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Application of Different Types of Magnet Retention Systems in the Prosthetic Practice

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Authors' contributions

This work was carried out in collaboration between all authors. Author DV designed the study, wrote the protocol and wrote the first draft of the manuscript. Author BPS managed the literature searches, and analyses of the study performed. Author DVS performed the internet based resources search, correspondence, translation and writing the final version of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The magnetic systems as retention units in overdentures are especially used in dental prosthetics designed on the appropriate endodontically treated dental root. With the rapid development of materials and technology their application with overdentures on implants is enabled.
In dentistry for a long time magnets made from alloys of aluminium - nickel - cobalt have been used with open field. Their success was limited because these magnets are susceptible to corrosion in contact with saliva and because their retention force is weaker than that retention offered by the mechanical attachments.
The preparation of the magnets from alloys of rare earth elements samarium and neodymium enabled greater magnetic force per unit size. Also a new generation of containers allows laser

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welding with which the protection of the magnetic units from salivary corrosion has been improved. The interest in such attachments is growing which is justified, because the magnets, unlike mechanical attachments have the potential of unlimited duration and may be superior to either mechanical ball or bar attachments in achieving retention for overdentures. Moreover, the magnetic unit provides little resistance to lateral displacement, with which the impact of potentially damaging lateral forces on the retention tooth or implant is reduced.

Keywords: Magnets; retention; overdentures; prosthetic practice.

1. INTRODUCTION

Throughout the decades the magnetic retention systems are present in the dental practice, tending to their constant development and improvement (Fig. 1). These systems find particular application in dental prosthetics as retention units in overdentures made on the remaining teeth or root. Recently, their application in overdentures on implants has become more popular.

As a clinical picture the subtotal edentulousness with few remaining teeth in terms of prosthetic treatment undoubtedly arouses huge interest for the therapist - prosthodontist. The presence of natural teeth, their involvement in retention, stabilization and the ability to transfer the chewing pressure physiologically in an optimal way are facts which separate subtotal prosthesis with total, making it close to the partial denture. Stored perceptive and proprioceptive sensitivity in the zone of the retained teeth is another factor in favour on the remaining teeth to be included and left in the subtotal prosthesis [1].

The small number of remaining teeth that have inadequate retaining apparatus can also be used for application of the magnetic retention systems. This is achieved by shortening the ratio clinical crown/clinical root, which makes maximum use of the remaining teeth or root for retention of mobile dental prosthesis, still within their periodontal durability.

Until 1970 the magnets were produced from cobalt - platinum alloy or Alnico (AlNiCo), alloy which contain aluminium, cobalt and nickel. From these two alloys are produced magnetic disks that are characterized by great strength of the magnetic field, but could not be reduced to a size that will allow their application for overdentures. Despite of the numerous flaws, magnets made from alloys of aluminium - nickel - cobalt (AlNiCo) have been used for a long time in dentistry. Yet these magnetic systems with open field lost their attractiveness, because clinical experience has shown that they are susceptible to corrosion under the influence of saliva [2].

With the introduction of alloys of rare earth elements Samarium (SmCo) and Neodymium (NdFeB) with a large force field and favourable internal properties from the previous alloy allowed the production of magnets that are much larger than bar attachments. Alloys of rare earth elements produce stronger and more stable magnetic force than previously available, because they have great ability and great magnet resistance to demagnetization [3,4].

At the University of Sydney, with the pioneering work of Gilings a magnet was developed with separated (split) poles made of samarium - cobalt ($SmCo_5$). This type of magnet, combined with retainer for magnetizing alloy produces a magnetic retention of closed field. The magnetic field (flux) in closed systems is contained in the unit of magnetic grip and therefore gets more and bigger attractive force per unit size than in the open field systems. Magnetic force penetrates through the system of closed field with much lower resistance than the surrounding air.

These magnets have many clinical advantages because of which they became immediately apparent. The magnet is placed in the prosthesis and flat holder on the retention root, so that the input path of the prosthesis does not depend on the retention element, which is of a great advantage for older or arthritics patients.

