Magnets in Complete Dentures

Rohit Raghavan[1], Mohammed Ramzi[2,*], Ranjith Kumar P[3], Shajahan PA[4], Jamshid Usman[5], Sowmya Balakrishnan[6]

[1]Professor & Head, [2,5,6]P. G. Student, [3,4]Professor, Dept. of Prosthodontics, Royal Dental College, Kerala

***Corresponding author:**
E-mail: ramzibds@gmail.com

ABSTRACT

Magnets have generated a great interest within dentistry and their applications are numerous mainly in retentive aids. The two main areas of use in dentistry are orthodontics and removable prosthodontics. The reason for popularity of magnets is their small size and attractive forces. This allows them to be placed within the prosthesis without being obstructive in the mouth. Mainly rare earth permanent magnets and soft ferro magnetic alloys are used in dental prosthesis. Retention of dentures by magnets is provided by their attraction or repulsion forces. Devices retaining the overdenture magnetically are called magnetic attachments. This article reviewed the alloys and method for magnetic attachments in overdentures.

Keywords: *Magnetic attachments, overdenture, magnetic keeper, Alnico, Platinum-Cobalt, Chromium-Cobalt-Iron, Cobalt-Samarium*

INTRODUCTION

Magnets have generated a great interest within dentistry and their applications are numerous.[1] They are being used as retentive aids for over dentures, removable partial dentures, implants, and in orthodontics for corrections of malocclusion and for treating un-erupted teeth. In Maxillofacial Prosthodontics they have been used for decades to reconstruct large defects with the help of multiple component prosthesis.[2]

Magnets became popular due to their small size and attractive forces; which allowed them to be placed within the prosthesis without creating an obstruction in the mouth. Various properties of magnets like attractive, repulsive forces or combination of both have been used.

Despite of their many advantages, they have poor corrosion resistance within oral fluids and therefore require encapsulation within a relatively inert alloy such as stainless steel or titanium alloy.[1] Advances in technology have made available a new family of magnetic alloy based on cobalt and other rare earth metals. They are small but are strong enough and can be used in dentistry for retentive purposes. The mutual attraction of the unlike poles are being utilized successfully to assemble multi component, maxillofacial prostheses and even in sectional dentures.[3]

History

Magnets were first documented in 2500-3000 years BC. Their origins are first reported in a vast land called Magnesia in Asia Minor. The region contained abundance of iron oxide which attracted metals to it. The locals named it 'Magnetite'.[4]

In the year 1953, magnets were introduced into the field dentistry. They were used to extrude impacted teeth, close diastema and achieve an ideal arch form, to distalize the molar, expand the maxilla transversely and to intrude the posterior teeth in open bite cases. Later in 1960s conventional magnets were applied in restorative dentistry as retentive devices for over dentures, removable partial dentures, and maxillo- facial prostheses.[5]

How do magnets work? / Mechanism of magnetism

Every atom in a material is a magnet because of presence of electron around the nucleus as a moving charge which produces a magnetic field. However, most electrons are paired, and the equal and opposite fields cancel out. In some atoms such as Ni, Fe, and Co, there are unpaired electrons that create a tiny magnetic field.[1]

In a magnetic material, a large portion of these atoms which have a tiny magnetic field, align in small regions called "domains". In an un-magnetized state, the orientation of these domains is random and no overall magnetization is experienced. On the application of a magnetic field, these domains align and reach a saturation point. On reaching the saturation point, the material is said to have been magnetized. On removal of the applied field, if the material holds its magnetization (remanence), it is called as a permanent magnet.[1]

'Flux density' refers to the magnetic field strengths around the magnet. It is usually measured in millitelsa**.** It ismeasured with the help of a miniature Hall probe and gauss meter.[6]

Breakaway loads

Breakaway load is the force, in grams, necessary to separate one magnet from the other for

the paired magnets or one keeper from the split pole magnet and remaining keeper. Generally, attachment systems should provide between 400 to 1000g of attractive breaking force to adequately retain a dental prosthesis.[7]

Classifications of Magnets

A) Based on Alloys used.[3]

a) Those containing cobalt

Examples: - Alnico, Alnico V, Co-Pt, Co_5Sm

b) Those not containing cobalt

Examples: - Nd-Fe-B, Samarium- Iron - nitride

B) Based on ability to retain magnetic properties (intrinsic coercivity or hardness).[3]

a) Soft (easy to magnetize or demagnetize) (less permanent)

Examples: Pd-Co alloy, Pd-Co-Ni alloy, Pd-Co-Cr alloy, Pd, Permendur (alloy of Fe-Co), Cr-Molybdenum alloy, Co-Pt alloy, Magnetic stainless steels.

b) Hard (retain magnetism permanently).

