Magnets In Orthodontics- A Review

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ABSTRACT:
Magnets have generated great interest in dentistry. They were used as retention devices in dentures and now have been extended in the use of orthodontic treatment. Though the size of the magnet was a drawback previously the introduction of rare earth magnets have made their use in orthodontics easier and simpler. This review discusses the uses of magnets in orthodontics.

KEYWORDS: magnets, rare earth metals,orthodontics
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INTRODUCTION:

The world around us has a magnetic energy both natural and artificial. Evolution and normal biologic process may well be magnetic field dependent. Magnets have been commonly used in dentistry primarily as retention agents in dentures and overdentures[1-3]. In orthodontics the use of magnets have been advocated and researched for the treatment of unerupted teeth,[4,5] for tooth movement along archwires,[6] expansion, fixed retention,[7] in the correction of anterior open bite and in functional appliances. Magnets are said to have advantages over other materials like power chain or niti coils as they provide measured forces for a continued period of time for each

type of tooth movement. They can be made to attract or repel and the force they deliver can be directed, and can exert their force through mucosa and bone.

It is important to ensure that magnets used intraorally for clinical use should not produce any side-effects at a local or systemic level. A full evaluation must include three levels of testing as follows:
• Level 1: In vitro testing in order to establish the toxic, allergic or carcinogenic nature of the material.
• Level 2: In use testing on animals.
• Level 3: Clinical trials. Magnets used in orthodontics produce static magnetic fields.

Biological testing of magnets containing rare earth elements has evaluated the effects of both the static magnetic field, and possible toxic effects of the materials or their corrosion products.
Lars Bondemark and Jure Kurol compared in vitro the cytotoxic effects of uncoated and parylene coated rare earth magnet by using two methods as follows:[8]

1. Millipore filter method
2. Extraction method

Types Of Magnetic Materials:

In various dental applications, the following materials have been used:
• Platinum-Cobalt (Pt-Co)
• Aluminum-nickel-cobalt (Al-Ni-Co)
• Ferrite
• Chromium-cobalt-iron (Cr-Co-Fe
• Samarium-cobalt (Sm-Co)
• Neodymium-iron-boron (Nd-Fe-B)

KINDS OF MAGNETIC MATERIALS :

Ferrite Magnet:
Ferrite of barium and strontium is generally utilized for magnetic preparation. These magnets are exceptionally impervious to demagnetization . They are likewise accessible as bar, block, and ring. The thickness is 5 g/cm3 and these magnets are not utilized in the orthodontics.

Aluminum–Nickel–Cobalt Magnets
These magnets offer high field strength at a sensible expense. These are stronger than other magnets. Economically it is accessible as rod,block and ring structure. Their thickness is 7.3 g/cm3. These magnets are accessible in both isotropic and anisotropic structures. In any case, the dangers of demagnetization expense were the issues with these ordinary magnets. The clinical utilization of these ordinary magnets is exceptionally confined due to their size.

Rare Earth Magnets:
Recently Samarium–Cobalt (SmCo) and Neodymium– Iron–Boron (NdFeB) magnets are accessible. These two magnets are known as rare earth magnets. These rare earth magnets, which have a place with the lanthanide arrangement, are 20-times more stronger than the past magnets. Thus, for the same force magnitude a 20-times smaller magnetic unit can be applied with
rare earth magnets. Because the oral cavity dictates the size of the appliance, this increase in F/V ratio (also known as the miniaturizing effect) makes the use of magnets in dentistry a beneficial modality Rare earth metals are consolidated in the magnets to increment their capacity to be polarized, to get coercivity property and to build Curie temperature. The rare earth magnets are equipped for delivering high powers comparative with their size because of the property of magnatocrystalline anisotropy.

This property permits single crystalline o be aligned in one way, subsequently expanding the attraction. The rare earth magnets give maximal power at short distance in correlation with elastics, which accomplish most extreme power of something else distance, for example on opening of mouth.

