

Dental magnetic systems as prosthetic attachments on retained roots

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Introduction

Magnetic retention is a popular method of attaching removable prostheses to retained roots 1, 2. Despite their advantages, which include ease of cleaning, ease of placement for both dentist and patient, constant retention with number of cycles, automatic reseating and reduced lateral stresses on the roots, magnets have small attractive forces compared to other prefabricated prosthetic attachments 1 - 4. Nevertheless, there is a strong evidence that retention is of great importance for a patient's satisfaction 4, 5. Contemporary two different physical and technical concepts can be found: mono systems consisting of a magnet and a corresponding keeper from magnetizable alloy with an open (MO) or with a closed magnetic field (MC) 1. The force produced by any two magnets is inversely proportional to the square of the distance between them 6. Separation between magnet and keeper, however caused, will result in a drastic reduction in the retention. MC's produce the highest initial retention force. MO's are more voluminous and providing a comparatively lower initial retention force. Nevertheless, the release of the retention is not so noticeable when the magnets are separated for a small distance. 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 manufacturer'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 contemporary magnetic systems for dental implants.

Material and Methods

11 products of different height and diameter were tested (Tab). All of these retention systems consisted essentially of a magnetic assembly which is incorporated into the prostheses and a corresponding keeper. In the magnetic units rear earth magnets from NeFeB are embedded. To protect the brittle rare earth magnets against corrosion they are incorporated into a thin non magnetizable alloy casting (Ti or stainless steel). The keepers consist of a magnetizable corrosion resistant alloy. They can be classified into the cement-in keepers, the cement-on keepers and two types of cast keepers-those cast entirely in magnetizable alloys and those where a magnetizable keeper is incorporated into a non magnetizable alloy casting. 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 keepers was locked onto the base of the testing machine (Fig). 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 keeper 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.

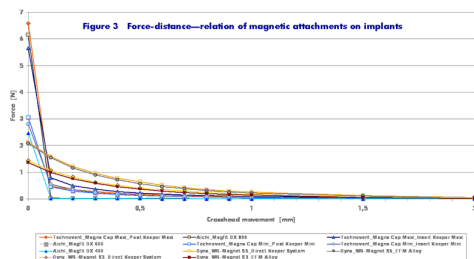


Fig. 3 Force-distance-relation of magnetic attachments on implants

Table 1 Magnetic attachments for retained roots

Manufacturer	Magnet assembly		Magnet characteristics		
	Keeper	Magnet	System	Field	Alloy
Alchi Steel (Japan)	Magfil DX 400	Magfil DX 400	mono	closed	NiFe88
	Magfil DX 600	Magfil DX 600	mono	closed	NiFe88
	Magfil DX 800	Magfil DX 800	mono	closed	NiFe88
Dyna (Netherlands)	Direct System-Keeper	WR-Magnet S3 small	mono	open	NiFe88
	Direct System-Keeper	WR-Magnet S5 standard	mono	open	NiFe88
	EFM Alloy	WR-Magnet S3 small	mono	open	NiFe88
	EFM Alloy	WR-Magnet S5 standard	mono	open	NiFe88
Technovent (Great Britain)	Insert Keeper - Mini	Magna Cap - Mini	mono	closed	NiFe88
	Insert Keeper - Maxi	Magna Cap - Maxi	mono	closed	NiFe88
	Post Keeper - Mini	Magna Cap - Mini	mono	closed	NiFe88
	Post Keeper - Maxi	Magna Cap - Maxi	mono	closed	NiFe88

