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Retentive forces of two magnetic systems compared with two precision attachments

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Abstract: Magnetic retention devices based on cobalt/samarium alloy are new to dentistry, whereas precision attachments have been used for many years. In this study, the retentive forces of two magnetic systems were compared with two different precision attachment units. The retentive forces were evaluated with an Instron testing machine with a cross-head speed of 0.5 mm/min. Eight samples were used for each of the four attachments for a total of 32 samples. The attachments were embedded in an acrylic block and tested for initial retention and retention after 300 cycles. The retentive forces of the precision attachments were greater than the magnetic attachments for the initial retention. However, as more cycles were completed, the retentive force decreased in the precision attachments and increased in the magnetic attachments. The results were statistically significant among the four attachment systems ($p = 0.0117$). (J. Oral Sci. 40, 61-64, 1998)

Key words: retentive force; magnetic attachments; precision attachments.

Introduction

Retention is a fundamental aim for the adequate functioning of dental prostheses. Modern dentistry can replace missing teeth with sophisticated fixed bridges or removable cast alloy partial dentures which are comfortable, efficient and esthetic. Retention of tooth supports offers many advantages. A great variety of attachments have been developed (1). These range from sophisticated to simple, expensive to inexpensive and provide varying degrees of retention (2). Although widely used and very effective, they are, however, susceptible to wear or damage. The retention force with Ceka, and Kurer precision attachments gave initial values of approximately 1 kg but after several cycles values were as low as 200 g (2). After the inevitable wear has taken place, most attachments provide retention in vitro in the range 100-400 g (2). Some manufacturers have recognized this problem and design their attachments so that the worn parts can be easily adjusted or even replaced (1,2). It is possible that permanent, dynamic and positive retention could result from placing one magnet in a natural tooth structure and a corresponding magnet in a dental prostheses (3,4). In the late 1960's permanent magnets based on cobalt and rare-earth elements, notably samarium, were developed (5). Rare-earth alloys must be exposed to an extremely strong magnetic field to become magnetized, but once magnetized, they require a correspondingly strong reverse magnetic field to be returned to the non-magnetic state (2). This quality allows the Cobalt-Samarium alloy to be made into magnets as short as 1 mm without significant loss of magnetic field strength (2). The results of the studies on the retention of mini-magnets suggest an important role of these magnets in the retention of dental prostheses (6-15).

The aim of this study was to compare the retentive capacities of two precision attachments to that of two mini-magnetic systems.

Materials and Methods

Two commercially produced precision attachment units and two dental magnetic systems were tested. The precision attachments used were the Kurer Press Stud (Kurer anchor systems, Teledyne Getz. Illinois USA) and the Ceka attachment (CEKA N., Antwerpen, Belgium). The magnetic systems examined were: a. The closed field system using the Gillings K5 mini-tag kit (Innovadent, Sydney, Australia) that consists of paired magnets and attached keeper (denture element) and detachable keeper (root element); and, b. The open field system using the Dyna magnet with a fabricated keeper (Dyna Dental Engineering, Bergen op Zoom, The Netherlands) that consists of a magnet (denture element) and detachable keeper (root element).

Eight samples were used for each attachment system for a total of 32 samples. The systems used in this study were embedded in the center of 25 × 30 mm acrylic blocks using a teflon ring mold that had open upper and lower surfaces (Figs. 1-3). At the inner side of the mold, there was a negative space to form the handling parts of the acrylic resin blocks. A fluid mixture of autopolymerizing acrylic resin was poured into the mold and the attachment systems were embedded in it by the help of a fixature (Fiksator-Bego, Germany).

For Ceka attachments, a pink wax rod 2 mm in diameter and 2 mm in length (1 mm of it in acrylic resin) was placed into the hole of a female part (Fig. 4).

A glass-plate was then placed on the mold and the

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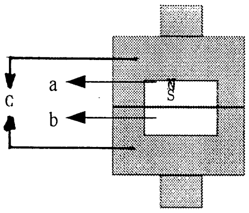
acrylic resin was allowed to cure. In the lower part of the mold the systems were taken and placed together. Then the acrylic resin surface was isolated with a liquid lubricant by a brush. After closing the upper part of the mold, the fluid mixture of autopolymerizing acrylic resin was poured in it and a load was applied on it. When the acrylic resin was polimerized, the acrylic blocks were tested for retentive force of the precision attachments and mini-magnets. Retentive force was evaluated by an Instron testing machine (Model 1185, Limited High Nyocombo-England) with a cross-head speed of 0.5 mm/min. The breakaway forces were determined for initial retention and after 300 cycles for each sample.

The retentive forces determined for initial retention and after 300 cycles were evaluated by the Wilcoxon Matched-Pairs Signed-Ranks test, the Kruskal Wallis one-way ANOVA and the Mann -Whitney U-Wilcoxon Rank Sum W test.



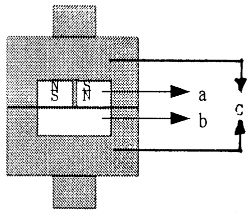
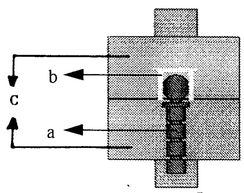


Fig. 1 Fig. 2

Fig. 1 Diagrammatic representation of open-field magnets.
a. Denture element (magnet)
b. Keeper (magnetizable alloy)
c. Acrylic block

Fig. 2 Diagrammatic representation of closed-field magnets.
a. Denture element (a modified horseshoe magnet)
b. Keeper (magnetizable alloy)
c. Acrylic block