The adjustments that are inevitable because of spending (abrasion) with these magnets are avoided, and maintenance is convenient than in the mechanical systems based on retention - attachments.

With the application of new alloys, initial concern about the possible biological effects of magnetic fields has been resolved. The advantages of the system of closed magnetic fields over the counter parts placed in an open magnetic field, refer also to the retention features.

Magnetizing alloy based on palladium, cobalt and nickel, with its rapid development allow development of root cap and preparated tooth with the use of standard laboratory techniques.

Reduction of the dimensions of the magnetic retention unit and increase in its retention of power contribute to the development of various sandwich -type designs in which a magnet between two ferromagnetic plates act as a magnet with poles apart, but takes far less space.

Greater reduction in the dimensions has become possible with the introduction of alloys of iron - Neodymium - boron (NdFeB) that have even more power to the magnetic field and other favourable internal properties of cobalt–samarium alloys. Sandwich design allows the magnet to be placed at short distance from the retainer to fit the corrosion resistant jacket. This is necessary because of suspicion of developing intraoral corrosion of the magnetic alloy with its exposure to moisture (saliva).

The new magnets with closed- field have greater attractive force per unit size while the holder and magnet are in contact, but this effect decreases rapidly with separation of the magnet and holder [5,6]. The magnetic field in dental attachments with closed field is almost 4 times stronger (about 5.8 N) than in older attachments with open magnetic field, and dismantling of the magnetic flux of the closed box is smaller.

Generally speaking, the life of the magnetic force is unlimited, which means that the retention force of the magnetic systems should be preserved long after the demise of the mechanical attachments. In addition, the magnetic unit provides little resistance to lateral displacement, which reduces the impact of potentially damaging lateral forces on the retention tooth or implant [7].

The system by closing of the magnet in a metal capsule is later presented, which provides protection against corrosion in the mouth. According to one manufacturer (MAGFIT, Aichi Steel Corporation, Aichi, Japan) the integrity of the system is provided with carefully micro laser welding of the two parts of the capsule to a depth of 70 μm [8,9]. The parts are made of 19Cr-2Mo-0.1Ti magnetizing stainless steel and laser welded with a thin layer of 16Cr-12Ni-2Mo non magnetizing stainless steel which contains 12% of nickel. According to the manufacturer, less than 1 in 10 capsules related with overdentures are separated by the prosthetic base in the clinical observation period of 8 years, and no one magnetic unit has been detected to lose the magnetic attraction [9].

The magnetic retention unit for overdentures generally consists of magnetic prosthetic retention element built into the base of the prosthesis and ferromagnetic holder in the root of the tooth that is embeds into the remaining natural tooth or root. These two elements accomplish utmost retention while they are in contact.

According to the method of setting of the root part, until now three different types of magnetic systems have been developed for overdentures:

≠ With cementing in previously done a little wardrobe closets in the coronary part of the root;
≠ With built in molded root cap;
≠ With threaded wedge root canal or parapulpal threaded bolts.

Each of them has certain advantages and disadvantages.

By shortening the clinical crown (practical, fitting the magnetic unit in the cervical third of the crown) a very positive effect is achieved on the reduction of tooth mobility, which indirectly improves the condition of the parodontal tissue. The forces that act on the root are not crossing the periodontal tolerance. During the functioning time, the prosthesis can make minimal lateral movements without a significant lateral effect on the root which would adversely affect the teeth – and the parodontal complex.

The most suitable teeth for retention carriers are shown:

- Mandibular canines;
- Maxillary premolars;
- Mandibular premolars;
- Maxillary incisors.

The constructed holder can be cemented at the root and than is prepared for accepting the magnets. The overdenture is placed in the mouth to open over the holders. Magnets are placed in the holder and with self adhesive acrylate are attached to the prosthesis. This straightforward technique allows easy replacement of worn magnets.

Another kind of technique, describes the use of prefabricated holders that are cemented in proper position with glass - jonomer cement [10].

