Evaluation of Magnetic Retention Abutments in Implant Supported Prostheses

تقييم دعامات التثبيت المغناطيسية في التعويضات المحمولة على الزرعات

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ABSTRACT

Aim of the Study: In the fixation of dentures in the treatment of edentulous or partially edentulous patients a retentive material is required which is not prone to corrosion. The clinical applicability of titan magnets was investigated as well as their long-term use and metal stability in order to minimize complications.

Materials and Methods: The Steco magnet system used during the period from 1996 to 2003 was evaluated in regard to the defects observed in their casing. The broken magnets were taken out and analyzed under a microscope in regard to the nature of the fractures. The rate of complications was classified in defect classes I (without loss of cover), II (with loss of cover), III (fracture of the threads) and IV (defect of the oppositional magnet located in the Prosthesis).

Results: Of the 725 magnetic inserts available for examination, 77 proved defect or showed extreme signs of wear. Most of the fractures were categorised into class I, meaning a fracture with loss of the cover. The magnet field strength proved to be stable, only less than 3 % showed signs decreasing field strength.

Conclusion: The 77 defect magnetic Inserts with titan cover belonged mostly to the first generation of the magnet system. In this generation the welding-seam was done manually.

At that time there was no quality control system available to ensure that the welding-seam was without defect. Apart from the quality control system, there has certainly an x-ray investigation of all titan magnets to be done to ensure that there are no defects in the material at the time of fabrication.

Of course, further studies are needed for an incontestable recommendation of this system. The early generations proved insufficiently resistant for the oral environment. A variety of defects and, contrary to other reports, decreases in the magnetic field strength were observed. These shortcomings led to further improvements, reflected in the various generations, the latter showing defect rates acceptable for the clinical implementation of this system.

Clinically The study revealed that the application of the titan magnet system in implantation is an established method and that it is feasible for anchoring of dental prostheses, also not for the biological surroundings since the rate of complications arising is less than three per cent.

Keywords : *Implant supported prostheses, Magnetic Abutments*

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الملخص

مشكلة و هدف البحث : في سياق البحث عن وسيلة تثبيت للأجهزة المتحركة الكاملة و الجزئية و أن تكون غيرقابلة للتآكل ، تم استقصاء التطبيق السريري لمغانط التيتانيوم بفحص استقرار المعدن مع الاستعمال طويل الأمد و تحري الاختلاطات.

المواد والطرائق : تم دراسة عيوب الإطار في نظام مغانط ستيكو Steco المستخدم خلال الفترة بين ١٩٩٦ و ٢٠٠٣ عند المرضى المراجعين لمشفى جامعة هامبورغ لجراحة الوجه و الفم و الفكين . حيث تم جمع المغانط المكسورة و تحليلها بالمجهر لتحديد طبيعة الكسر. و تم تصنيف أنواع العيوب الحادثة إلى : عيوب من الصنف الأول (دون فقد الغطاء) ، الصنف الثاني (مع فقد الغطاء) ، الصنف الثالث (كسر الحلزنات) ، الصنف الرابع (عيوب المغناطيس المقابل الموجود في التعويض) .

النتائج : من أصل ٧٢٥ مغناطيس خضع للتحليل ، فقد أظهر ما عدده ٧٧ مغناطيس عيوب أو علامات اهتراء شديد. معظم الكسور صنفت ضمن عيوب الصنف الأول (أي كسر دون فقد الغطاء). أثبتت قوة الحقل المغناطيسي استقرارها ، إذ أظهر ما نسبته أقل من ٣ % من الحالات علامات انخفاض قوة الحقل.

