

Wear Resistance and Retentive force of New Magnetic Attachments Used in Over Denture: An In Vitro Study

Aung Soe Myint¹, Yuriko Komagamine¹, Wu Shanglin¹, Kenta Kashiwazaki¹, Neri Annika¹, Kaho Hoteiya¹, Tamaki Hada², Manabu Kanazawa¹

¹Gerodontology and Oral Rehabilitation, Graduate School of Medical and Dental Sciences, Institute of Science Tokyo

²Oral Devices and Materials, Graduate School of Medical and Dental Sciences, Institute of Science Tokyo

I. Introduction

Overdentures with magnetic attachments might experience eccentric movements during oral function potentially causing surface wear on the magnetic attachments¹. Recently, a magnetic attachment approximately half the thickness of conventional magnetic attachments has been developed². The effect of wear on retentive force when the thin magnetic attachment is used with overdentures has not yet been investigated.

II. Objective

This study aimed to evaluate the two types of magnetic attachments provide adequate wear resistance and sufficient retentive force for daily clinical use.

III. Materials and Methods

A total of **10 pairs** of each **MT 900** and **MTS 700** magnetic attachments (MagneDesign, Japan) (Fig. 1) were tested, respectively. The retentive force was measured 15 times using a universal testing machine (Instron 5544, Instron) (Fig. 2) before and after 30,000, 60,000 and 90,000 of wearing test³. The measurement of retentive force also utilized a retentive force measuring device. A 3mm of gliding movement was performed by using a wearing machine (K655, Tokyo Giken) (Fig. 3)⁴. Both magnets were observed by using digital microscope (VHX-1000, Keyence) (Fig. 4) under $\times 100$ magnifications. The results were statistically evaluated by One-way repeated measures ANOVA and post hoc Tukey-Kramer multiple comparison test using GraphPad Prism 10 ($P < 0.05$).

Magnet	MT900	MTS700
Photo and diagram of magnet	 Magnet	 Magnet
	 Keeper	 Keeper
Diameter of magnet & keeper	4.0 mm	4.0 mm
Thickness of magnet	1.3 mm	0.6 mm
Thickness of keeper	0.8 mm	0.4 mm
Thickness of total	2.1 mm	1.0 mm
Retentive force	9.0 ± 0.5 N	7.0 ± 0.5 N

Fig 1. MT 900 and MTS 700 magnet assemblies and keepers (MagneDesign)



Fig 2. Universal Testing Machine (Instron 5544, Instron) & Retentive force measuring device assembled on Universal Testing Machine



Fig 3. Wearing Machine (K655, Tokyo Giken)



Fig 4. Digital Microscope (Keyence VHX-1000)

IV. Results

After 90,000 wear cycles, the MT900 exhibited a statistically significant progressive decrease in retentive force at 30,000, 60,000 and 90,000 cycles respectively (Fig 5). In contrast, the MTS700 revealed significant increase of about 0.7 N between 0 and 30,000 cycles, consequently the values remained stable through 60,000 and 90,000 cycles (Fig 6). After 90,000 cycles, the surface morphologies of both magnetic assemblies and keepers were observed by using Digital Microscope under $\times 100$ magnifications. The MT900 exhibited minor surface irregularities on the magnetic assembly (Fig.7), whereas the MTS700 experienced complete loss of outer yoke of the magnetic assembly resulted in exposing inside magnet (Fig. 8).