Examples: Alnico alloys, Nd-Fe-B, Co-Pt, Co_5Sm.

C) Based on surface coating: (Materials may be Titanium or palladium, stainless steel).[3]

a) Coated

b) Uncoated

D) Based on the type of magnetism.[3]

a) Attraction

b) Repulsion

E) Based on type of magnetic field.[3]

a) Open field

b) Closed field

- Rectangular Closed-field Sandwich Design
- Circular Closed-field Sandwich Design

F) Based on number of magnets in the system.[3]

a) Single

b) Paired

G) Based on the arrangement of the poles.[3]

a) Reversed Poles

b) Non reversed poles.

Open field system:

The Japanese were the first to use rare earth magnets to increase the retention of dental prosthesis. Magnets or steel plates were embedded into decoronated root structures and, the like magnets, were cured into the denture base so that the attractive force would unite the prosthesis. The first magnetic devices to be used were open-field type where one magnet each was placed in the jaw and the denture. This configuration provided unshielded magnetic fields which could be experienced within the oral cavity. So these unshielded, encapsulated magnet, that uses only one pole for retention are classified as open field system.[8]

Closed field systems:

Because of the fears about the possible effects of magnetic fields on oral tissues, closed-field systems were developed. If the two poles of a magnet are connected by a soft ferro-magnetic material (keeper), the external magnetic field is shunted through the keeper, thus eliminating the external magnetic fields.[5]If the magnetic path between the magnet in the denture and a root cap is closed by a ferromagnetic material, stronger magnetic force can be obtained. This type of attachments is called as 'closed field type'.

The first closed-field system to be introduced commercially was the Gillings split-pole magnet (Innovadent).[8] It consists of paired magnets arranged with the opposite poles adjacent to each other. Two magnetizable keepers, one fixed and one detachable, convey the magnetic field from North Pole to adjacent South Pole in a closed circuit. This eliminates nearly all external magnetic fields in the mouth, whether the denture is being worn or not.

Types of magnetic materials used for dental prosthesis

Two types

1) Rare earth permanent magnets and
2) Soft Ferro magnetic alloys.

Rare earth magnets are composed of

a) Sm-Co

b) Nd-Fe-B

The most important quality of rare earth magnets is the maximum energy product and the magnetic field strength. Sm-Co can be embedded in heat polymerizing resin when fabricating dentures as its curing temperature is above 700^0C, and their magnetic properties are stable below 200^0C. Nd-Fe-B has curing temperature which is low about 300^0C and magnetic properties deteriorate above 80^0C. Therefore care should be taken not to overheat the magnet.

Soft Ferromagnetic Alloy:

Materials of rare earth magnets are too hard to make it possible to shape them into a form suitable for each patient. Because of the fear, of effect of magnetic field on the soft tissue, and to overcome this problem, soft magnets were introduced in the year 1984 for use in the root face. They are composed of Pd-Co, Pd-Co-Cr and Pd-Co-Ni.

Magnets in Complete dentures

Various devices such as springs, suction cups, clips and studs all have been used to retain complete denture in the mouth. Magnets have also been used for this purpose because they are small and are easy to incorporate into a denture.[9] The first attempt of using magnets to retain dentures involved implanting them within the jaw, problems ensued because of the large size of the magnets and the inadequate forces that they provided.[10] Improvements in magnetic materials have allowed smaller and more powerful magnetic attachments.

Implantation of magnets

Two types:

a) Magnet Repulsion and
b) Magnet Attraction.

The first recorded use of magnets in prosthetic dentistry involved using the repulsion of like poles of magnets to maintain and improve the seating of complete dentures.[10] The magnetic material used was Alnico type that has been discontinued because of large bulk necessary for magnet strength.

The use of attractive force retention was reported in the early 1960s.[9] This first attempt was made with Al-Ni-Co V which was surgically implanted in the mandible of edentulous patients. Because of the distance between the two magnets, they provided inadequate force to aid in retention.

After that the smaller and stronger Co-Pt magnets were implanted.[9] Several disadvantages were associated with Co-Pt magnets, including their high cost, limited availability, difficult fabrication. The implanted magnet migrated through the bone and tissues until it became exposed in the oral cavity.[1] As material technology improved, smaller magnets were made that could be incorporated into the retained roots with similar units built into the denture.