الاستنتاجات : تتبع المغانط ذات الغطاء التيتاني التي أظهرت عيوباً إلى الجيل الأول من أنظمة المغانط . و كان الالتحام في هذا الجيل يصنع يدوياً . و عندها لم يتواجد نظام لضبط الجودة للتأكد من أن يتم

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الالتحام دون عيوب . و بغض النظر عن نظام ضبط الجودة ، فمن المؤكد أنه عند تصنيع المغانط التيتانية ، يتم إجراء صور شعاعية للتحقق من عدم وجود عيوب في المادة. و بالتأكيد ، نحن بحاجة لإجراء دراسات إضافية قبل التوصية باستخدام هذا النظام . و لقد أظهرت الأجيال الأولى مقاومة غير كافية للبيئة الفموية ، كما لوحظ وجود عيوب متنوعة ، و بالتناقض مع دراسات سابقة ، لوحظ انخفاض في شدة الحقل المغناطيسي . و أدت هذه المشاكل إلى تحسينات ظهرت في الأجيال اللاحقة ، حيث أظهر آخرها نسبة عيوب مقبولة في التطبيق السريري .

سريرياً أظهرت هذه الدراسة أن استخدام المغانط التيتانية مع الزرعات هي طريقة مثبتة و ملائمة لتثبيت التعويضات السنية ، كما أنها متوافقة مع العناصر الحيوية المحيطة مع نسبة اختلاطات منخفضة.

الكلمات المفتاحية : *التعويضات المحمولة على الزرعات ، الدعامات المغناطيسية .*

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INTRODUCTION:

The systematic implementation of dental implants have led to a change in philosophy in the prosthetic treatment of large tissue defects in the maxillofacial area or following tooth loss. With their rigid anchorage in the bone via ankylosis, implants facilitate the adaptation and incorporation of epitheses or prostheses. Acting as a bridge between the implant and prosthesis, various abutments and supraconstructions have been devised for their retention and fixation.

The desire to use magnets to fulfill these demands failed not because of the functional difficulties encountered but rather because of the lacking in biocompatibility of the ferromagnetic materials available. Also the implementation of magnets as a permanent fixture within the organism has raised the concern of different scientist, although no detrimental effects could be attributed to this phenomenon [1,2]. Subsequently their use has found little acceptance whereby certain advantages must find mentioning. 1) Magnetic fixed dentures demand little manual dexterity making it especially suitable for elderly patients. 2) The small size and good accessibility of the magnetic inserts provide a good hygienic environment. 3) Economically the magnets are inexpensive and can be incorporated in an existing denture. 4) Maintenance cost are low and repairs always possible. 5.) Perpendicular forces are not conveyed to the implant due to displacement of the magnet by lateral movement.

One problem which remains is the fact that ferromagnetic metals are susceptible to corrosion, especially when the junction between abutment and implant does not fulfill the demands of precision. The periimplantary soft and osseous tissues are very sensitive to metal ions, even in minute concentrations [3,]. The subsequent metallosis is suspected of promoting the degeneration of the periimplantary tissue, terminating in a periimplantitis.

In keeping these facts in mind, we performed this retrospective study to evaluate the clinical feasibility of titanium encased magnets used in implant prosthetics [4,5].. The main point of scrutiny were the stability of the metal parts to corrosion and to loading and the eventual long term effects, precipitating as failure or complication [6,7].

AIM OF THE STUDY:

Is to evaluate the clinical feasibility of titanium encased magnets used in implant prosthetics.

The main point of scrutiny were the stability of the metal parts to corrosion and to loading and the eventual long term effects, precipitating as failure or complication

MATERIALs AND METHODS:

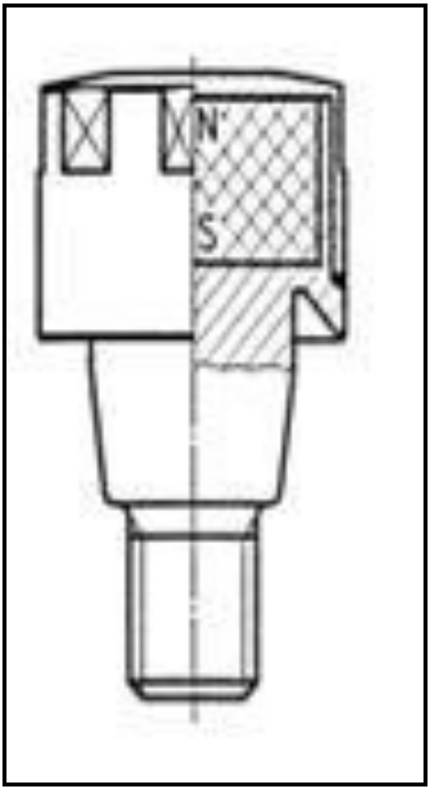
The study sample were gained from inserts implemented between the years 1996 and 2003. All subjects were treated with Steco-magnets in the University Medical Center Hamburg-Eppendorf (Department of Oral and Maxillofacial Surgery) . For simplicity and to detect manufacturing differences, the defects were grouped according to the implant system in which they were introduced. The total number of implants receiving magnetic abutments and subsequent prosthetic rehabilitation in the study was 725.

