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REVIEW OF THE EFFECTS OF NEODYMIUM MAGNETS ON HEALTH

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Abstract: Magnets are used in many contemporary technologies, as well as in the disciplines of medical and dentistry, thanks to their magnetic field qualities. Recent studies have focused on the potent form of magnet known as neodymium. A brief explanation of the meaning, background, and properties of rare earth magnets are given in this review. A thorough summary of the findings from research that have been conducted thus far on the impact of magnets, and specifically neodymium magnets, on biological tissues, systems, organs, diseases, and treatment is also presented. There is a chance for negative consequences, despite the fact that they are utilized in the health sector in a variety of tools. Neodymium magnets seem to have considerable potential for both diagnostic and therapeutic applications.

Index Terms **- Neodymium, Health, Diabetes, Neural**

I. INTRODUCTION

The Biomagnetic healing is the therapy that helps the body heals itself. Magnetic healing is an ancient therapy. Biomagnetic therapy which is the art and science of application and removal of magnetic fields for therapeutic benefit. Magnetic field is an invisible region of space around a magnet in which a detectable force is exerted from the body of the magnet.

Biomagnetism is the phenomenon of magnetic fields produced by living organisms; it is a subset of bioelectromagnetism. In contrast, organisms' use of magnetism in navigation is magnetoception and the study of the magnetic fields' effects on organisms is magnetobiology.

The origin of the word biomagnetism is unclear, but seems to have appeared several hundred years ago, linked to the expression "animal magnetism". The present scientific definition took form in the 1970s, when an increasing number of researchers began to measure the magnetic fields produced by the human body. The first valid measurement was actually made in 1963, but the field of research began to expand only after a low-noise technique was developed in 1970. Today the community of biomagnetic researchers does not have a formal organization, but international conferences are held every two years, with about 600 attendees. Most conference activity centers on the MEG (magnetoencephalogram), the measurement of the magnetic field of the brain.

Different organs, including the heart, brain, and lungs, also generate weak magnetic fields that can be measured with magnetic sensors. Typically, the strength of the magnetic field is much weaker than the corresponding physiological bioelectric signals. Biomagnetism is the measurement of the magnetic signals that are associated with specific physiological activity and that are typically linked to an accompanying electric field from a specific tissue or organ. With the aid of very precise magnetic sensors or SQUID (Superconducting Quantum Interference Device) magnetometers, it is possible to directly monitor magnetic activity from the brain (magnetoencephalography, MEG), peripheral nerves (magnetoneurography, MNG), gastrointestinal tract (magnetogastrography, MGG), and the heart (magnetocardiography, MCG).

Neodymium is a chemical element and it was discovered in 1885. This element (atomic number 60) has a silvery-white metallic color and belongs to the group of lanthanides, which is a subgroup of rare earth elements (atomic numbers 57–71) in the periodic table and rapidly oxidizes in air. Lanthanides play important roles in new technological developments, such as wind turbines, electronic hybrid vehicles, and in the defense industry.

In nature, neodymium does not exist in metallic or in mixed forms with other lanthanides but is refined for general use and has been mined in the USA, Brazil, India, Australia, Sri Lanka, and predominantly in China. Neodymium-iron-boron magnets were developed by General Motors and Hitachi in the 1980s. Because it provides high magnetic force even in lesser amounts, it has been increasingly given a more prominent role in the manufacture of strong permanent magnets made up of rare earth elements. In the field of information technology, neodymium magnets are particularly used in hard disc drives, mobile phones, video and audio systems of television.

Neodymium magnets are also commonly used in magnetic separators, filters, ionizers, in production of on–off buttons, safety sector and security systems. Grease filter producers use neodymium magnets in metal separators to more effectively filter out iron powder in oil. Additionally, they are beneficial in covering machines, cars with awning and in the production of magnetic tool belts.

They are also used in jewelry clips, identification badges and in the production of baby strollers that are attached to carriers via magnets.

The health sector is another field where neodymium magnets are incorporated in medical devices for example in magnetic resonance imaging devices to diagnose and treat chronic pain syndrome, arthritis, wound healing, insomnia, headache, and several other diseases due to their ability to generate a static magnetic field. An increase in their usage has been observed over the last decade. These magnets are thought to have a curing effect and are therefore sometimes called “magic magnets”.

NASA uses neodymium magnets to maintain the muscular tonus of astronauts during space flights. Neodymium magnets have push–pull forces and have been used as a motion-generating device in orthodontic treatments; molar distillation, and palatal expansion.