Samarium–Cobalt Magnet

It is powdered metallurgically handled between metallic composite of Cobalt and rare earth metals. It is accessible in two structures, viz. SmCo5 and Sm2Co17.

1. Better attractive properties when analyzed than other rare earth magnets aside from Nd–Fe–B magnets.
2. even with a flat shape, there is not really any demagnetization making it ideal and little for orthodontic use.

3. The power important in orthodontics can be acquired from a little size of the magnet quantifiable in mm.
4. Attractive properties are constant in course of time, for example high protection from demagnetization with time.

5. High Curie purpose of 680°C permitting heat disinfection and control with heat up to 200°C without demagnetization. .

6. They can likewise be encased in tempered steel coats.

Advantages:

1. It eliminates patient compliance as it is operator controlled
2. It creates less torment and uneasiness.
3. Continuous force is exerted
4. Treatment time is decreased.
5. more acceptableas periodontal complications are reduced
6. friction is eliminated
7. adjustments are minimal and hence reduced chair time
8. Better dirction of force control

Disadvantages:

1. Risk of tarnish and corrosion
2. The products of tarnish and corrosion are are cytotoxic.
3. Concerns have been expressed on the bioeffects of static attractive fields.
4. Bulk of magnets is a concern
5. Cost is additionally an ominous factor.
6. Bitterness

Neodymium–Iron–Boron Magnet

This is the most as of late created combination with most noteworthy attractive energy per unit volume. It is accessible in both isotropic and anisotropic structure. They are less weak than SmCo magnets. They are 240-times more vulnerable to consumption than SmCo magnets and 20-times more remarkable than AlNiCo magnets. There are three types as referenced beneath.

1. Neo 1i. It is most reasonable magnet since it is less expensive and likewise has sufficient protection from consumption.

2. Neo 3i. It can withstand demagnetization at higher temperature be that as it may, helpless protection from erosion.

3. Neo 5i. It is freshest and most complex magnet. It has better energy creation and opposition than demagnetization.

MAGNETIC FORCE IN ORTHODONTICS

Magnetic force delivery systems are now popularly used for

1. Relocating impacted teeth.[9]
2. Expansion of arch.
3. Distalization/mesialization of teeth.[10]
4. Intrusion of posterior teeth in open bite cases.[11]
5. Class II correction with functional appliance.
6. Skeletal correction with functional appliance (FOMA).[12]
7. Closure of midline diastema
8. Uprighting and derotation of teeth.
9. Retainers.[13]
10. Magnetic brackets.[14]
11. PUMA—hemi facial microsomia[15]
12. Class II correction with magnetic twin block (Clark).
13. Non-extraction and extraction cases.
14. Non-extraction and extraction cases.
15. Magnetic appliance for treatment of snoring patients
16. with and without obstructive sleep apnea.
17. Extrusion of fractured teeth.
18. Fixed magnetic appliance.

MAGNETIC APPLIANCES :

❖ **Magnetic Activator Device (MAD):**

It can be used for the correction of

1. Mandibular deviations (MAD I).
2. Class II malocclusion (MAD II).
3. Class III corrections (MAD III).
4. Skeletal open bite (MAD IV).

The SmCo magnets were used in attractive and repellingmode to achieve orthodontic and orthopedic correction. InMAD, attracting magnets are used on a two piece (upper and lower) activator. This helps to allow a free movement of mandible.
In ClassII malocclusions with open bite, it is combined with posteriorrepelling magnets on the maxillary plate for expansionof the arch which is called magnetic expansion device (MED). Further, MAD IV is used for skeletal open bite caseswith posteriors repelling magnets and also anterior attractingmagnets. NdFeB magnets are used in MAD IV

❖ **Active Vertical Corrector**

Skeletal open bites are caused mainly by over eruption of the upper posterior teeth or vertical over growth of the posterior dento-alveolar complex.Orthodontically, early correction can be achieved through high pull headgears, activators, combined headgear and upper plate, open bite bionator, activator headgear combinations active and passive bite blocks and vertical chin cups.

