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Retention performance of magnetic attachments on dental implants

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Introduction

Implants in the edentulous jaw have become standard treatment. The use of an implant retained overdenture with magnets offers a simple treatment approach to the problem of instability of complete denture 1, 2. Advantages with magnets include a simplified clinical technique and reduced lateral stresses on the abutments 3. Contemporary three different physical and technical concepts can be found: dual systems with two unlike magnets and an open magnetic field (DO) and mono systems consisting of a magnet and a corresponding keeper from magnetizable alloy with an open (MO) or with a closed magnetic field (MC) 4. The force produced by any two magnets is inversely proportional to the square of the distance between them 5. Separation between magnet and keeper, however caused, will result in a drastic reduction in the retention. DO's are relatively voluminous and providing a lower initial retention force which is admittedly remaining when the magnets are separated for a small distance. So an adequate re-seating force for the prosthesis is given. MC's have a smaller design and produce the highest initial retention force. The characteristics of MO's are positioned between the other two types. The retention provided would be quite close to that claimed by the manufacturer as long as the magnet and the abutment remain in contact. This condition may not be possible in the clinical situation. The retention in function is very sensitive to distance. The point to be made, therefore, is that the manufacture's claimed retention may not be what is obtained clinically. Following the manufacturers' information recently developed or improved products despite their small size should produce high retention forces.

Objectives

The aim of this study was to verify and to compare the initial retention force and the force-distance relation of contemporar magnetic systems for dental implants.

Material and Methods

12 products of different height and diameter were tested (Tab 1 and Fig 1). All of these retention systems consisted essentially of a magnetic assembly which is incorporated into the prostheses and a corresponding magnetic implant abutment. In the magnetic units rear earth magnets from SmCo or NeFeB are embedded. The magnetic implant abutments consist of a magnetizable corrosion resistant alloy or a rear earth magnet as well. To protect the brittle rare earth magnets against corrosion they are incorporated into a thin non magnetizable alloy casting (Ti or stainless steel). From each product or combination 5 specimens were tested in an adjusted and computer navigated pull-testing machine (Z005, Zwick, Ulm, Germany). A special non magnetizable holder for the implant abutments was locked onto the base of the testing machine (Fig 2). To avoid tilting of the moving magnet it was fixed on the tip of a special holder which was connected with the crosshead by a nonflexible string. The crosshead speed was set at 20 mm/min (s=40 mm). The breakaway force was the maximum force during the separation of the magnet and the abutment when the magnet slowly moved away. The breakaway force measurement was repeated ten times and the mean for each sample was used. The results were descriptive and statistical analysed (H-/U-Test, p□0.05). The findings were compared with the manufacturers' statements.

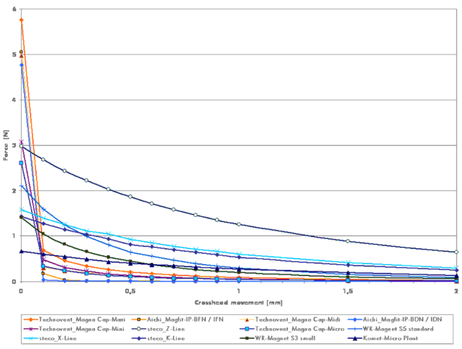

Fig.3 Force-distance-relation of magnetic attachments on implants

Table 1 Magnetic attachments for dental implants

Manufacturer	Magnet assembly		Magnet characteristics		
	Implant abutment	Magnet	System	Field	Alloy
Aichi Steel (Japan)	Magfit-IP-IDN abutment keeper	Magfit-IP-IDN dome type	mono	closed	NeFeB
	Magfit-IP-IFN abutment keeper	Magfit-IP-IFN flat type	mono	closed	NeFeB
Brasseler (Germany)	Komet MicroPlant primary anchor	Komet MicroPlant secondary anchor	duo	open	NeFeB
Dyna (Netherlands)	Medical-Sekundärteile	WR-Magnet S3 small	mono	closed	NeFeB
	Medical-Sekundärteile	WR-Magnet S5 standard	mono	closed	NeFeB
steco (Germany)	X-Line Titanmagnetics Insert	X-Line Titanmagnetics	duo	open	SmCo
	Z-Line Titanmagnetics Insert	Z-Line Titanmagnetics	duo	open	SmCo
	K-Line Titanmagnetics Insert	K-Line Titanmagnetics	duo	open	SmCo
Technovent (Great Britain)	Magnabutment Mini	Magna Cap - Micro	mono	closed	NeFeB
	Magnabutment Mini	Magna Cap - Mini	mono	closed	NeFeB
	Magnabutment - Maxi	Magna Cap - Midi	mono	closed	NeFeB
	Magnabutment - Maxi	Magna Cap - Maxi	mono	closed	NeFeB