Table 2 Initial retention forces of the tested magnetic attachments

Manufacturer	Magnet assembly		Initial retention force		
	Keeper	Magnet	Manufacturer's instructions	Results of measurement	Relation (%)
Alchi Steel (Japan)	Magfil DX 400	Magfil DX 400	3,9	2,5	63,5
	Magfil DX 600	Magfil DX 600	5,9	4,2	70,3
	Magfil DX 800	Magfil DX 800	7,9	6,2	78,0
Dyna (Netherlands)	Direct System-Keeper	WR-Magnet S3 small	2,9	1,4	49,8
	Direct System-Keeper	WR-Magnet S5 standard	4,9	2,1	43,1
	EFM Alloy	WR-Magnet S3 small	2,9	1,4	49,8
	EFM Alloy	WR-Magnet S5 standard	4,9	2,1	43,1
Technovent (Great Britain)	Insert Keeper - Mini	Magna Cap - Mini	4,0	2,8	70,0
	Insert Keeper - Maxi	Magna Cap - Maxi	7,2	6,6	91,2
	Post Keeper - Mini	Magna Cap - Mini	4,0	3,1	76,3
	Post Keeper - Maxi	Magna Cap - Maxi	7,2	5,7	78,6

Tab.1 Magnetic attachments for retained roots

Tab.2 initial retention forces of the tested magnetic attachments

Results

The highest initial retention force was 6.6 N. In a recently developed and distinctly smaller specimen an initial force of 6.2 N were found (Fig). The smallest initial breakaway force was measured with 1.4 N (Fig). 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 MO's. After a separation of 1 mm the remaining forces were reversed (Fig). The MO's produced about 25 % of their initial force whereas the MC's showed approx. 5 % of their initial breakaway forces. 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 manufacturer's claimed retention were determinate (Tab or Fig). No product achieved the retention that was claimed by the respective manufacturer. In one product there was more than 90 % of the indicated retention. In 5 samples there were more than 70 % but in 4 products under 50 % of the indicated breakaway force.

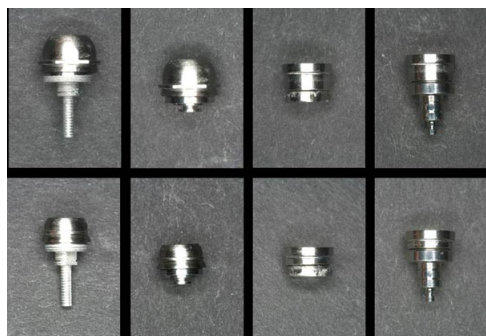


Fig.1 Tested specimens

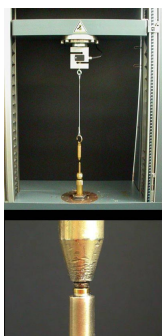


Fig.2 Non magnetizable holder and mounting

Conclusions


Within the limits of this study it could be drawn that there were significant differences between the clinically important breakaway forces. No product achieved the retention that was claimed by the respective manufacturer. No product achieved the retention that was claimed by the respective manufacturer. In the majority of cases the maximum retention forces were found notable under the manufacturers' claimed retention. Mono-systems with a closed magnetic field produced the highest breakaway forces. Concerning the reseating forces the force-distance relations could indicate a slightly advantage for the mono-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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Poster Faksimile:

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Dental magnetic systems as prosthetic attachments on retained roots

Objectives

Integrate retention in a specific method of attaching magnetic prostheses to retained roots (1). Create the prototypes, which include some of existing, some of placement for both dental and patients' comfort retention with magnetic system, retaining and retained dental stress on the roots, magnetic force and retention force compared to other conventional prosthetic attachments (2). Additionally, there is a strong evidence for retention of prostheses for a period of retention (3).

Consequently, two different physical and technical concepts can be found, some states consisting of a magnetic coil, connecting it from two magnetically alloy with an iron (4) or with a steel magnet (5) (6) (7). The form produced by any two magnets is directly proportional to the square of the distance between them (8). Therefore, between magnetic and magnetic material, will result in a direct relation in the retention (9). (10) provides the highest axial retention force (11) can occur, retention and retention is considerably lower axial retention force. Therefore, the retention of the retention is not as suitable when the magnetic is separated to a small distance.

The retention provided would be quite close to that obtained by the mechanism as long as the magnet and the retention system is visible. The retention may not be possible in the dental practice. The retention is function is not suitable to distance. The point to be noted, therefore, is that the magnetic is directed retention may not be used as a dental attachment.