Over denture retained by magnetic attachments

Various mechanical attachments have been used to retain over denture by friction. But the retention may be lost gradually due to wear and moreover masticatory forces produce lateral forces to the abutment through the attachment and the teeth may be loosened and finally extracted. Magnetic forces are suitable for the retention and overcoming these difficulties.[11] Devices retaining the over denture magnetically are called as'magnetic attachments'.

The advantages of this technique over the buried magnetic implant technique are:[12]

1) The magnet is not buried in bone or soft tissue, and therefore there is no surgery involved.
2) There is no danger of compression of soft tissue between the implant and the magnet.
3) The implant does not interfere with the normal function of any of the tissue.
4) The implant is easy to maintain or replace.

Alloys and methods for magnetic attachments in over denture:

First reported use of magnets for the retention of over dentures took place in 1960s with the rehabilitation of a patient with a cleft lip and palate.[9] Magnetic Co-Pt alloy was used to produce crowns for 3 remaining teeth with cast Co-Pt also built into the denture. This was soon followed by the technique of cementing magnets within the retained roots for the retention of overdentures.[12] A Sm-Co was cemented into a prepared cavity in the root surface, and a similar magnet was placed in the denture.[10]

Soft magnetic root keepers

Because of fears over the effects of magnetic fields on the soft tissues, a soft magnetic material, Pd-Co-Ni alloy was developed for use in the root face. After assessment of the magnetic and physical properties and corrosion resistance, the Pd- Co-Ni alloy was found to be the most suitable.[10] Theadvantage of these alloys is that the root element possesses no permanent magnetic properties; thus, no magnetic fields are experienced within the oral environment once the dentures are removed.

Other soft materials used for root keepers are Stainless steel, Permendur (Co-Fe) and the chromium-molybdenum alloys. Such alloys have been cast to form a root coping or pre-formed into a keeper with or without a screw thread for cementation into the root or attachment to an implant.[10]

The standard magnetic retention unit consists of the magnetic retention element and keeper element. Magnetic retention element is made up of paired magnets, an attached keeper, and two protective end plates covering the paired magnet faces. Keeper element is detachable, oval-shaped, magnetizable, preformed disk or a cast root cap.[11]

Selection of keeper:

1. **Cement-in keeper:** It should be used where available denture space is limited because, when completed, the root face is level with the gingiva. It is not suitable for small roots, because of the danger of lateral root perforation, or for patients with high caries susceptibility, because a ring of dentine is left exposed. It is 5mm long, 3mm wide and 1.2mm thick, and root face should be large enough to accommodate a cavity of this size. It is fitted in one appointment.[13]

2. **Screw-on keeper:** It can be used where there is adequate available denture space, or where the root face is too small to accommodate a cement-in keeper. Because it is easily removed and

replaced, it should be used where further root treatment may be required, or where the root may require shortening because of anticipated gingival recession. When completed, the root face will be 1.2mm higher than the gingival. It is 6mm long and 4mm wide in its largest dimensions, and usually covers most of the root face. It is fitted in one appointment.[13]

3. **Cement-on keeper:** It is identical to screw- on keeper, except in the manner of its retention by a soldered-in wire loop. It is difficult to remove, but the easiest of all keepers to fit. The operation can be completed in minutes. It is the type favored by most users.[13]

4. **Cast root cap and dowel keeper:** It should be used where total root face coverage is required because of the likelihood of dental caries. It must be cast in a magnetizable alloy, and cobalt chromium casting techniques are necessary.[13]

Magnetic retention element insertion

Two systems of insertion have been used.

I. Chairside insertion.
II. Laboratory insertion.

Clinical considerations

As with all over dentures, case selection and patient education is very important. The patients must be convinced that regular, effective oral hygiene is essential if the gingival margins and supporting bone are to remain healthy and eventual extractions avoided. In addition to cleaning the denture-bearing tissues, root faces, and gingival margins at least twice a day with a soft brush and a fluoride dentifrice, the patient should scrub all surfaces of the denture. The denture should be soaked in denture cleaning solution every few days. Oral hygiene instructions should be reinforced on recall visits, and any areas where gingival inflammation or plaque is present should be pointed out.

Clinical problems

In comparison with other denture retention systems, magnetic ovedenture retention gives few clinical problems. The retentive force does not deteriorate with time or use, and may even increase if the contacting surfaces of the denture and root element wear slightly to produce a more intimate contact.

