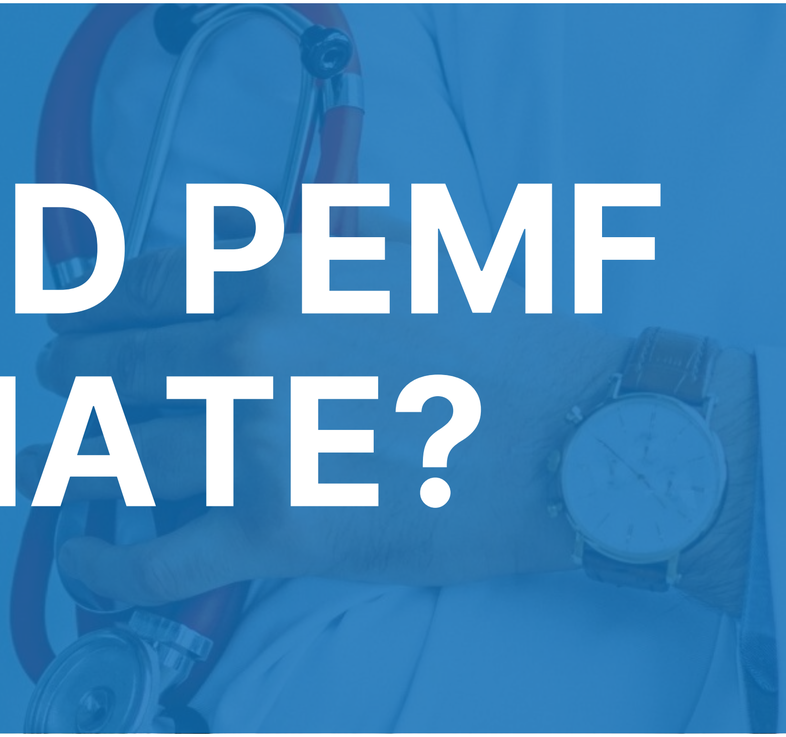
OlyLife

The History and Science of PEMF and Terahertz Waves

WHEN DID PEMF ORIGINATE?



WHEN DID PEMF ORIGINATE?

While PEMF Therapy is currently experiencing tremendous growth and its use is rapidly expanding, it is far from new.

This technology can be traced back to as early as the discovery of "animal electricity" at the end of the 1700s, and less sophisticated magnetic therapies have been utilized by ancient civilizations dating back to as long ago as 4000 BCE.

"Modern use of energy fields to stimulate bone repair actually began ... at the end of the eighteenth century. By the mid-1800s, the preferred method for treating slow-healing fractures was to pass electricity through needles surgically implanted in the fracture region. The technique was banished from medical practice early in the 1900s."

–James L. Oschman, PhD Energy Medicine: The Scientific Basis

As quoted by Dr. Oschman above, PEMF therapy has had a rather debated and thus broken trajectory throughout its long history. There was a significant period of time in the United States when this and related therapies (including not only electric medicine, but also herbalism, osteopathy, and homeopathy) were banned from use after the publication of the 1910 Flexner Report, which drastically changed the American medical system, biasing medical education toward biochemical and surgical models of care.

"American medicine profited immeasurably from the scientific advances that this [post-Flexner] system allowed, but ... [it also] created an imbalance in the art and science of medicine" (Duffy 2011). Physicians were jailed for utilizing electrotherapeutic modalities, institutions were closed down, and the field of electric medicine was stunted (Flexner 1910; Beck 2004).

Through the 1930s, there was a diverse and rich electric medicine presence in, with a variety of modalities being invented, tested, and used in medical care, and with its fair share of controversy to boot. Claims for cures of cancer and mental health illness abounded and the research methods were questioned (see the below timeline for some examples). Tesla's coil and related research and inventions are perhaps one of the more famous forms of PEMF that emerged during this time period. By 1935, electric medicine in the US was largely replaced by what was purported as more evidence-based pharmaceutical and surgical interventions.

"It is fascinating to follow the saga of how the energetic approach to bone healing was discovered, accepted as a therapy, rejected, and reinstated by the medical community."

–James L. Oschman, PhD Energy Medicine: The Scientific Basis

A resurgence of research in the 1960s, particularly related to fracture and bone healing, documented successes, lack of side effects, and energy field mechanisms that led to the FDA's approval for very specific uses: "Pulsed electromagnetic field (PEMF) therapy has been approved by the FDA for treatment of fracture non-unions and for the enhancement of bone formation after lumbar and cervical spine fusion surgery" (Huegel et al, 2018). See also Bassett 1974, 1977, 1978; Oschman 2016; FDA 2020.

However, beyond fractures and bone healing, claims to the efficacy of PEMF are not currently substantiated by the FDA and are even subject to legal proceedings. Hence the disclaimer at the start of this post, and the careful languaging around most PEMF distributors' descriptions of what this modality can be used for.

