



ELECTROMAGNETIC DENTISTRY

Dental Science

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ABSTRACT

Pulsed electromagnetic field stimulation is a new technique to encourage bone formation, in growth of bone on dental implants. The electromagnetic waves are invisible radiant energy, which contributes to anxiety and the negative perception of the dental unit chair in close contact with the human body. Electromagnetic field improves cell-biomaterial interactions and antibiotic efficacy in infections.

KEYWORDS

Electromagnetic waves, Electromagnetic hypersensitivity, Electromagnetic Device.

INTRODUCTION

James Clerk Maxwell in 1864 proposed his Dynamical theory of the Electromagnetic field, he observed theoretically that an electromagnetic field disturbance travels in free space with the velocity of light. He conjectured that light is a transverse electromagnetic wave. The first description of how to generate electromagnetic waves other than light was given by Fitz Gerald and Lodge between 1879 and 1883. Hertz radiated and received electromagnetic waves of frequency lower than light. 1

Electromagnetic energy is generated when electricity flows, Electromagnetic waves consist of two components including electric and magnetic fields, propagate in space at the speed of light. The frequency of the electromagnetic wave varies depending on the frequency: very low frequency, low frequency, communication frequency, microwave, infrared, visible, ultraviolet, X-ray and gamma radiation in the order of increasing destructive power. 2
Electromagnetic hypersensitivity is a phenomenon where individuals experience adverse health effects while using or being in the vicinity of devices emanating electric, magnetic or electromagnetic fields (Bergqvist et al. 1997). 3

Extremely low frequency, communication, and microwave radiations, which have weaker destructive power than X-ray or gamma ray, do not have enough destructive power to destroy molecular bonding in cells. Strong electromagnetic waves cause pathological features such as headache, visual loss, leukemia, brain tumor, accumulation of brain waves in the human body, circulatory disorder, male reproductive disorders and cancer. The activity of nerves, cells and hormones in our body is regulated by microscopic electrical signals. When the body is exposed to strong electromagnetic waves, the flow of intercellular ions such as Na^+ and K^+ is disturbed and a physical disorder occurs. Each cell in a living biological tissue is surrounded by medium containing charged particles that freely change position relative to the cell when exposed to external electromagnetic radiation. When human body is exposed to a magnetic field, the melatonin hormone decreases the frequency of carcinogenesis and leads to various diseases such as lethal cell membrane loss and calcium ion pumping. The electromagnetic waves emitted by various electric facilities and electronic products are colorless and odorless, and are not visible to naked eye, the damage is not apparent immediately, and the symptoms worsen. 2

Pulsed electromagnetic fields

Exogenously applied low-frequency, low-energy, pulsed electromagnetic fields accelerate bone repair. They are indicated for patients with muscle-skeletal pain, soft tissue inflammation and wound healing. The membrane of a living cell forms an electrical as well as a chemical barrier that mediates cellular interactions with the external environment that serve as the primary mechanism of field transduction. 4

It has been widely used in hospital settings to promote wound healing and decrease pain and inflammation (Guo, Kubat et al. 2011). Electromagnetic energy has been shown to affect wound healing and to significantly shorten each phase of the process (Bentall 1986; Rawe and Vlahovic 2012). 5

Laser therapy is a modern therapeutic technique that can be effectively used as a complement to traditional mechanical therapy for the treatment of peri-implantitis. Diode lasers have been shown to photobiomodulatory effects promoting wound healing and tissue regeneration. Diode lasers stimulate fibroblasts and osteoblasts, cause increased production of Ribonucleic acid messengers, which leads to significant collagen production during tissue healing. The effect of a magnetic field on the surgical field also has an anti-inflammatory, analgesic, regenerating and accelerating tissue healing effect. Magnetic-laser therapy combines the therapeutic factors widely used in modern medicine: magnetic field, low laser radiation and infrared light radiation. 6

Effect on bone

Matsumoto et al. stated that a pulsed electromagnetic field promotes bone formation around dental implants in animal models by stimulation of osteogenesis include promotion of vascularisation, collagen production and osteogenic cell proliferation and differentiation. 7

Human bone marrow-derived mesenchymal stem cells effect the repair and regeneration of bone when exposed to physical stimuli such as pulsed electromagnetic fields on nanostructured titanium surfaces, improved their differentiation to osteoblasts in osteogenic condition by interfering with selective calcium-related osteogenic pathways osteogenic pathways, such as permeation and regulation of cytosolic and extracellular calcium concentration, and enhanced osteogenic features such as the expression of osteogenic genes and protein production. Low level laser therapy improves and accelerates bone repair within titanium scaffolds and in vitro electromagnetic stimulation helps bone osteoblasts proliferation and extracellular matrix deposition on a titanium plasma-spray surface. Pulsed electromagnetic field affects osteoblast cell proliferation and differentiation of bone tissue by increasing Deoxy Ribonucleic acid synthesis, it enhances during cell differentiation, the expression of bone markers genes and the deposition of a calcified matrix and accelerates extracellular collagen production and bone mineralization. 8

