REVIEW ARTICLE

Magnets in Prosthodontics

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ABSTRACT

The numerous applications of magnets is useful in dentistry. Its after the introduction of the powerful cobalt-samarium magnets in the sixties, their use has increased, and the fabrication of these magnets in smaller dimensions is now possible i.e. a few millimeters in width and height conventional magnets have been used as retentive devices for removable partial dentures, obturators and also the maxillofacial prosthesis. The retentive forces and the compactness of the rare earth magnets particularly have resulted in their widespread use for overdentures .

KEYWORDS: Magnets, Retentive device

INTRODUCTION

Magnets have a history comprising of approximately 3000 years and are in use since then for various applications. Hippocrates (460–360) BC was the 1st who gave medical references to magnetism. The styptic iron oxides magnetite and hematite was used by him to stop bleeding and to control haemorrhage.[1] The first use of magnets in dentistry dates back to 1940, when the attempt to improvise the retention of dentures in patients with severely resorbed edentulous mandibles was made by Freedman. The design of magnetic attachments has changed in the last 20 years with new rare earth materials based on neodymium-Iron-Boron alloy.[2]

HISTORICAL BACKGROUND

More than 20 centuries ago, an iron-ore called Magnates was discovered. The ancients termed it as *load stone*. It attracts tiny bits of iron. The action was attributed to be an the invisible effect called magnetism named after magnesia, the area in ancient Greece where this type of rock was found. The use of magnets in medical literature was documented back in early 19th century. Magnets are also being extensively used by the orthopedic surgeons to overcome the non-union of fractures.[3]

Prosthodontists were the first to recognize the value of these magnets in dentistry. The few enlisted applications of the past were, magnetic alloys used for fixation of dentures (Freedman 1953, Thompson 1964 & Winkler 1967), surgical incorporation in the edentulous mandible for retention of the complete dentures at the molar region (Behrman 1960), and also used in sectional dentures (Fredrick 1976)[3,4] additionally, they were also implied in maxillofacial prosthesis for the fabrication of obturators, restoring eyelid and lip closure (Nadear 1956, Robinson 1963, Javid 1971, Orlay and Cher 1981).

CLASSIFICATION

Classification of Magnets is described as under:

A. **Based on Alloys used**

- Those comprising cobalt Examples are Alnico, Alnico V, Co-Pt, Co5Sm
- Those not comprising cobalt Examples are Nd-Fe- B, Samarium Iron Nitride.

B. **Capability to retain magnetic properties (intrinsic coercivity or hardness)**

- Soft (easy to magnetize or demagnetize) (less permanent) Examples are: Pd-Co-Ni alloy, Pd-Co alloy, Pd-Co-Cr alloy, Pd, Co-Pt alloy, Magnetic stainless steels, Permendur (alloy of Fe-Co), Cr-Molybdenum alloy.
- Hard (retain magnetism permanently). Examples are: Alnico alloys, Co-Pt, Co5Sm, Nd- Fe-B.

Type of surface coating (materials may be stainless steel, Titanium or palladium)

- Coated ,
- Uncoated

D. Based on the type of magnetism

- Repulsion ,
- Attraction

E. Based on type of magnetic field

- Open field ,
- Closed field
  - Rectangular closed-field sandwich design,
  - Circular closed-field sandwich design,

F. By the number of magnets in the system

- Single ,
- Paired.

G. Based on the arrangement of the poles

- Reversed poles,
- Non reversed poles.

H. Based on number of magnets in the system:[Fig.1]

- Duo-system open field
- Mono-system open field
- Mono-system closed field

How to cite this article:
A.Meenakshi, Fatima N, Bharti V, Paul P. Magnets in Prosthodontics. Int J Oral Health Med Res 2015;2(4):81-84.

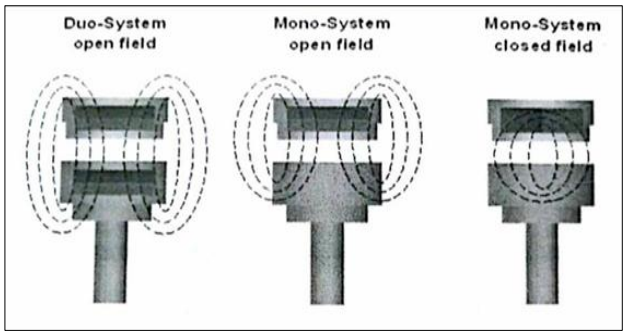

Fig-1: Based on number of magnets in the system

PROPERTIES

- Density – 8.1G/cm3.
- Co-efficient of thermal expansion – 12.6*10-6/C similar to cobalt chromium casting alloy.
- Hardness – Very high with the elongation to nearly zero resulting in slightly brittle.
- Fabrication –The processing of the magnet is complicated, though its filing is possible with a dental tool. The necessity to prepare standardized magnets designed commercially for specific applications has been evolved .The current rare earth magnets are fabricated by sintering with a fine alloy powder pressed together into a mould, forming a cohesive non-porous mass.[2]

