

MAGNETS IN PROSTHODONTICS

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Abstract:

Magnets have generated great interest within dentistry, and their applications are numerous. They are mainly used in orthodontics and removable prosthodontics. The reason for their popularity is related to their small size and strong attractive forces; these attributes allow them to be placed within prostheses without being obtrusive in the mouth. Despite their many advantages, which include ease of cleaning, ease of placement and removable for both dentist and patient and persistent retention with number of cycles after repeated removal and placement, magnets have poor corrosive resistance within oral fluids and therefore require encapsulation within a relatively inert alloy such as stainless steel or titanium. An attempt has been made to discuss various applications of magnets in Prosthodontics.

Key words: Magnets; Rare earth; Dental implant; Maxillofacial prosthesis; Overdenture; Dentistry; Biomedical material

INTRODUCTION

Magnets have been in use for various applications, their history comprising of approximately 3000 years. Medical references to magnetism were made by Hippocrates (460–360 BC), who used the styptic iron oxides magnetite and hematite to stop bleeding and to control hemorrhage.¹ The first use of magnets in dentistry dates back to 1940, when Freedman attempted to improve the retention of dentures in patients with severely resorbed edentulous mandibles. In the last 20 years, the design of magnetic attachments has changed with new rare earth materials based on neodymium-Iron-Boron alloy.²

HISTORICAL BACKGROUND

More than 20 centuries ago, an iron-ore called Magnate was discovered. The ancients called it a *load stone*. It attracted tiny bits of iron. Though the action was not understood, it was attributed to 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 dates back to the early 19th century. Magnets are being widely used by the orthopedic surgeons to overcome the non-union of fractures.⁴

In dentistry, prosthodontists recognized the value of these magnets first. These magnetic alloys were used for fixation of dentures (Freedman 1953, Thompson 1964 & Winkler 1967). They were surgically incorporated in the edentulous mandible for retention of the complete dentures in the molar region (Behrman 1960), and also used in sectional dentures (Fredrick 1976).^{4, 5} Additionally, they are also used in maxillofacial prosthesis for obturators, restoring eyelid and lip closure (Nadear 1956, Robinson 1963, Javid 1971, Orlay and Cher 1981).

TYPES OF MAGNETIC MATERIAL

In the various dental applications of magnets, the following materials have been used:

I. CONVENTIONAL MAGNETS

1. Platinum cobalt
2. Aluminum-nickel-cobalt (alnico)
3. Ferrite

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4. Chromium-cobalt-iron

II. RARE EARTH MAGNETS

1. Samarium-cobalt (SMCO)
2. Neodymium-iron-boron

PROPERTIES

- Density – 8.1G/cm^3 .
- Co-efficient of thermal expansion – $12.6 \times 10^{-6}/\text{C}$ similar to cobalt chromium casting alloy.
- Hardness – Very high and elongation nearly zero resulting in a slightly brittle.
- Fabrication – The magnet is difficult to process, though possible to file it with dental tools. Since, it is necessary to prepare standardized magnets which are designed commercially for specific applications. Most current rare earth magnets are produced by sintering with a fine alloy powder being pressed together into a mold, forming a cohesive non-porous mass.²

Design Available

An open field system consists of a cylindrical magnet with open ends. It can be either single or paired.

A closed field system of magnets consists of paired magnets and an attached keeper and a detachable keeper. The magnet pairs are arranged with opposite poles adjacent and magnet faces abut magnetisable alloy “keeper”. Keepers can be either oval or circular disks. The paired magnets may be 2.5mm in diameter and 1.5mm high or 3mm in diameter and 2.5mm high. The keepers are magnetisable, low coercivity, stainless steel end plate which joins the unlike poles of a magnet. These “keepers” provide a closed field pathway for the magnetic field and almost eliminate the external field.²

APPLICATION

Magnets can be used in various applications:

1) Magnets retained tooth supported overdenture.(Fig 2)

The magnetic retention unit consists of a denture retention element and a detachable “keeper” element. The denture-retention element has paired, cylindrical, cobalt-samarium magnets, axially magnetized and arranged with their opposite poles adjacent.⁶

2) Magnets retained implant supported overdenture.

Many of the problems reported by conventional complete denture wearers can be eliminated when implants are used to support fixed prosthesis or removable overdentures.

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

3) Magnets in Maxillofacial Prosthesis:

The use of magnets is the most efficient means of providing combined prosthesis with retention and stability in patients with deformities requiring complex rehabilitations. The majority of prosthesis with magnets is sectioned and has a magnet in each section. When the sections are assembled properly, the magnets are attracted to each other and retain the sections.

Magnets are used in orbital prosthesis auricular prosthesis, large and small maxillary defects and intra oral-extra oral combination prosthesis.^{8,9,10}

BIOCOMPATIBILITY OF MAGNETS

- It is concluded that the magnetic potential produced by intraoral magnets in the surrounding blood

vessels is very negligible ($2 \times 10^{-5}V$) compared to resting membrane potential of cell membranes (60-100V).¹¹

- Though rare earth metals are biocompatible and acid resistant, it is advisable to seal them hermetically for dental use.

ADVANTAGES

- Magnets provide both retention and stability.¹
- The roots or implants do not need to be parallel.
- Soft tissue undercuts may be engaged.
- Potentially pathologic lateral or rotating forces are eliminated providing maximum abutment protection.
- Roots with as little as 3mm of bone support are adequate for use as abutments with magnetic appliances.
- They do not directly induce stress to root abutments.

DISADVANTAGES

Corrosion of magnetic attachments may occur by two different mechanisms¹² :-

1. Corrosion of the magnet due to the breakdown of the encapsulating material.
2. Corrosion of the magnet due to diffusion of moisture and ions through the epoxy seal.

The main problem associated with the use of magnets as retentive devices is corrosion. Both Sm-Co and Nd-Fe-B magnets.^{1,2} are extremely brittle and susceptible to corrosion, especially in chloride-containing environments such as saliva and the presence of bacteria increases the corrosion of Nd -Fe-B magnets.

It is therefore necessary to encapsulate or coat the magnets for use in dental applications.

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, 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.

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.

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