Included were all the generations of Steco-magnets, which were available on the market from 1987 to 2002. The structure of the last generation (G 7) (Fig. 1) has following further development and improvement : The cover, laser welded to the magnet, It has a spherical surface area. The application is achieved using a snap-on applicator. The magnets are made up of a Sm-Co alloy (samariumcobalt). The abutments surface has been improved being more resistant to wear. The most pronounced difference when compared to the previous generations (G3, G4, G5) is the location of the laser welding. In these generations the magnets were welded in the middle equator of the magnet.

To allow a systematic evaluation of the defects observed, a classification was developed.[8]

Four classes were defined: Defect class I (without loss of the cover), Defect class II (with loss of the cover), Defect class III (fracture of the threads), Defect class IV (defect of the oppositional magnet located in the prosthesis).

Fig. 1. : Structure of the G7 Magnet insert



Defect I: The figures 2 and 3 illustrates one damaged insert from two different angles. Clearly visible are the damages in the vicinity of the magnet with displacement of the cover as well as signs of wear on the lateral surfaces.

Fig. 2. Defect I.

Fig. 3. Defect I.

Defect II: Figures 4 and 5 show the effect of abrasion of the cover. Over numerous years, the cover has been worn thin. The lateral defects allow the assumption that an incorrect fit of the cover denture existed. If the abrasion leads to a perforation of the casing, moisture penetrates and comes in contact with the magnet. The subsequent corrosion develops such forces that the cover is literally "blown off" the insert.

Fig.4. Defect II.

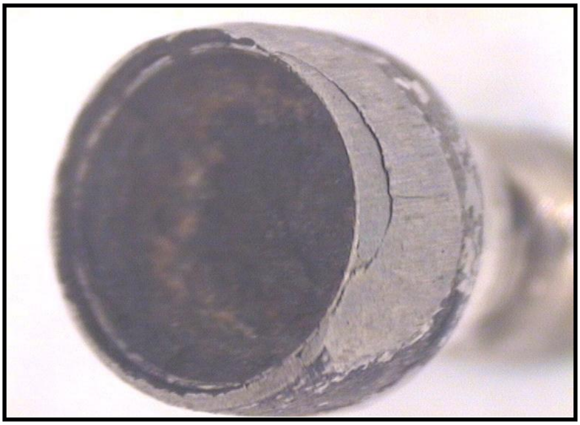
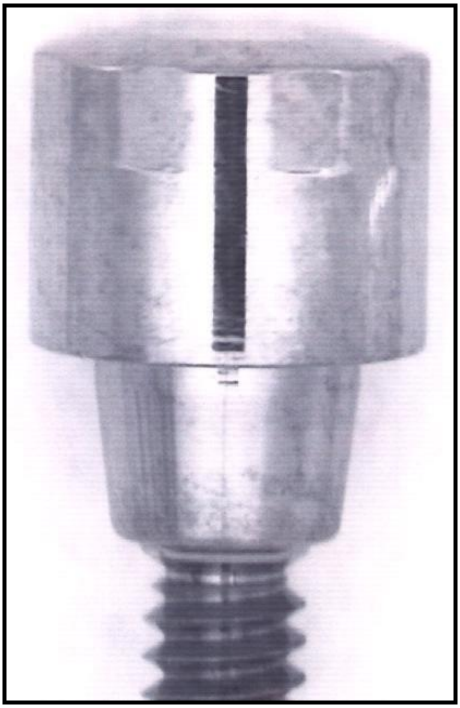


Fig. 5. Defect II.