The active vertical corrector (AVC) is an adaptation of the present day bite block therapy introduced in 1986 by Dr. Eugene L. Dellinger. It works as an energized bite block.
It is a simple removable appliance consisting of posterior occlusal bite blocks containing repelling magnets which intrudes the posterior teeth causing the mandible to rotate upward and forward. Hence, AVC is now used as non-surgical alternative treatment for skeletal open bite.

- **Fixed Magnetic Appliance**

The fixed magnetic appliance consists of SmCo magnets in a upper and lower splints embedded in a repelling mode. The acrylic blocks are bonded and extended along the posterior segment only with a wire continuing from these splints to the incisors which are also bonded lingually to these teeth.
Thus in the entire arch the repelling force is transmitted.

- **Magnetic Twin Block**

Dr. William J. Clark modified twin blocks by the addition of attracting in magnets to occlusal slanted planes, utilizing attractive power as an actuating system to augment the muscular reaction to treatment. Clark had utilized SmCo and neodymium–boron.

Attracting Magnets:
The attracting magnetic force pulls the appliances together and encourages the patient to occlude actively and consistently in a forward position

Repelling Magnets:
It might be utilized in twin blocks with less mechanical initiation incorporated into the occlusal slanted planes. It is proposed to apply extra improvement to advance stance as the patient closes into impediment. The detriments of utilizing repulsing magnets are:
The measure of enactment isn't clear and reactivation of the slanted planes would deactivate the magnets.

Indications for magnetic twin blocks:

1. Patients with weak musculature fail to respond to functional therapy.
2. Used only where speed of treatment is an important consideration.
3. Correction of facial asymmetry by using attracting magnets on the working side to correct unilateral mandibular displacement in growth

REPELLING MAGNETS:
Gianelly et al and Takami Itoh et al have utilized repulsing magnets for distalization of molars. A modified Nance appliance to the maxillary first premolars is fixed with a wire expanding from the first premolars to the palatogingival surfaces of the incisors and welded to the system of the appliance.

The acrylic button is set anteriorly to contact the incisors. This strengthens the dock capability of the ordinary Nance apparatus by remembering the incisors for the framework. A auxillry wire is additionally welded with a circle at its finish to the labial surfaces of the first premolar groups so both
wires stretched out posteriorly to rough the mesial surfaces of the first molar groups.

The repulsing surfaces of the magnets are brought into contact by passing a 0.014 ligature wire through the loop on the auxillary wire, at that point tying back a washer foremost to the magnets. In this way, the magnets must be isolated if the molars moved distally or the incisors moved anteriorly.

The power applied by the magnets starts at 200–225 g, yet, drops generously as space opens. With 1 mm of space between magnets, the apparatus power is just 75 g.

Subsequently, retying the ligature once every week to guarantee at least 75 g of power against the molars reactivates the magnets. After molars are distalized, 0.016 × 0.022 curve wire
with stops is embedded to keep up the molar positions The molars are distalized around 3 mm in 7 weeks in those patients who don't have second molars. The pace of molar development in patients with second molars is normally 0.75–1 mm every month.

Blechman and Steger[16] demonstrated that the substantial development in the vast majority of the cases is most likely inferable from the fundamental property that repulsing attractive shaft faces keep away from offbeat developments and consistently endeavor to keep up an equivalent air hole along
their whole vertical shaft measurement, when obliged to slidealong a typical guide wire.

- **Magnetic Brackets**

It comprises of a SmCo magnet with an edgewise section on one surface to get curve wires and a cross section on the sub-par surface to encourage direct attaching to teeth. The magnets were covered with nickel and chromium to forestall erosion. They are intended to convey 250 g of power and to frame an ideal curve in both maxilla and mandible on fulfillment of treatment. In spite of the fact that more limited treatment time and great biocompatibility were seen and measurements of the sections to acquire essential power levels. The unpredictability of research facility arrangements is viewed as most extreme inconveniences.