NASA has also investigated the effects of electromagnetic fields on the human organism and cultured cells. The Space Administration has studied the use of PEMF technology to mitigate the myriad health challenges associated with space travel and microgravity conditions. A 2003 paper investigated the therapeutic effects of time-varying electromagnetic fields (TVEMF) to propagate neural progenitor cells, where an electrode or coil emitted an electromagnetic field into a culture medium. The paper states "In both experimental configurations, the proliferation rate of the TVEMF cells was 2.5 to 4.0 times the rate of the non-waveform cells. Each of the experimental embodiments resulted in similar molecular genetic changes regarding the growth potential of the tissues" (Goodwin et al, 2003). Goodwin and others' research resulted in multiple patents of these electromagnetic field devices that are currently in use. In other NASA reports PEMF technology is cited as an effective countermeasure for bone loss and atrophy (Luttges 1989, Bryerly et al, 2005).

“Development of new systems is being made easier in the US by the recently updated FDA position, allowing PEMF systems to be marketed without FDA approval if their primary purpose is for the management of wellness."

–Dr. William Pawluk, MD

A BRIEF MAGNETISM & PEMF TIMELINE

4000 BCE - People in the Indus Valley's use of lodestones attributed to the treatment of disease (note: lodestones, which are magnetized magnetite (iron oxide), are an example of a magnetic modality, not pulsed electromagnetic fields as in our discussion; however, these examples speak to the ancient use of magnets therapeutically)

2000 BCE - physicians in China developed written protocols for using lodestones on acupuncture points, as described in “The Yellow Emperor’s Book of Internal Medicine.”

Egyptian physicians also used lodestones. There are tales of Cleopatra sleeping on a lodestone bed or wearing a lodestone headband over her third eye center with the intent to preserve her youth.

~400 BCE - The Grecian Hippocrates was reported to use magnets for pain mitigation; headaches in his healing centers were treated with lodestones. Fun fact: magnet refers to the area of Magnesia in Central Greece where lodestones were historically obtained.

1000 CE - Chinese scientists around the year 1000 used lodestones to magnetize iron; these magnetized stones pointed south if floated in a bowl of water; by 1100, these became the first magnetic compasses.

Late 1700 - Franz Mesmer coined 'animal magnetism' and developed a theory based off of the concept that there is a natural transference of energy between all things.

A BRIEF MAGNETISM & PEMF TIMELINE

1800s - Michael Faraday studied electromagnetism, discovered electromagnetic induction, discovered diamagnetism, discovered electrolysis, created the first electromagnetic rotational device which would eventually lead to electric motors. Faraday established through his work and research that a changing magnetic field produces an electric field. “Faraday’s Law” later became one of the four Maxwell equations. Faraday proposed the concept of electromagnetic fields defined as forces extending into the space around a conductor.

Mid 1800s - Slow-to-heal fractures were routinely healed by surgically implanting needles around the fracture site and pulsing electricity through the area.

Late 1800s - Russian engineer Georges Lakhovsky hypothesized that each cell has its own frequency, oscillating at a specific amplitude. Lakhovsky developed a Multiple Wave Oscillator or Radio-Cellulo-Oscillator, which produced a wide range of therapeutic frequencies, from extremely low frequencies (ELF) to gigahertz (GHz) radio waves.

1890s - American Electro-Therapeutic Association conducted annual conferences on the therapeutic use of electricity and electrical devices by physicians on ailing patients.

1890s - Nicola Tesla's inventions included what would be termed the Tesla Coil, with implications as far reaching as power generation to human tissue healing. In an 1898 paper, “High Frequency Oscillators for Electro-Therapeutic and Other Purposes," he stated that one feature of pulsed magnetism was its apparent harmlessness, passing significant amounts of electrical energy through the human body. These Tesla Coils were used to treat the body without contact using pulsed magnetic fields of up to a hundred thousand volts.

A BRIEF MAGNETISM & PEMF TIMELINE

1922 - Alexander Gurwitsch posited that muscle tissues, the cornea, blood, and nerves are all transmitters of “biophotons,” coherent light emitted by animal and plant cells, his work and provided a basis for the design of later bioelectromagnetic therapy devices.

1925 - Georges Lakhovsky published “Curing Cancer with Ultra Radio Frequencies” in Radio News, stating “the amplitude of cell oscillations must reach a certain value, in order that the organism be strong enough to repulse the destructive vibrations from certain microbes.” Lakhovsky's Radio-Cellulo-Oscillator (RCO) produced low frequency ELF.

1929 -The San Diego Union reported on the progress of Dr. Royal Raymond Rife's work in "Local Man Bares Wonders of Germ Life" and in 1938, Dr. Rife, Philip Hoyland and their ray-tube machine were a front-page story in the San Diego Evening Tribune. Rife invented the "Universal Microscope," and later the "Rife Ray Machine," utilizing very high frequencies purported to treat a wide variety of specific pathogens, which he could visualize in his high-powered microscopes. He discovered that organisms have a natural range of refraction to various light environments, suggesting that organisms could be classified and identified by their index of refraction using the Risley prism under the Universal Microscope. His work was highly influential and subjected to litigation, his lab was raided and his microscopes were destroyed.