Static magnetic field has been reported to stimulate bone formation via osteoplastic differentiation or activation. The amount of neodymium magnets used in all these areas has risen from 1 ton to 60,000 tons between 1983 and 2007. Since 1990, China has been predominant in the mining of rare earth elements. The mining of rare elements has various environmental impacts because of the low concentration of these substances; therefore, many countries have stopped the mining of rare elements and almost all countries depend on imports from China.

As of 2012, 50,000 tons of neodymium magnets are produced officially each year in China, and 80,000 tons in a "company-by-company" build-up done in 2013. China produces more than 95% of rare earth elements and produces about 76% of the world's total rare-earth magnets, as well as most of the world's neodymium.

II. EFFECTS OF NEODYMIUM MAGNETS ON HEALTH AND MEDICAL USAGE

2.1 Cardiovascular system

In a study conducted in 2004, laser doppler was reported to significantly reduce blood flow and Skin Blood Perfusion (SBF) in the 2nd and 4th fingers of the non-dominant hands of both poles of the neodymium magnet.

Another study indicated that neodymium magnetic fields increases the nail bed microcirculation although this study conflicted with other studies.

The flow of red blood cells in the skeletal muscle capillaries exposed to strong static magnetic fields has been reported to be reduced, Intra tumoral microcirculation is characterized by tortuous micro vessels with chaotic structures and unstable irregular blood flow. A study has reported a decrease in the blood stream and blood vessel density in tumors that were treated using static magnetic fields. In the same study, it was shown that in non-tumoral skeletal muscles exposed to static magnetic fields, platelet activation and adhesion increased. The magnetic field generated by neodymium magnets is thought to increase microcirculation but the effects on this are not clearly known.

In a study, a special device was surgically placed on the backs of laboratory mice. Neodymium magnets were attached to the device in one group, and non-magnetic, equal-sized, and same-weight platters were attached in the other group. The arteriole and venule diameters of the mice exposed to static magnetic field generated by neodymium magnets were demonstrated to be considerably reduced.

Another study, conducted in 2015, where the portal veins of dogs were cut and reconstructed, the anastomosis in one group was performed using traditional manual sutures and that in the other group was by covering it with rings comprising of neodymium magnets. In the latter, the recovery lasted for a considerably short time and the intima was smoother and regularly formed than in the former.

Bipolar ablation catheters, unipolar ablation catheters and bipolar catheters with magnets attached to them have been tried in thick and tight tissues where it is hard to create a full-thickness lesion like in the left ventricular wall. Both the transmural passage and the thickness of the lesion formed by the magnetized bipolar catheter were found to be higher than others.

2.2 Neural system

Magnets can be used to generate magnetic fields in neural electrical activity research. The effect of magnetic fields created using neodymium magnets on neural damage was examined in a study where they were applied on 17 healthy volunteers for 2 hours. The test conducted to measure mental ability revealed that the parameters tested on the 17 volunteers were not affected by the magnetic fields and to generate a magnetic field with neodymium magnets seemed to be safe on these parameters.

Recurrent Transcranial Magnetic Stimulation (rTMS) is an approved and effective treatment method for major depression. Synchronized TMS (sTMS), which is the modified form of rTMS, has also been tried for the treatment of the same. A study conducted in 2014 revealed that while the occurrence rate of patients who suffered from major depression and treated with sTMS declined by 48%, it declined by 19% in the control group, and this difference was statistically significant. Neodymium magnets are used in TMS to generate magnetic fields and In contrast to electroconvulsive treatment for major depression, TMS does not require anesthesia. Further, another study conducted in 2015 revealed the use of sTMS to be effective in the treatment of major depression.

Placing of magnets on upper and lower eyelids in the treatment of lagophthalmos has obtained successful results. Alternative treatment methods including magnetic therapy have been researched on menopause vasomotor symptoms and it has been found that they are not effective in the treatment of these symptoms.

In another study, to ensure glottis aperture in bilateral vocal cord paralysis, magnets were placed ex vivo in sheep larynx had the gap widened. The device provide a suitable glottis aperture that benefit from magnets and this may be used in the future.

2.3 Skeleton, muscle, and joints system

The effect of neodymium magnet implants placed in rabbit tibia and that of non-magnetic implants on bone tissue have been compared. Magnetic implants reinforced both medulla and cortex around the bone tissue and the increase in the medulla was statistically significant.

In another study conducted using a trabecular damaged rabbit model, a magnetic scaffold was placed in the damaged area of the distal femoral epiphysis and cylindrical neodymium magnets (NdFeB) were placed in a nearby area, the interaction observed. At the end of the experiment, it was found that NdFeB protects against micro movements by keeping the magnetic scaffold constant and it is important in maintaining regular tissue regeneration.