COMPONENTS

The standard magnetic retention unit is a two component system: Magnetic retention element and keeper element. The magnetic retention element is made up of paired magnets,an attached keeper,and two protective and plates covering the paired magnet faces.The magnetic retention element is oval in shape and is 5mm long,3.2mm wide and 3mm high.

The keeper element is a detachable, oval shaped, magnetizable preferred disk or a cast root cap. The keeper element is prepared with a magnetizable alloy,which is not a magnet but it acts as a magnet(induced magnet) when it comes in contact with magnetic retention of element (Fig 2). The alloy used is Pd-Co-Ni alloy or stainless steel alloy.

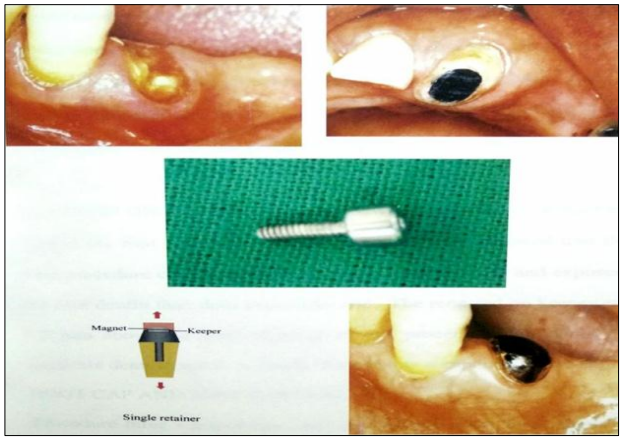

Fig-2: Keeper System

Recently a new permanent magnetic alloy introduced is an alloy of neodymium-ironboron,which has got 20% more magnetic strength than cobalt samarium per unit volume.

Cemented in keeper is a preformed disk of 5mm long, 3.2mm wide and 1.2mm thick.Screwed on keeper is a preformed disk 1.2mm thick with one face 5mm long and 3.2mm wide and the other face 6mm long and 4mm wide.

APPLICATIONS

Magnets can be used in various applications:

Magnets retained tooth supported overdenture.
The magnetic retention unit consists of a denture retention element and a detachable "keeper" element. Its denture-retention element has paired, cylindrical, cobalt-samarium magnets, are magnetized in axial direction with their opposite poles adjacent[7].

Magnets retained implant supported overdenture.(Fig.3)
The various problems reported by the complete denture wearers can be eliminated with implant supported fixed prostheses or removable overdentures.

Recent developments in titanium osseointegrated implants have made the science of implantology more predictable.

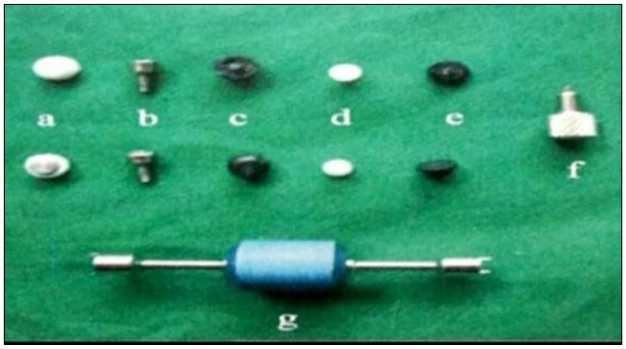

Fig-3: Magnetic attachment set(Shiner-Preat corporation) a:Magnet with capsule, b:Implant keeper, c:Processing piece, d:Model piece, e:Impression piece, f:Shiner hex driver, g:Magnet tool.

Magnets in Maxillofacial Prosthesis:
The use of magnets is the most efficient means of providing combined prosthesis with retention and

Fig-4a,b: Magnetic Retention for Maxillofacial Prostheses.

stability in patients with deformities requiring complex rehabilitations. The majority of prosthesis are designed with using sectioned magnets with magnets in section.