The impressions are taken of the holders and the magnets are tried in the mouth applied to the basal plate made of heat–polymerizing material. Once the magnets are placed in the appropriate position, further workflow is the same as in the preparation of traditional prosthetic construction.

Some techniques prefer during the polymerization in the denture to be set a holder for space, which is later replaced by a magnet. This is done to avoid heating of the magnet.

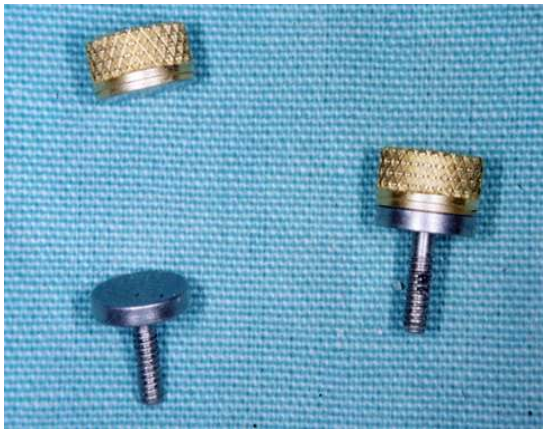


Fig. 1. Display of the magnetic retention system

1.1 Purpose

The purpose of the study was to share our own clinical experience and therapeutic result with some representatives of the magnetic systems.

2. MATERIALS AND METHODS

Magnets of the type Comsteel 444 were used in our material (Fig. 2). Among them the coronary part owns a threaded intraradicular wedge and root cap with 5 mm diameter and a height of 2 mm. The retention magnetic part of the prosthesis is in the form of a cylinder with a diameter the same as the root and the height of 4 mm. The retail package holder contains holders for space for the retention element, made of highly fire resistant mass and with the dimensions of the retention element.

These magnetic retention systems were installed as retention elements for overdentures at eight patients with subtotal edentulism and by regular six-monthly controls was monitored their behaviour in the period of three years.

The clinical procedure for setting of these magnetic retention systems was initiated by preparing the roots-carriers of magnetic elements. Each root used for setting the retention elements should be sufficiently long, straight, strong and properly endodontically treated (Figs. 3, 4, 5).

Fig. 2. Factory packaging of the Comsteel 444 magnetic systems

It is very important for the impression technique to be taken precise functional impression and to be cast an accurate working model. As impression material the elastomer masses are recommended.

In the skeleton, by replacing the holders of the space remains an empty space in which part later the retention magnet is placed, the second part of the magnetic unit.

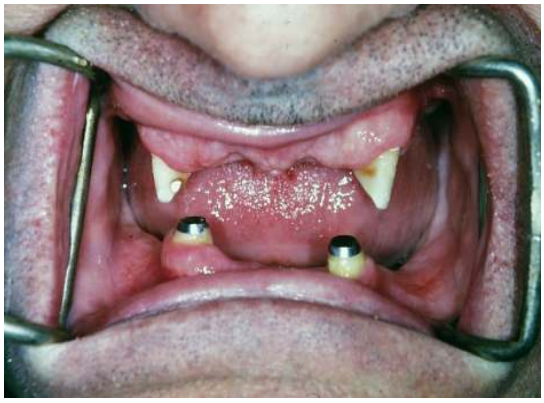
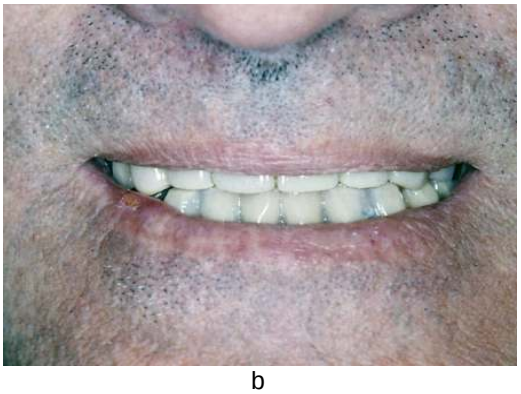


Fig. 3. Preparation of the patient for construction of the frontal bridge and complex prosthesis

a b

Fig. 4. (a) and (b) Technical work of overdenture with Comsteel 444 retention magnetic systems

a



b

Fig. 5. (a) and (b) display of the lower denture with magnetic retention system

3. RESULTS AND DISCUSSION

Based on the clinical observations and numerous literary data for magnetic systems certain conclusions were obtained. Notably, all patients had achieved satisfactory retention force of about 250 gr. for retention unit that is equivalent to most situations and is limited within the parodontal durability. The retention is increased with the inclusion of many magnetic units. With that by setting the magnetic systems as a means of retention was shown as justified.