In a randomized double blind placebo controlled research, the curing effect of neodymium magnets on osteoarthritis symptoms was investigated; participants were made to try on four types of wrist straps. During the comparison, magnetic neodymium wrist straps were used as an experimental device, and low magnified, demagnetized, and coppery wrist straps were used as control devices. The WOMAC Osteoarthritis Index, McGill Pain Questionnaire-Pain Rating Index (PRI), visual analog scale, and medicine intake were evaluated. Among these scales, only PRI subscales revealed statistically significant difference. Therapeutic benefits of wrist straps have attributable placebo effect. These devices have no major adverse effects therefore can be used for placebo effect.

In another study, the difficulty of forming a control group where magnetic bracelets tested, addressed that giving a weakly effective wristband to the control group might not be effective in relieving pain in arthritis as the participant could test the strength of the wrist.

In a research in which the role of static magnetic field in carpal tunnel treatment was researched on, the effects of two different magnetic field levels on the median nerve were evaluated. In a randomized double blind placebo controlled research, 12-week long observation was performed after a 6-week long interference. Participants who were diagnosed with carpal tunnel syndrome using electrophysiological tests wore neodymium magnets and non-magnetic disks all night long. Boston Carpal Tunnel Questionnaire, Symptom Severity Score (SSS), Function Severity Score (FSS), and four parameters measuring the median neural activity were used. These parameters included sensory distal latency, sensory nerve action potential amplitude, motor distal latency, and compound motor action potential amplitude. Among the groups, no significant difference was found in SSS and FSS median nerve conduction. A recovery in symptoms was observed in a 6-week period for SSS and FSS in both groups. The change of symptoms in both magnetic and non-magnetic disc groups occurred in the same direction and size.

In two systematic reviews conduced in 2012 in which magnetic wristbands and several other alternative treatments were examined for arthritis, by citing the lack of enough research on the subject, it was concluded that there was no consistent evidence that it was effective for rheumatoid arthritis and osteoarthritis treatment.

In a study, the effect of static magnetic field on the treatment of delayed onset muscle soreness revealed no difference with that of a placebo.

2.4 Gastrointestinal system

In a study conducted in 2012, neodymium magnets were used to fix endoscopically determined colon tumors. During the laparoscopic surgery performed without tools such as fluoroscopy or ultrasonography, the magnets were used for an easy access to the tumor. The intraoperative localization of marked lesions was successful in 27 (96%) of 28 patients.

In an animal study, ring-shaped magnets were endoscopically used for magnetic compression anastomosis (magnamosis), being placed opposite to each other in the targeted areas. Magnets have also been surgically used in humans; unwanted tissues in the operative area were safely removed using magnetic forceps in 44 laparoscopic operations, including cholecystectomy, gastrojejunostomy, and splenectomy, performed on pediatric patients between 2009 and 2011.

Previous studies on swallowed magnets have documented life-threatening injuries including, fistula and perforation, particularly in children. In two separate studies comparing the number and size of magnets swallowed by children in 2002–2009 and 2010–2012, there was an increase in the number of cases involving more than one magnet and a decrease in the size of the magnet swallowed, but all cases required surgical intervention. This result was attributed to an increase in the availability of magnets to children in everyday life. These findings suggest that the use of magnets rather than safety pins can be particularly harmful for children. North Atlantic American Society for Pediatric Gastroenterology, Hepatology, and Nutrition advocated for the ban on the sale of strong magnets including neodymium, but they stated in 2014 that these efforts were not effective enough.

2.5 Use of magnets in dentistry

Magnets have also been used in orthodontic operations. The outward movement of the buried tooth root in cases of dental fracture can be achieved using magnets in 9–12 weeks. The root reaching out can then be reformed by methods such as porcelain coating. Neodymium magnets are used with coatings as they are not resistant to corrosion and gradual loss of strength.

III. CONCLUSION

Electronic devices are being increasingly used in our lives. Fossil fuels are being replaced by renewable energies, a field that increasingly uses rare earth elements. These elements are used in electric cars and wind turbines. Although procurement challenges and high prices lead producers to seek alternatives, rare earth elements are still being used in numerous technology and Because of their demand, the health effects of these powerful magnets must be addressed along with their environmental impacts.

In this review, the history, definition, and properties of rare earth magnets were briefly explained. Additionally, basing on the results roughly examined from the studies carried out so far, it is concluded that there are effects of magnets, especially neodymium magnets, on body systems, tissues, organs, diseases, and treatments. Although they have been used in various diagnostic devices in the health sector and as therapeutic tools, magnets are potentially harmful to the body and pose increased risk of accident. Despite insufficient studies conducted on the effects of neodymium magnets, they appear to have a great potential for both diagnostic and therapeutic procedures.

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