The magnets are attracted to each other retaining the sections, when assembled.

Magnets are used in orbital prosthesis auricular prosthesis, large and small maxillary defects and intra oral-extra oral combination prosthesis.[8](Fig.4)

Magnetic retention for sectional dentures:[9]
Application of cast iron-platinum keeper to collapsed denture for a patient with constricted oral opening.

BIOCOMPATIBILITY OF MAGNETS

- It is concluded that the magnetic potential produced by intraoral magnets in the surrounding blood vessels is very negligible (2*10-5V) compared to resting membrane potential of cell membranes (60-100V)[10].
- The hermetical sealing of rare earth metals is advised in spite of them being biocompatible and acid resistant

EFFECTS OF MAGNETS ON TISSUES AND THEIR SAFETY

The possible ways by which a magnet can cause injury to the tissues are :

- The Physical effects caused due to the steady magnetic fields (magnetism) around them.
- The alloys and their corrosion products causing chemical effects .

In 1960, Behran[11] studied the physical effects of magnetism both on bone and soft tissues of 450 subjects and concluded that it is completely innocuous to tissues. Its seen that the closed-field system offers better tissue compatibility when compared to a open field system. The retention of the denture element adjoins the keeper in the root also holding the denture with the help of magnetic attraction. When the position is achieved, no external field surrounds the denture or the root.

Late back in 1979, Tsutsui[12] and his colleagues stated that Cobalt-Samarium dose not have harmful chemical effects. Cobalt has also been an essential dietary trace element in reminants. Samarium salts are not considered toxic. A rare earth salt, Cerium Oxalate (which also contains samarium) is a recommended treatment for sea sickness with the dosages up to 1 gm/day.

Nevertheless, Walmsley[13] suggests that the magnets mentioned in any of the materials have to be encapsulated. He also observed that if the coating wears out, the magnet can come in contact with saliva, resulting in magnetic corrosion. It was also noticed that the rate of corrosion increased in the presence of bacteria like Streptococcus sanguinus. Thus there would be reduced lifespan of the magnet. Also, its was seen that coated magnets produce no effect on human dental pulp, gingiva,osteoblasts or blood flow. Only the magnets which are uncoated have shown to produce cytotoxic effects on the cells. The most sensitive to effects of these rare earth magnets are oral mucosal fibroblasts

ADVANTAGES & DISADVANTAGES

Advantages are as follows:[4]

1. Magnets provide both retention and stability.
2. Rotates a functional 12 degrees,allowing for up to 24 degrees of abutment divergence.
3. This also provides for an easy non-critical path of prosthesis insertion and removal.
4. Parallelism of the roots or implants is not must .
5. Soft tissue undercuts may be engaged.
6. Potentially pathologic lateral or rotated forces are eliminated providing maximum abutment protection.
7. Enables automatic reseating of the denture if dislodged during chewing.
8. Shorter roots equal to 3mm of bone support also are adequate and can function abutments with magnetic appliances.
9. The root abutments are not subjected to direct stress.

Disadvatages are as follows:

- Corrosion is the main problem associated with the use of magnets as retentive .The SmCo and Nd-Fe-B magnets[1,2] possessing the properties brittleness and susceptibility to corrosion, more seen in chloride-containing environments such as saliva and the presence of bacteria increases the corrosion of Nd - Fe-B magnets.
- Mechanisms causing Corrosion of magnetic attachments.
  - The breakdown of the encapsulating material.
  - Diffusion of moisture and ions through the epoxy seal.
- It is therefore necessary to encapsulate or coat the magnets for use in dental applications.However,continual fading of the encapsulating material leads to more exposure of the magnet.
- Deep scratches and gouges caused due to wear on the surface and also by debris and other particles that become trapped between the magnet and the root.
- Finally there will be loss of retention that is provided by the attachment.
- The abrasive nature of the titanium nitride-coated soft magnetic tooth keeper which is also used with some implant system may lead to excessive wear of the magnet.

CONCLUSION

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, low cost, self adjustment, innate stress breaking, comparative freedom of lateral movement,

minimum potential for trauma to the retained root, also eliminating the need for adjustment in service. The fabrication clinical procedures do not require special skills. The various manufactures offer variety of options to the dentist to select the appropriate treatment plan.

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Source of Support: Nil
Conflict of Interest: Nil