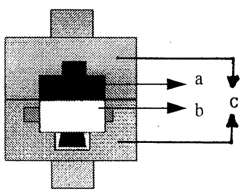


Fig. 3 Fig. 4

Fig. 3 Diagrammatic representation of Kurer attachment.
a. Denture element
(Male part of a precision attachment)
b. Root element (female part of a precision attachment)
c. Acrylic block

Fig. 4 Diagrammatic representation of Ceka attachment.
a. Denture element
(Male part of a precision attachment)
b. Tooth element
(female part of a precision attachment)
c. Acrylic block

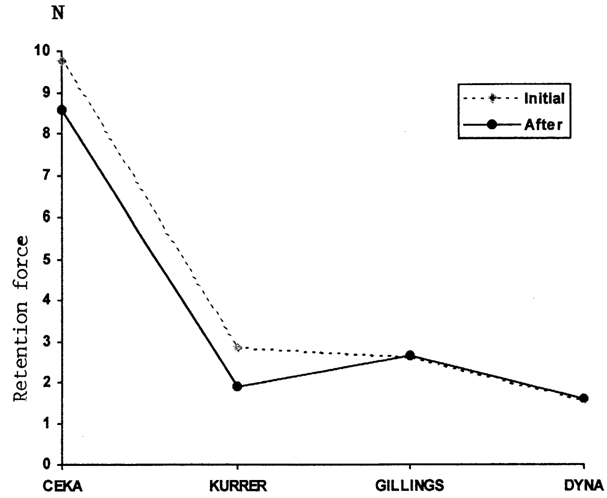


Fig. 5 Mean retentive forces of magnetic systems and precision attachments.

Results

The mean and standard deviations of initial retention and retention after 300 cycles for both the magnetic systems and the precision attachments are shown in Table 1. The retentive forces of the magnetic systems and the precision attachments are compared and illustrated in Fig. 5.

The results of the Wilcoxon Matched-Pairs Signed-Ranks test, which compared the initial retention to the results obtained after 300 cycles in all four systems, were statistically significant ($p = 0.0117$).

The Kruskal-Wallis one-way ANOVA revealed significant differences between all four systems for the initial retention values ($x^2 = 27.8182$, $p = 0.000$) as well as after 300 cycles ($x^2 = 29.0909$, $p = 0.000$). Since the Kruskal Wallis ANOVA revealed significant differences between groups, the groups were then compared two by two using the Mann-Whitney U-Wilcoxon Rank Sum W test. The initial retention and the results obtained after 300 cycles were statistically significant for the Ceka-Kurer Press Stud, Ceka-Gillings, Ceka-Dyna, Gillings-Dyna ($u = 0.0$, $p = 0.0002$). The initial retention ($u = 8.0$, $p = 0.0104$) and the results obtained after 300 cycles ($u = 0.0$, $p = 0.0002$) were also significant for the Kurer-Gillings.

Discussion

Many of the attachments and retentive devices used to improve the mechanical stability of overdentures require specialized equipment and accessories with sophisticated chairside and laboratory techniques. The attachments are subject to wear and may require adjusment or replacement (7). A method of denture retention which overcomes some of these difficulties uses small, but very strong, permanent magnets. The magnetic system has a number of advantages over most precision attachments. These advantages include simplicity, low cost, self-adjustment, reusability, inherent stress-breaking, automatic reseating after denture displacement,

Table 1 The mean and the standard deviations of retentive forces of two magnetic systems and two precision attachments for initial retention and retention after 300 cycles (Newton)

System	Retention (Initial)		Retention (After 300 cycles)		Change (Percentage)
	X	SD	X	SD	
CEKA	9.76	0.09	8.59	0.08	-%12
KURER PRESS STUD	2.85	0.16	1.89	0.04	-%34
GILLINGS (closed-field)	2.60	0.06	2.66	0.06	+%2
DYNA (Open-field)	1.57	0.06	1.61	0.06	+%2

Speed. 0.5 mm/min
1N=102 gf.

comparative freedom of lateral and rotational denture movement, low potential for trauma to the supporting roots, ease of denture relining and unchanging retention and thus eliminating the need for adjustment (1). The parallelism and path of insertion restrictions common to many precision attachments are eliminated. The height of the denture retention element (3 mm) is less than many precision attachments.

The magnetic system used to retain dentures may be an open-field or closed-field system. Whether the open-field system causes any deleterious effect by the magnetic flux that scatters to the tissues has not been determined. The precision attachments used in this study showed a greater initial retention than magnetic attachments but the mechanical attachments are subject to wear, and after 300 *in vitro* cycles, they showed a significant loss of retention (Table 1). In comparison, insertion and removal has no effect on magnetic retention units. The magnetic field is permanent and does not deteriorate with time or use.

Disadvantages of the magnetic systems include the possibility that those systems with a range of retention between 140 and 310 g (1.37 to 3.03N) may be insufficient for overdenture retention. It has also been suggested that magnets could be more suitable for use in maxillofacial two-part protheses (16). Gillings (17) stated that displacing forces may be as low as 23 to 54 g (0.22 to 0.53N) for a maxillary denture. In addition, systems that have high retention values will provide high denture stability but high retention values will also impose high stresses to the supporting roots when the denture is inserted or removed (1).

In conclusion, the retentive force of precision attachments was decreased after 300 cycles, while the magnetic retainers' retention was increased over time and use. An increased number of abutments should be tested to determine if it would provide more satisfactory initial retention for the magnetic systems.

Conclusions

1. The precision attachment systems showed greater initial retention force than the magnetic systems.
2. The initial retention force of the closed-field magnetic system was found to be greater compared than that of the open-field magnetic system.
3. After 300 cycles, depending on the wear of the female and male parts of precision attachments, the retentive force was decreased.
4. Regarding the magnetic systems, after 300 cycles the retentive force was increased according to the induction of magnetic fields

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