- **Propellant Unilateral Magnetic Appliance (PUMA)**

A new appliance is introduced for stimulating an autogenous costochondral graft in hemifacial microsomia which consists of SmCo magnets embedded in lower acrylic bite blocks in the repelling mode. The long axis of the magnets is perpendicular to the blocks interface.

- **Rare Earth Magnets And Impaction**

Rare earth magnets are utilized for eruption affected teeth. A attractive section is attached to an affected tooth and intraoral magnet connected to a Hawley type retainer is utilized to direct the emitting tooth. Vertical sections with the attractive pivot corresponding to the base of the section are utilized for affected incisors furthermore, canines and level sections with their attractive pivot opposite to the base of the section are utilized for affected premolars and molars. It is suggested that a little reinforced magnet on an affected canine and a bigger magnet on a removable plate to pull in it and guide it to impediment

- **Magnets For Midline Diastema**

The rectangular magnets (SmCo) are bonded to deliver 117.5 g of force of attraction on each maxillary central incisor to close midline diastema. It is also mentioned that the possibility of bonding the magnets palatally for better esthetics.The magnet size of 5 mm × 3 mm × 1 mm is recommended.

Advantages

1. Absence of friction and no reactivation are needed which
are advantageous.
2. Minimum tooth tipping.
3. Less chair side time.
4. Better oral hygiene.
5. Magnets can be reused after recycling.

- **Expulsion Of Fractured Teeth**

A subgingival crown root fracture presents the clinician with a difficult problem to keep up the periodontal tissues healthy. A technique has been accounted for by utilizing attractive power to expel the broken root. The attractive framework comprises of possibly a couple of tube shaped parylene or treated steel covered NdFeB magnets set in the coronal part of the excess tooth with a slender layer of composite. Pivotally over the root magnet, another bigger parylene covered above said magnet 5 mm × 5 mm × 2 mm estimation can be installed in the acrylic modewith a greatest hole of 2 mm. To achieve good esthetics
and maintain space, the appliances can be supplied with a
pontic for missing crown during treatment. After the desired
extrusion, the tooth can be restored.

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❖ **Magnets In Extraction Cases**

The upper sectional arch to which the magnetic assembly isattached is free for sliding through the occlusal upper molartube and is ligated to the mesial aspect of the upper caninebracket. The lower magnet is attached to a similar sectionalarch passing through the occlusal tube of the lower molar
band. The upper and lower magnetic pole in attraction mustface each other in order to generate the force necessary tomove the upper canine distally along the base arch wire ifthis is desired. If the lower anchorage loss is not required,this can be controlled in the traditional manner with the base
arch wire.Clinically thistranslates into a force that is essentially horizontal and most effective between centric and rest position.

❖ **Non-Extraction Case**

The Class II mechanics produced by repulsion are accomplishedby reversing the attraction position and eliminatingthe air gap. In this situation, the upper magnet is immediatelymesial to the upper molar tube and the lower magnet ismesial to the upper magnet with 0 mm gap if maximum
force is required. Both magnets are positioned so that theline of their pole faces is approximately 70° from the horizontalplane to reduce interference from mandibular movement

❖ **Magnetic Retainer**

The same magnets used for closing the midline diastema canbe refixed on the palatal aspect of maxillary incisors afterrecycling.

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RECYCLING:

The recycling does not affect the biocompatibility and force stability of the magnets even though the recycling process involved autoclaving. It is also recommended that new partially encased SmCo magnets be stored in water for 24 hours before use to reduce the release of cytotoxic components. It is proven that high cytotoxicity for uncoated SmCo5 magnets and low for NdFeB magnets. It is also felt that the magnets should not be recycled for ethical reasons and also they demagnetize during the recycling process.

CONCLUSION:

The various types of magnets and their incorporation into rthodontic appliances are discussed. Further researches are required to determine the effects and long term stability of the treatment done with appliances with magnets incorporated in them. Further investigation is required to probe into the biological effects of magnets.

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