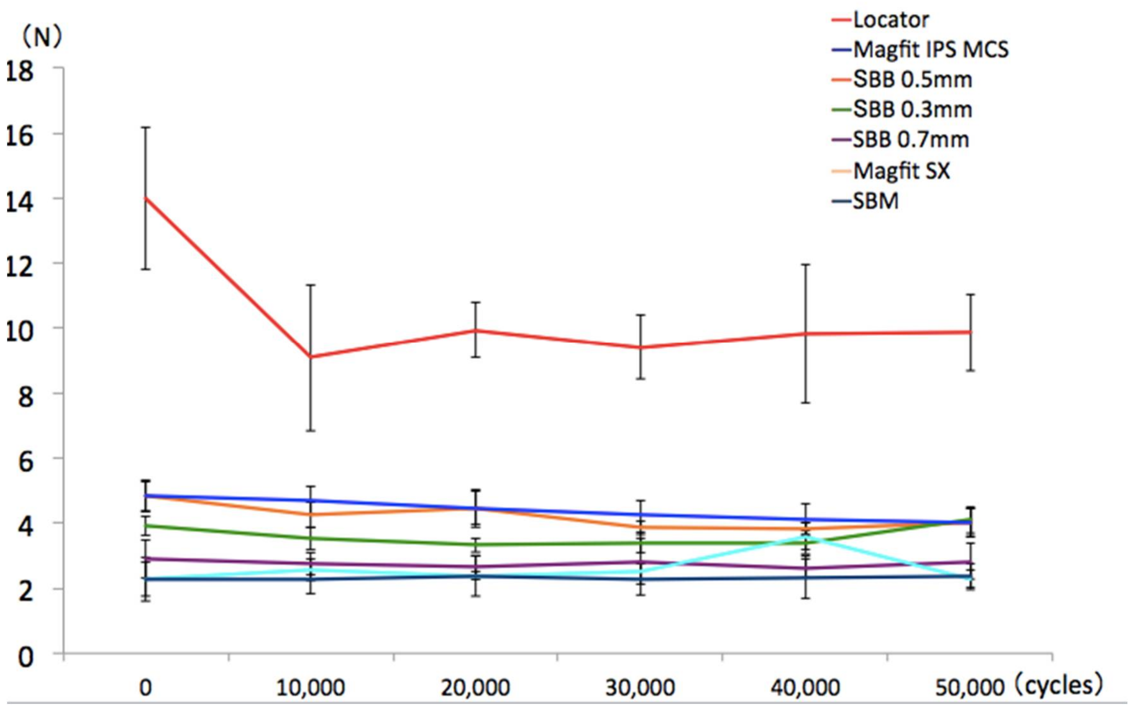

Fig. 5 Changes of retentive forces of each attachment

The vertical displacement of Magfit SX, SBB and SBM attachments showed slight decrease after loading (Fig. 6). 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.

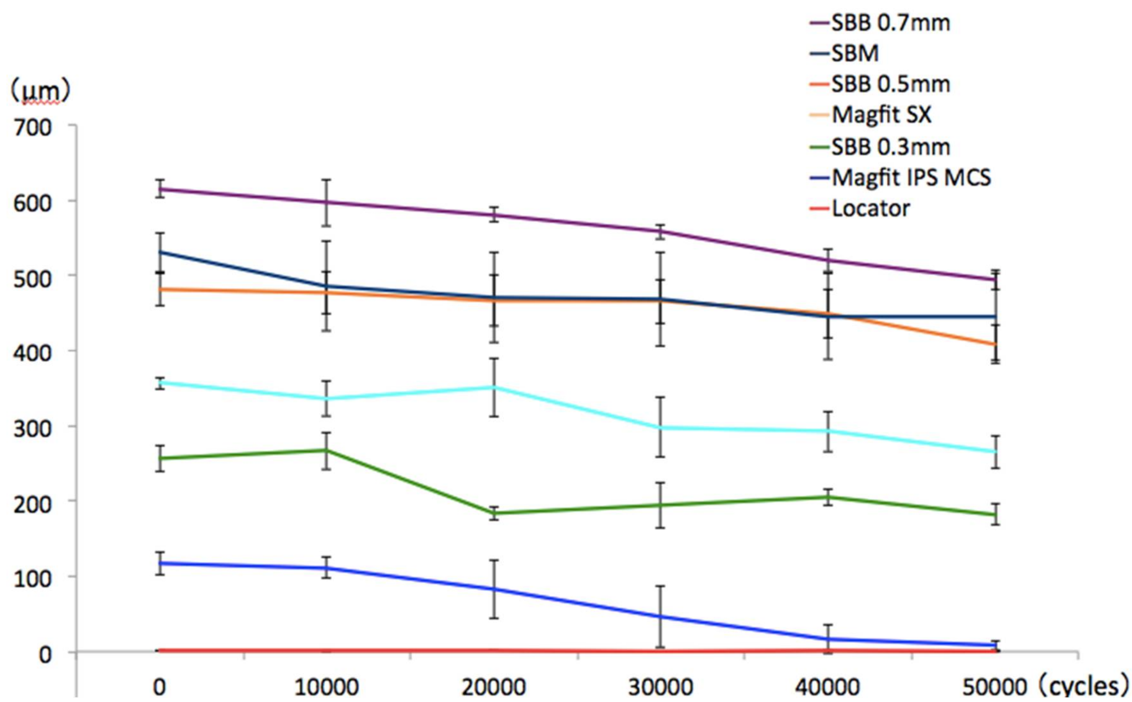

Fig. 6 Changes of vertical displacement of seven attachments

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 for the case needed larger retention. When a static load of axial direction is applied to the implant superstructure and the alveolar mucosa, the displacement was approximately less than 5 μm [2] and 300μm [3], respectively. The stress-breaking attachment may compensate for these displacement differences in accuracy. The vertical displacement of Magfit SX, SBB, and SBM attachments showed slight decrease after repeated loading. However, these attachments may distribute the occlusal force equally between the alveolar ridge and the implant. The possibility of clinical application was suggested that the SBM attachment should be miniaturized.

Conclusions

Although the initial retentive force of the locater attachment was significantly greater than the other attachments, it remarkably decreased after 10,000 cycles. There were no significant differences of the retentive forces and vertical displacements of two magnetic attachments, SBB and SBM attachment between before and after repeated loadings.

References

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