Tab.1 Magnetic attachments for dental implants

Table 2 Initial retention forces of the tested implant magnetic attachments

Manufacturer	Magnet assembly		Initial retention force		
	Implant abutment	Magnet	Manufacturer`s instructions [N]	Results of measurements [N]	Relation [%]
Aichi Steel (Japan)	Magfit-IP-IDN abutment keeper	Magfit-IP-IDN dome type	5,9	4,8	80,8
	Magfit-IP-IFN abutment keeper	Magfit-IP-IFN flat type	6,4	5,1	78,9
Brasseler (Germany)	Komet MicroPlant primary anchor	Komet MicroPlant secondary anchor	1,5	0,7	44,5
Dyna (Netherlands)	Medical-Sekundärteile	WR-Magnet S3 small	2,9	1,4	48,6
	Medical-Sekundärteile	WR-Magnet S5 standard	4,9	2,1	43,0
steco (Germany)	X-Line Titanmagnetics Insert	X-Line Titanmagnetics	1,7	1,6	92,9
	Z-Line Titanmagnetics Insert	Z-Line Titanmagnetics	3,0	3,0	99,4
	K-Line Titanmagnetics Insert	K-Line Titanmagnetics	1,6	1,4	89,1
Technovent (Great Britain)	Magnabutment Mini	Magna Cap - Micro	3,0	2,6	86,9
	Magnabutment Mini	Magna Cap - Mini	4,0	3,1	77,0
	Magnabutment - Maxi	Magna Cap - Midi	6,2	5,0	80,2
	Magnabutment - Maxi	Magna Cap - Maxi	7,2	5,8	80,0

Tab.2 Initial retention force of the tested implant magnetic attachments

Results

The highest initial retention force was 5.8 N. In a recently developed and distinctly smaller specimen an initial force of 5.1 N were found. The smallest initial breakaway force was measured with 0.7 N (Fig 3 and Tab 2). Beside the different initial forces the recorded force-distance relations according to the respective type of magnetic system were characteristically for each of the samples. The highest retention forces achieved the MC's followed by the DO's and MO's. After a separation of 1 mm the remaining forces were reversed (Fig 3). The DO's produced about one third of their initial force whereas the MC's showed approx. 5 % of their initial breakaway forces. The results of the MO's were between. The value of the retention force is depending on the dimension of the magnet unit. Therefore the discrepancies of the recorded breakaway forces and the manufacturers' claimed retention were determinate (Fig 3 and Tab 2). In one product there was nearly no difference between the experimental and the manufacturers' values. In another specimen more than 90 % of retention that was claimed by the respective manufacturer could be found. In 7 samples there were more than 75 % but in 3 products under 50 % of the indicated breakaway force.

Fig.1 Tested specimens

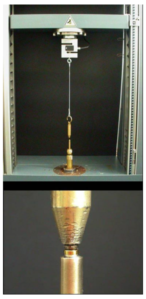

Fig.2 Non magnetizable holder and mounting

Conclusions

Within the limits of this study it could be drawn that there were significant differences between the clinically important breakaway forces. In the majority of cases the maximum retention forces were found notable under the manufacturers' claimed retention. Mono-systems with a closed magnetic field were the smallest and produced the highest breakaway forces. Concerning the reseating forces the force-distance relations could indicate advantages for the more voluminous dual-systems with an open magnetic field. These results should be taken into consideration when choosing implant supported magnetic attachments for individual situations.

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