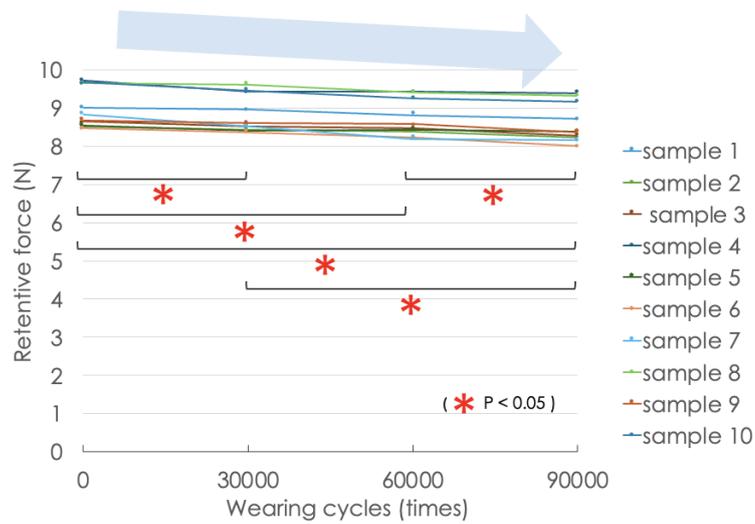


Fig 5. Results of Retentive force for MT 900 after the wear test

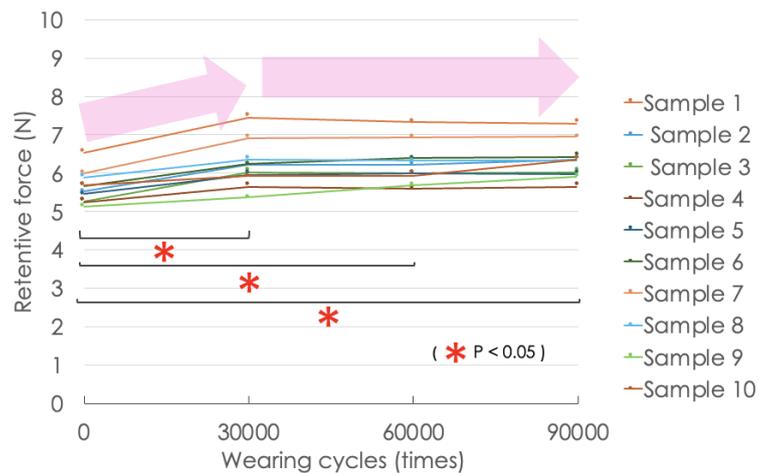


Fig 6. Results of Retentive force for MTS 700 after the wear test

V. Discussions

The MT900 might reduce retentive force due to a roughened magnetic assembly surface, resulting in gap and less contact area with the keeper. Conversely, the MTS700 might increase retentive force because the magnet became exposed, leading to higher magnetic flux density. Future research should determine how many wearing cycles it takes for the magnet inside magnetic assembly to become exposed in the MTS700.

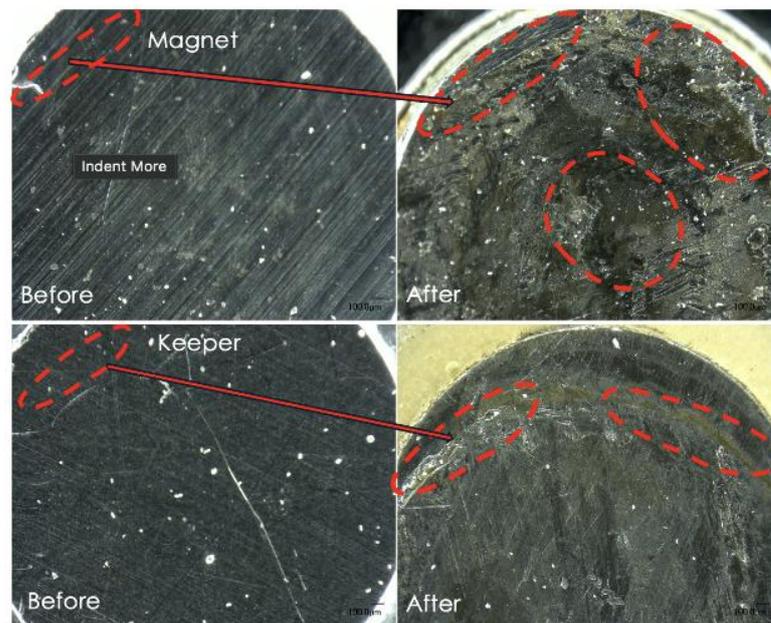


Fig 7. Surface Morphology of MT 900 examined under Keyence microscope, circled areas highlighted alterations before and after the wear test

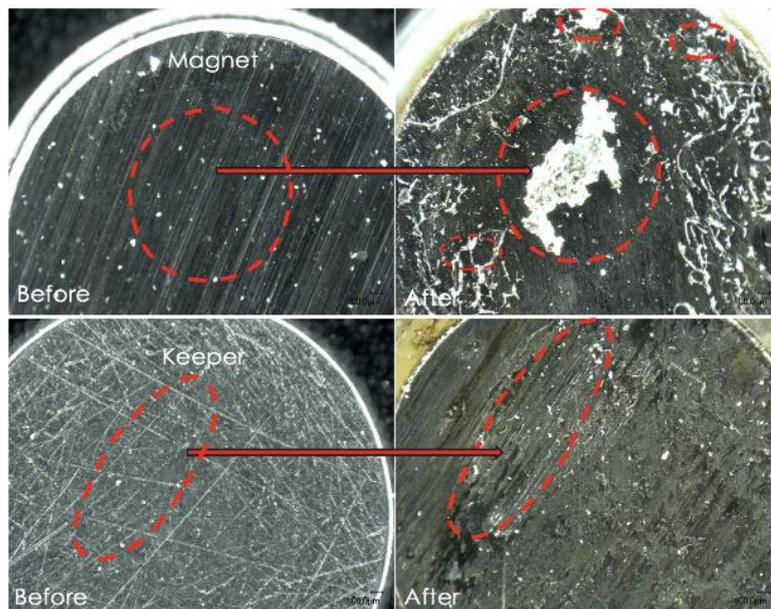


Fig 8. Surface morphology of MTS 700 examined under Keyence microscope, circled areas highlighted alterations before and after the wear test.

VI. Conclusions

Under limited experimental conditions, both MT 900 and MTS 700 magnets still possess enough retentive force to provide after 90,000 cycles of wear simulation. So, it can be concluded that both magnets can be used for daily clinical practices as overdenture attachments.

References

- 1) Huang Y, Tawada Y, Hata Y, Watanabe F. The change in retentive force of magnetic attachment by abrasion. *Odontology*. 2008 July;96(1):65–8.
- 2) Putra Wigianto AY, Ishida Y, Matsuda T, Goto T, Watanabe M, Ichikawa T. Novel Magnetic Attachment System Manufactured Using High-Frequency Heat Treatment and Stamp Technique: Introduction and Basic Performance. *Dent J*. 2022 May 2;10(5):75.
- 3) Takahashi M, Togawa G, Kanyi M, Yamaguchi H, Takada Y. Effect of crosshead speed on retentive force measured using a device specified in ISO 13017:2020.
- 4) Hasegawa M, Umekawa Y, Nagai E, Ishigami T. Retentive force and magnetic flux leakage of magnetic attachment in various keeper and magnetic assembly combinations. *J Prosthet Dent*. 2011 Apr;105(4):266–71.