Development of a Self-Adjusting Magnetic Attachment for Implant Overdentures

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This study aimed to clarify the efficacy of a newly developed self-adjusting magnetic attachment (SMAT) that allowed 0.4 mm of vertical and 8 degrees of rotational movements using an in vitro model. Comparison between the SMAT and a conventional magnetic attachment (CMAT) was performed for the retentive force under different dislodgement directions. Lateral forces to the abutment were also compared among the SMAT, CMAT, dome-shaped magnetic attachment, and a ball attachment. The SMAT maintained retentive force more effectively than the CMAT, even in oblique directions of dislodgement. A smaller lateral force to the abutment was found for the SMAT compared to the CMAT or ball attachment. *Int J Prosthodont 2011;24:241–243.*

Magnetic attachments have been used to increase the retention, support, and stability of overdentures with natural abutments as well as implants.[1] However, there are still some problems that need to be addressed.[2] To prevent corrosion and deterioration, a laser-welded stainless steel housing system, called a yoke, was established and has been proven to be effective clinically.[3]

One of the remaining issues, however, is a lack of resilience, which allows denture base movements as a result of the viscoelasticity of the denture-bearing mucosa, thereby decreasing contact between the magnet and its keeper and resulting in decreased retention.[4] To solve this problem, a new type of magnetic attachment, designated the self-adjusting magnetic attachment (SMAT), was developed with a mobile polyoxymethylene housing that allows up to 0.4 mm of vertical and 8 degrees of rotational movements, depending on the situation (Fig 1). The purpose of this study was to examine the retention and stress-reducing capability of the SMAT using an in vitro model.

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Materials and Methods

A standard implant (3.75 × 13 mm, Biomet 3i) was embedded into the midline area of an acrylic resin edentulous mandible with an artificial mucosa (Model N30, Nissin). An abutment ring was connected to the implant with four strain gauges attached to the long axis surface at right angles to each other, as described previously.[5] A common keeper screw (IP-B 30Type, Aichi) for an SMAT or conventional flat magnetic attachment (CMAT) was connected to the implant.

Retentive forces were measured using a testing machine (SV52A, Imada) by pulling an SMAT or CMAT magnet embedded in an autopolymerizing resin block (5 × 5 × 5 mm) fabricated on the left side of the abutment at a speed of 0.5 mm/s. The resin block movement was recorded at 90, 80, and 70 degrees to the surface of the keeper. Five samples were made for each attachment, and measurements were repeated 10 times at each angle to obtain the maximum retentive force.

The reduction in lateral forces to the implants with an SMAT, CMAT, dome-shaped magnetic attachment (DMAT; IPDM, Aichi), or ball attachment (Dal-Ro, Biomet 3i) were evaluated by strain gauge outputs. A load of 50 N was applied at the midline, canine, or left first molar area on the occlusal table of an overdenture placed on the model. Each male and female attachment was fixed inside the denture base or on the abutment. The forces exerted on the implant were calculated using a force-strain calibration equation. Statistical analysis was performed using analysis of variance (ANOVA), and multiple comparisons were performed using the Bonferonni test ($P < .05$).

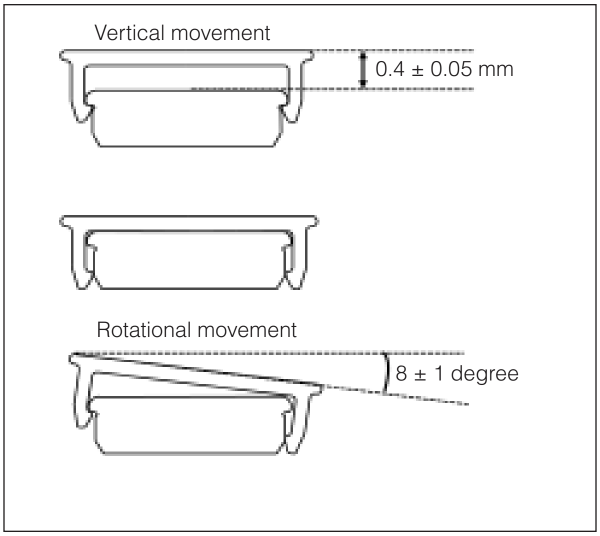
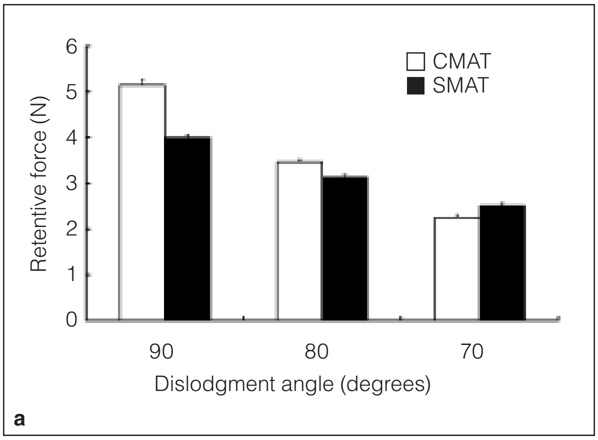
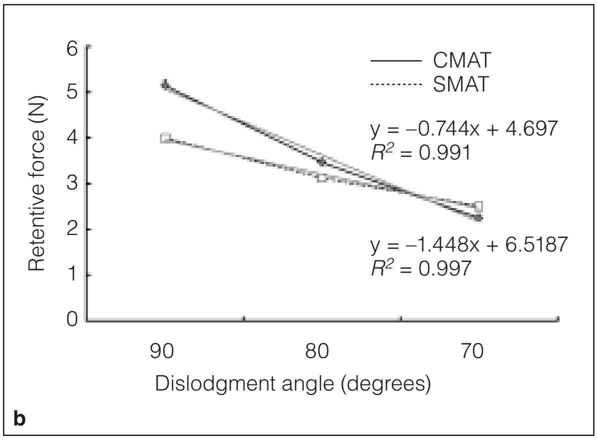


Fig 1 Schematic diagram of SMAT movements.