More important is that the used teeth mostly were with inadequate retaining device, yet they were used for retention for overdentures, without this negatively to be reflected on them (with the accelerated collapse of the retaining device). In the period of three years during the course of clinical observation of patients, the loss of any retention tooth was not registered.

Magnetic unit provides little resistance to lateral displacement, which reduces the impact of potentially damaging lateral forces on the retention tooth or implant. That is, the system provides a level of degree of self adjustment and if the sufficient gingival extension of the prosthetic base is provided, it acts as a buffer of the occlusal forces.

This capacity of the magnetic retention systems becomes available and arouses more interest in making the magnetic retained overdentures over implants. Namely, since magnetic retention systems can resist only small forces, 10% of the normal retention forces, the implantologist can count that only a small lateral load is transferred through the magnetic unit placed on implants.

The described system is easy for application, requires no special skill, is not expensive, can be performed with standard equipment, materials and techniques, and requires no special laboratory equipment.

Magnetic attachments serving as a means for retention for overdentures are usually shorter

than mechanical attachments, which is particularly useful in patients with limited space and large interocclusal aesthetic requirements.

Magnetic attachments can also tolerate moderate divergent position of 2 or more abutments or retention teeth because it does not depends on the way the prosthesis is put in the mouth, unlike mechanical attachments requiring parallel set of retention teeth (abutments).

In addition, the patients with physical disabilities and the elderly patients suffering from fatigue more easily accept the magnetic-retained dentures because they are simpler for setup and removal from the mouth [11,12].

The reliability of magnets from alloys of rare earth elements is fully investigated. The effects of biological tissues have shown that static magnetic fields do not cause changes in human dental pulp, or the gingival tissues close to magnets [13]. An in vitro study of osteoblasts failed to show any difference in cell cultures when they are exposed to static fields associated with these magnets [14]. Further fields do not produce any effect neither blood flow [15].

The magnets, unlike mechanical attachments, have the potential of unlimited durability and therefore could be superior to mechanical ball or bar attachments in achieving retention for overdentures.

All surfaces of the system are exposed to the oral fluids circulation which is beneficial for hygiene aspect. New magnetic units are resistant to corrosion, bio-inert, stable and compatible with oral tissues. The newest magnetic systems today are increasingly being applied as a treatment modality over dental implants especially in the lower jaw.

With proper oral hygiene the oral health is maintained and caries is not a significant problem. It is made possible by the increased accessibility of the marginal gingiva.

The magnets, however, even the ferromagnetic holders made from stainless steel can cause side effects in the performance of certain diagnostic tests with magnetic resonance imaging of the head and neck [16,17]. Therefore, at the patients with magnetic retained overdentures the dentures must be removed and even unscrewed the ferromagnetic holders before they undergo on the diagnostic examinations with magnetic resonance imaging.

4. CONCLUSION

The magnetic retention prosthetic system is not recommended as a substitute for conventional precision retention element, but as a useful alternative for comfort, functionality and value system that the system of overdentures allows.

This retention system has proven particularly useful in the preparation of overdentures over a small number of remaining teeth with inadequate periodontal apparatus or implants. In addition, it's good acceptance by patients (especially elderly and disabled, with limited ability to open the mouth) and by therapists (due to the simplicity of its application procedures) are of paramount importance for becoming available and of greater relevance of the magnetic retention systems.

CONSENT

All authors declare that "written informed consent" was obtained from the patients for publication of this case report and accompanying images.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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