Keeper element wear is not a problem, and the protective end plate thickness is sufficient to give a service life estimated to be at least 10 years before the underlying magnet alloy is exposed. Magnets may corrode, if they are not completely surrounded by denture base resin, and saliva penetrates around them. As with all over dentures, denture base fracture may occur, unless the base material is thick.

Commercially available magnetic systems

Open field	Closed field
DYNA	INNOVADENT
GOLDEN	SOLID STATE
	MAGNEDENT
	SCHINNER
	GILLINGS
	JACKSONS- Regular and mini

All these provide satisfactory retention. Apart from corrosion / physical damage all these system keep their retentive power indefinitely.

Advantages of magnetic attachments

a) Small size within over denture.
b) Magnetic force work together with the negative pressure and adhesive retention over denture base.
c) Increases the stability.
d) Easily constructed without special technique.
e) Insertion and removal of ovedenture is easy.
f) Reduces lateral forces on the abutment tooth.
g) Teeth in poor condition such as residual root with caries and cyst, impacted teeth, loose teeth can be used as abutment due to minimal lateral pressure on the teeth.
h) Also available for other prosthetic treatment such as retention of a removable bridge, minor toots movement, and eruption of tooth.

Disadvantages:

a) Low corrosion resistance
b) Cytotoxic effects of the leachants
c) High cost
d) Short track record.

Failure of dental magnets

The main problem associated with the use of magnets as retentive devices is corrosion. Both $SmCo_5$ and Nd-Fe-B magnets are extremely susceptible to corrosion, especially in chloride containing environments. Therefore the magnetic materials must be securely separated from the oral fluids before use in dental applications. Although some current magnet assemblies are encapsulated in stainless steel or titanium, some devices are failing approximately 18 months in clinical use because of corrosion and loss of the retention provided by the attachment. [9]

CONCLUSION

Dentistry is an ever changing science. As new research and clinical experience broaden our knowledge, changes in treatment are required. Magnets were used only occasionally for dental purpose several decades ago. Since the advent of rare

earth magnet alloys, the intra oral magnets are shaping the course of esthetic and retention for both complete and removable partial denture. Their benefits include simplicity, self-adjustment, inherent stress breaking, comparative freedom of lateral movement, a low potential for trauma to the retained root, and the elimination of the need for adjustment in service.

Magnetic attachment systems do not have coplanar, parallel, or dovetail surfaces, which are difficult to use and expensive to machine. Also, do not have to have moving parts or springs, which can fatigue and wear out.

The clinical procedures for the fabrication do not require any special skill and the option offered by the various manufacturers gives the dentist a wide variety of choice in selecting the appropriate treatment plan. Finally, it is clear that over denture treatment is a valuable option for the dentist and the use of magnet expand the option to the retention of the tooth root, that might otherwise scheduled for extraction.

As a result of latest research and development in the field of permanent magnetic alloys, there has been rekindled interest lately in the use of magnets in medicine and dentistry as attachment systems.

REFERENCES:

1. Magnets in prosthetic dentistry. J Prosthet Dent. 2001; 86(1):137-42.
2. Effects of static magnetic fields on bone formation in rat osteoblast cultures. J Dent Res. 2003; 82(12):962-966.
3. A close-up on obturators using magnets: Part I-Magnets in dentistry. JIPS. 2005; 5(3)114-118.
4. htpp://www.newi.ac.uk/BUCKLEY/ magnet,htm
5. Investigations into the failure of dental magnets. Int. J. Prosthodont. 1999:12; 249-54.
6. Magnetic retention for over dentures. Part II. J Prosthet Dent 1983:49; 607-18.
7. Retention and wear of precision-type attachments. J Prosthet Dent 1983:49; 28-34.
8. Application of rare earth magnetic retention.T.R. Jackson, BABBUSH'S
9. The interaction of a magnetically retained denture with osseointegrated-implants. J Prosthet Dent. 1988; 60:486-490.
10. Over dentures with magnetic attachments. Dental clinics of North America. 1990; 34(4):683-709.
11. Magnetic retention for the over dentures. Allen A. Brewer. 2nd edition. 376-397
12. The use of magnets in a maxillofacial prosthesis. J Prosthet Dent. 1971:25;334-40.
13. Magnetic denture retention systems: inexpensive and efficient. International Dental Journal 1984:34; 184-97.