Defect III: In figure 6 the fracture encompasses the threads, seen as a shining area at the beginning of the threads.

Fig. 6. Defect III.



Defect IV: Figures 7 and 8 portray the oppositional magnet, whereby only the casing is visible.

Fig. 7. Defect IV.

Fig. 8. Defect IV.

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The magnet and the corrosion were removed to allow close scrutiny of the damage. Parts of the cover and of the lateral casing have broken off and the casing has been deformed. The signs of wear and tear as well as the detrimental effects of the corrosion have taken their toll. Additionally, on the cover small cracks are visible and signs of abrasion [9].

The magnetic field strength of the defect titanium magnetic inserts was measured and compared to the new and exchanged magnets in order to detect any changes in the magnetic field strength. The results were statistically analyzed to determine whether a statistical significant difference existed between the implant system (p= 0.05) global test.

RESULTS :

Overall, 77 of these magnets proved to be defected or showed severe signs of wear. The table I shows the defects observed at the abutment .

Table I. showing the types of implants used in the study and the number and percentage of related defects

Implant System	**Total Number**	**Number of Defects**	**Percentage (%)**
IMZ (Dentsply)	296	36	12.16
ITI (Straumann)	340	38	11.17
Branemark (Nobel Biocare)	30	2	6.66
Semados (Bego)	53	0	0

Frialit 2 (Dentsply)	2	1	50
Ankylos (Dentsply)	4	0	0

The magnets which were incorporated in the cover dentures (oppositional magnets) also showed signs of wear. These defects were not implant type correlated but listed according to the year in which they were used as retentive element. The table II reflects these results .

Table II. showing the number of examined cases and the related number of defects in the different periods of the study .

Year	**Total Number**	**Number Defect**	**Percentage (%)**
1996	29	3	10.34
1997	56	6	10.7
1998	74	2	2.7
1999	129	2	1.55
2000	113	1	0.88
2001	173	1	0.5
2002	81	0	0

2003	70	1	1.4

The 77 defected magnet inserts can be categorised according to their defect class as follows in (tab.III).

Table III. showing the number of defective cases in each group of defect classification.

Defect Class	**Number**	**Implant type (manufacturer)**
Defect Class I	9	5-IMZ, 3-ITI, 1 Branemark
Defect Class II	63	29-IMZ, 32-ITI, 1 Branemark
Defect Class III	5	2-IMZ, 3 ITI
Defect Class IV	(16)*	Not implant specific

The inserts and oppositional magnets were treated separately in the evaluation, since different forces are exerted on them . No statistical significant differences were discovered between the different implant systems.

DISCUSSION:

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With this retrospective study it was possible to highlight the pros and cons of the Steco-magnetic system, emphasising the complications encountered during the follow-up period. One undeniable advantage of the magnetic system is the protection of the enossal implants against overloading. Should hypercritical forces be exerted on the cover denture, especially in a perpendicular plane to the implants axis, the cover denture is displaced. The bond between the insert and oppositional magnet is purely achieved by the magnetic field strength produced by the magnets, a barrier which can be overcome once enough force is applied. If it is assumed that this positive effect can be reflected in reduced periotest values (that means, higher stability), in implants using magnets as compared to implants with bar constructions, lower periotest values should be measurable. In a study involving 30 patients with a bar construction of the mandible – see Teerlink J. Periotest[10], measured periotest values are ranging from -4 to +2, with an average of -1.74. In a similar study involving ceramic implants measured values are ranging from -6 to +5 with an average of -1. In comparison, the average value obtained in this retrospective study was -1.75 and therefore lies slightly beneath those values obtained by Teerlink[10]. To what extend, if at all, these lower values are a reflection of a more physiological force distribution on the implants supporting a magnetic suprastructure, needs to be further investigated.

One advantage of the magnetic system is the fact that the magnetic field strength does not decrease with time, as seen in other retentive elements like bars, which are based on friction[11].