Figs 2a and 2b **(a)** Mean retentive force and **(b)** results of linear regression analysis when comparing the SMAT and CMAT at different dislodgment angles.

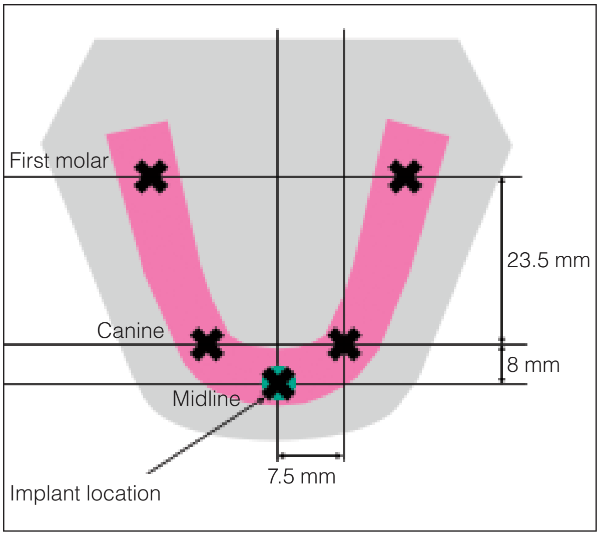
Results

The SMAT showed a lower maximum retentive force (4.00 N) than the CMAT (5.15 N) at 90 degrees. However, the maximum retentive forces decreased to 3.13 N (–22%) at 80 degrees and 2.51 N (–37%) at 70 degrees with the SMAT, compared to 3.47 N (–33%) at 80 degrees and 2.25 N (–56%) at 70 degrees with the CMAT (Fig 2a). ANOVA and multiple comparisons showed the statistical difference among the SMAT, CMAT, and dislodgement angle ($P < .05$). The rates of decrease in retention were significantly larger with the CMAT than the SMAT when coefficients of linear correlation were compared (Fig 2b).

Lateral force measurements with the strain gauges indicated a significantly smaller lateral force for the SMAT ($P < .01$) than the other three types of attachments under the three different loading conditions (Figs 3a and 3b).

Discussion

The retention of magnetic attachments decreases rapidly when contact between the magnet and its keeper decreases because of displacement of the denture base, a result of the resiliency of the mucosa or bone resorption (Fig 4). This situation can occur easily under implant overdentures[4] since compensation by the periodontal membrane cannot be expected, compared to that with a natural abutment. Moreover, a lack of resilience with the magnetic attachment may cause greater stress to the implant. The present results indicate that the SMAT, which allows both vertical and rotational denture base movements, can effectively solve these problems while maintaining the retentive force and reducing lateral stress to the implant.



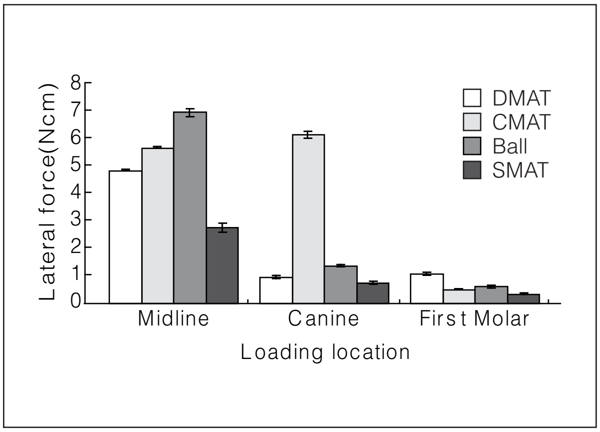


Fig 3a *(left)* Different locations for load application.

Fig 3b *(above)* Mean lateral force exerted to the implant at different loading locations.

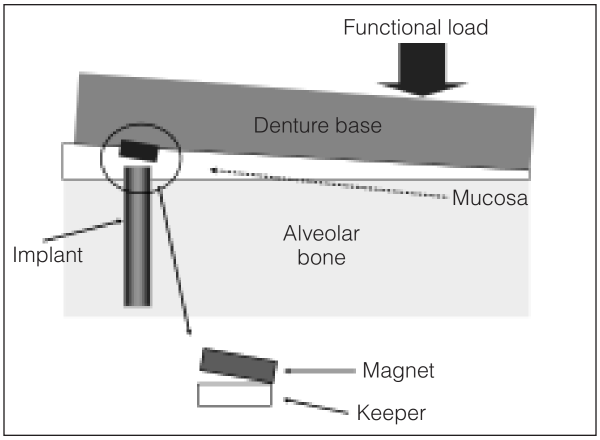


Fig 4 Movement of the denture base seen with a CMAT.

Conclusion

Within the limitations of this study, the SMAT maintained retentive force more effectively than the CMAT, even in oblique directions of dislodgement. The SMAT also reduced the lateral forces to the abutment compared to the CMAT, DMAT, or a ball attachment.

References

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