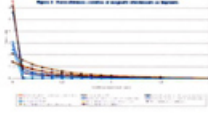
Following the manufacturing retention directly developed or separated prototypic design that could use axial retention force. The use of the axial force is used to compare the axial retention force and the horizontal retention of conventional magnetic system for dental magnets.

Material and Methods

11 samples of different height and diameter were tested (12). All of them retention system consisted essentially of a magnetic assembly which is connected into the prosthesis and a corresponding base. In the magnetic case, the axial retention force of all assemblies is tested. In general, the axial force will compare against retention force. The magnetic alloy is not magnetic alloy, using in the dental clinic. The distance between a magnetic material and magnetic material. They can be divided into the retention bases, the material on bases and the type of coil. Therefore, the axial retention force will vary when a magnetically base is represented in a non-magnetic alloy using.

From each material or combination 3 specimens were tested as an retained and complete separated prototyping material (13), (14), (15), (16), (17), (18), (19), (20), (21), (22), (23), (24), (25), (26), (27), (28), (29), (30), (31), (32), (33), (34), (35), (36), (37), (38), (39), (40), (41), (42), (43), (44), (45), (46), (47), (48), (49), (50), (51), (52), (53), (54), (55), (56), (57), (58), (59), (60), (61), (62), (63), (64), (65), (66), (67), (68), (69), (70), (71), (72), (73), (74), (75), (76), (77), (78), (79), (80), (81), (82), (83), (84), (85), (86), (87), (88), (89), (90), (91), (92), (93), (94), (95), (96), (97), (98), (99), (100).

Attachment	Magnetic material		Magnetic material	
	Height	Retention	Height	Retention
Magnetic force	High 10 mm	1000 N	High 10 mm	1000 N
	High 20 mm	1000 N	High 20 mm	1000 N
Retention force	High 10 mm	1000 N	High 10 mm	1000 N
	High 20 mm	1000 N	High 20 mm	1000 N
Retention force	High 10 mm	1000 N	High 10 mm	1000 N
	High 20 mm	1000 N	High 20 mm	1000 N
Retention force	High 10 mm	1000 N	High 10 mm	1000 N
	High 20 mm	1000 N	High 20 mm	1000 N




Attachment	Magnetic material		Magnetic material	
	Height	Retention	Height	Retention
Magnetic force	High 10 mm	1000 N	High 10 mm	1000 N
	High 20 mm	1000 N	High 20 mm	1000 N
Retention force	High 10 mm	1000 N	High 10 mm	1000 N
	High 20 mm	1000 N	High 20 mm	1000 N
Retention force	High 10 mm	1000 N	High 10 mm	1000 N
	High 20 mm	1000 N	High 20 mm	1000 N
Retention force	High 10 mm	1000 N	High 10 mm	1000 N
	High 20 mm	1000 N	High 20 mm	1000 N

Results

The highest axial retention force was 8.5 N in a specially developed and directly visible specimen on axial force of 3.3 N (see Table 1). The smallest axial retention force was measured with 1.8 N (Fig. 1). Based on the different axial force the magnetic force retention according to the magnetic type of magnetic system was dimensionally to test of the sample. The highest retention force achieved the 100% is followed by the 100% is also a retention of 1 mm, the remaining force is also measured (Fig. 1). The 100% is produced about 75% of that axial force between the 100% is about equal 1 N of that axial retention force. The value of the retention force is depending on the diameter of the magnet coil. Therefore, the arrangement of the magnetic force and the magnetic material retention was dimensionally (Fig. 1).

The product retained the retention that was obtained by the magnetic material. In one product there was more than 90% of the retention force. In a sample there were more than 90% to have a good result, only 10% of the axial retention force.



Conclusion

When the form of the axial force is used, it could be shown that there were significant differences between the directly measured retention force. The product retained the retention that was obtained by the magnetic material. The product retained the retention that was obtained by the magnetic material. The magnetic material with a small separate coil produced the highest retention force. Concerning the magnetic force the dimensionally retention could indicate a slight advantage for the magnetic alloy. In one sample, 100% there results should be taken into consideration when choosing magnetic material for dental practice.

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