The in-vitro examination proposes that the crystalline structure of the magnetic alloy remains constant. If the magnet is exposed to corrosive elements, this structure changes with a subsequent decrease in the magnetic field strength. Therefore, the metal casing and its durability surrounding the magnet is of utmost importance for the prognosis and longevity of the entire structure. Additionally the casing has to be capable of withstanding the physical forces experienced during mastication. So far, titanium seems best suited for fulfilling this purpose. Especially vertical forces (pressure) are exerted on the titanium magnets which threaten the titanium casing. Interestingly the magnetic field strength of the defect magnetic inserts averaged

1.56 G (1G=0.1 mT) whereby the new ones averaged 1.9G. Assuming that the magnets are all equal in their field strength at the time of manufacture, contrary to the statement of Teerlink[10], the magnetic field strength seems to decrease with time. For the verification of this phenomenon, further studies have to be allotted. The average magnetic field strength does not vary according to the implant location whereby the load on the implants and therefore on the titanium magnets varies according to their location within the jaw. Since the titanium magnets manage to withstand the load experienced in the distal portions of the jaw, we can assume that the casing is sufficiently dimensioned.

With the advent of so-called rare earth magnets as described by Jackson [6], new possibilities of further reducing the size of the magnet-attachment systems exist by compromising the magnetic field strength. This promising development as well as the easy handling of the e.g. Steco-magnetics for the patient and dental practitioner alike make it a practical alternative to the conventional retentive elements used in cover dentures [11,12].

Conclusion:

The 77 defect magnetic inserts with titan cover belonged mostly to the first generation of the magnet system. In this generation the welding-seam was done manually.

At that time there was no quality control system available to ensure that the welding-seam was without defect.

Apart from the quality control system, there has certainly an X-ray investigation of all titan magnets to be done to ensure that there are no defects in the material at the time of fabrication.

Of course, further studies are needed for an incontestable recommendation of this system.

The early generations proved insufficiently resistant for the oral environment. A variety of defects and, contrary to other reports, decreases in the magnetic field strength were observed. These shortcomings led to further improvements, reflected in the various generations, the latter showing defect rates acceptable for the clinical implementation of this system.

REFERENCES:

1. Cerny R. The biological effects of implanted magnetic fields in Mammalien Tissues. Aust. Orthod J 1980; 6: 114-117.

2. Cerny R. The reaction of dental tissues to magnetic fields. Aust Dent J 1980; 25: 264-272.

3. Saygili G, Aydinlik E, Ercan M T, Naldoken S, Ulutuncel N. Investigation of the effect of magnetic retention systems used in prostheses on buccal mucosal blood flow. International Journal of Prosthodontics 1992; 5:326.

4. Gillings BRD. Magnetic retention for complete and partial overdentures. Part I. Journal of Prosthetic Dentistry 1981; 45:484-91.

5. Gillings BRD. Magnetic retention for overdentures. Part II. Journal of Prosthetic Dentistry 1983; 49:607-18.

6. Jackson TR. The application of rare earth magnetic retention to osseointegrated implants. International Journal of Oral Maxillofacial Implants 1986; 1:81-92.

7. Hemmings KW, Schmitt A and Zarb GA. Complications and maintenance requirements for fixed prosthesis and overdentures in the edentulous mandible: a 5-year report. International Journal of Oral Maxillofacial Implants 1994; 9:191-195

8. Walmsley AD, Brady CL, Smith PL, Frame JW. Magnet retained overdentures using the Astra dental implant system. British Dental Journal 1993; 174:399-404.

9. Angelini E, Pezzoli M, Zucchi F. Corrosion under static and dynamic conditions of alloys used for magnetic retention in dentistry. Journal of Prostetic Dentistry 1991; 65: 848-53.

10. Teerlink J. Periotest on objective clinical diagnosis of bone appostion towards implants. Int J Oral Maxillofac Implants 1991; 6:55-61.

11. Jackson TR. The application of rare earth magnetic retention to osseointregrated implants. Int J Oral Maxillofac Implant 1986;1:81-92.

12. Ichikawa T, Horiuchi M, Wigianto R, Matsumoto N. The influence of stud attachments on bad transfer to the implant and soft tissue. Int. J Prosthodont 1996; 9: 394-399.