The therapeutic effect of magnetic-laser therapy is manifested by immunomodulatory, anti-inflammatory, regenerative and enjoys from high bactericidal and detoxification effects it is a supportive treatment of peri-implantitis. It useful because of its bactericidal effect, can also accelerate the regeneration processes in the peri-implant area. The protective effect and slow absorption of hyaluronic acid provide reliable and predictable regeneration of augmentate. Barrier function of hyaluronic acid is important in the process of wound healing. It is an effective therapy for treatment of peri-implantitis. 6

Dental amalgam is the predominant tooth filling material in posterior teeth restorations because of its high strength, low cost, durability and ease of manipulation. Lack of chemical adhesion to the tooth structure is one of the amalgam disadvantages which can result in pulp irritation, postoperative pain, secondary caries and tooth discoloration, there is increased release of mercury from dental amalgam fillings after exposure to Magnetic Resonance Imaging or microwave radiation. Increase in microleakage after exposure to X-

ray is due to high energy of the x-ray photons which make chemical changes in the structure of amalgam. These chemical changes can be observed as alterations in chemical metallic bonds which may lead to gap formation leading to microleakage and tooth damage. 9

Electromagnetic devices

The Stomatognathic System is an integrated and coordinated morphofunctional unit, consisting of skeletal, muscular, angiological, nervous, glandular and dental structures that work in harmony to perform different functions such as chewing, swallowing, speaking, breathing, tasting and esthetics. Its study is crucial to achieving a correct maintenance of its normal function or restoration. Electromagnetic Articulography systems record, present and assess articulated structure movement. Due to the influence of electromagnetic fields, a small alternating electric current is induced in the sensors, whose parameters are recorded by the articulograph. All information is arranged in an ordered data matrix stored and exported as a digital binary file, which is processed by software. The digital binary files exported by the articulograph are processed and analyzed in order to obtain geometric (trajectory, distance, area) and kinematic parameters (time, speed) of the recorded movement. By recording each movement separately, it is possible to analyze their characteristics in the different spatial planes and achieve a comprehensive analysis. 10

Electric toothbrushes are widely used because of their convenience. They produce low-frequency electromagnetic fields, which could cause health problems,

e.g. interference with pacemakers. In dental clinics, light-cured resins that are polymerized by curing light sources, which produce low-frequency electromagnetic fields. To prevent curing lights from overheating, cooling fans with electric motors are built into the halogen-type curing lights. The magnetic fields levels of these lights depend on the strengths of the fan electric motors, it is found to be at different levels at the front, back, right and left sides of the brushes, which is likely to be related to the location of the motor or other electrical components inside the toothbrushes. It can induce electric currents in teeth and metallic appliances that are set in the oral cavity. The induced currents produce effects that may have an influence on human health. Magnetic fields from electric toothbrushes induce alternating electric currents in both dental metallic appliances and teeth. Electric currents in oral appliances, e.g. galvanic currents, can cause both discomfort for the user and corrosion of the metallic dental appliances. Rapid geomagnetic variations induce electric currents in power lines and pipelines, which lead to the destruction of power transmission systems and pipeline corrosion. 11

Magnetic resonance imaging

Magnetic resonance imaging was first introduced by Lauterbur. Magnetic fields and radiofrequencies, which are used by electromagnetic detectors to provide electronic images of body protons, are processed by a computer that generates them as digital images. 12

Magnetic resonance imaging is considered a powerful diagnostic method which enables the visualization of soft tissue contrast without the use of ionizing radiation. It creates images using a strong uniform static magnetic field and switching magnetic field gradients with radiofrequency magnetic field pulses. Magnetic susceptibility is an inherent property of matter, originating from its electron structure and is the tendency of a substance to attract magnetic lines of force. 13

There is no exposure to radiation and soft tissues can be visualized when it is used. It can be used as a secondary imaging technique when primary imaging techniques such as complex tomography and Computed Tomography scanning are not satisfactory. The magnetic field strength used is unlikely to cause tissue damage. It is contraindicated for patients with ferromagnetic metallic implants in their bodies because of the potential risks associated with movement or dislodgment of such objects. 12

Older apparatus radiate stronger magnetic field than newer products. Artificial sources of direct fields mainly consist of permanent magnets used for the retention of prostheses, electromagnets from different apparatuses. The source of the magnetic fields of the micromotors is the electromagnets which turn them. Electromagnets are a source of a

relatively small magnetic field and act at small distances, while working they affect the professional personnel by their maximal field. The force of magnetic field decreases with increasing distance from the source of radiation. 14

Summary

Exposure to low frequency electromagnetic field should be achieved by development of dental devices with low magnetic fields generation and keeping the devices away from tooth and metallic appliances as possible and elimination of metallic appliances from oral cavity. New regulatory standards specific to human health, and particularly for the craniocervical region, are also needed in conjunction with the current conventional electromagnetic compatibility standards. Further study is required to clarify the mechanisms by which the electric currents that are induced by electromagnetic fields affect human oral health, and to explore whether countermeasures can be developed to provide methods of protection.

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