1932 - at an American Congress of Physical Therapy seminar in New York, Dr. Gustave Kolischer stated: “Tesla’s high-frequency electrical currents are bringing about highly beneficial results in dealing with cancer, surpassing anything that could be accomplished with ordinary surgery.”

1910-1935 - the Flexner Report was published in 1910 and subsequently, all forms of electric medicine, including PEMF and magnetic therapies, were banned from use for a period of time, particularly after 1935. The AMA instead championed pharmaceutical and surgical interventions and discredited less-researched electrotherapeutic modalities

A BRIEF MAGNETISM & PEMF TIMELINE

1924-1950 - Morris Fishbein served as Secretary of the American Medical Association and Chief Editor of the Journal of the American Medical Association. Fishbein labeled natural healers (particularly Native American shamans, midwives, and chiropractors), as “quacks” and members of an “unscientific cult,” also campaigning against cannabis and herbal medicine. Fishbein was a major contributor to the repression of electric medicine during this time period.

1950s - featured a resurgence of medical interest in electrotherapeutic modalities: research centers began again investigating electric and magnetic therapies for fracture non-unions

1960-70s - Italian born scientist Dr. Antoine Priore’s electromagnetic therapy machine was developed and researched in France. His machine involved a complicated mixing of multiple electromagnetic signals in a rotating plasma, modulating output over very strong rippling magnetic field to which the body of the test animal was exposed. He also treated sleeping sickness in rabbits with remarkable results.

1979 - PEMF was approved by the FDA for treatment of fracture non-unions and for the enhancement of bone formation after lumbar and cervical spine fusion surgery

1970s to current - NASA researches and utilizes PEMF in space travel for mitigation of microgravity effects.

1970's - Fritz-Albert Popp coined the term "biophotons" and, building off the work of Royal Raymond Rife and others before him, showed that biophoton emission of living organisms exhibit coherent patterns, that this effect is universal across all living organisms. Popp and Bernard Ruth established a biophysical hypothesis which suggests that biogenic, long distance intercellular communication implies information transmission.

The FDA approved PEMF therapy to heal nonunion fractures in 1979.

1985 - Robert O. Becker's The Body Electric:
Electromagnetism and the Foundation of Life was published, and Becker, Dr. Andrew Bassett, and Dr. Arthur Pilla, developed a PEMF generator to stimulate bone fracture healing, currently approved by the FDA with an 80% success rate.

PEMF therapy was approved for urinary incontinence and muscle stimulation in 1998.

In 2004, the FDA approved pulsed electromagnetic field therapy for cervical fusion surgery patients at high risk for non-fusion.

2004 - FDA allows PEMF use in cervical spine surgeries

PEMF therapy was approved for the treatment of depression and anxiety in 2006.

The FDA approved PEMF therapy for treatment of brain cancer in 2011.

In 2015 the FDA reclassified PEMF machines from Class 3 to Class 2 medical devices. PEMF Complete PEMF therapy systems are FDA registered wellness devices.

2020 - FDA allows PEMF systems to be marketed without FDA approval as long as promoting wellness and not making medical claims.

Currently - the research continues!

PEMF THERAPY RECEIVES FDA APPROVAL

Pulsed electromagnetic field therapy has been an FDA approved form of treatment for almost 40 years. The popularity and awareness of PEMF therapy has increased significantly within the past decade. People are becoming more knowledgeable about the health advantages of PEMF therapy for people as well as PEMF therapy for animals. Now there are studies supporting the use of PEMF therapies in things as diverse as depression, rheumatoid arthritis, large-scale water treatment and sanitization, cervical disc herniations and the stability of dental implants, to name just a few.

How PEMF Regulates The Vagus Nerve Complex And Stress Response: A Comprehensive Guide

Stress, a prevalent and pervasive part of modern life, can negatively impact our physical and mental health. Chronic stress can lead to various health problems, including heart disease, mental disorders, and weakened immune systems. One of the most promising approaches to managing stress and improving overall well-being involves Pulsed Electromagnetic Field (PEMF) therapy.

PEMF has gained scientific recognition for its potential in regulating the Vagus Nerve and the Hypothalamic-Pituitary-Adrenal (HPA) Axis, crucial components in our body's stress response system. This article delves into the mechanisms of PEMF, its impact on the Vagus Nerve and HPA Axis, and its role in stress management.

Understanding Stress and Its Impact On Our Health

Stress, defined as the body's reaction to any change that requires an adjustment or response, can be physical, mental, or emotional. While a certain level of stress is necessary for survival, chronic stress can lead to detrimental health effects.

Chronic stress can cause various physical symptoms such as headaches, muscle aches, and digestive issues. It can also lead to mental health problems like anxiety and depression. The key to managing stress lies in understanding the body's stress response system, particularly the Vagus Nerve and the HPA Axis.

The Vagus Nerve and Its Role in Stress Response

The Vagus Nerve, the longest nerve in the autonomic nervous system, plays a crucial role in the body's stress response. It connects the brain to various organs, including the heart, lungs, and digestive tract, and is responsible for regulating several bodily functions.

When we're under stress, the Vagus Nerve sends signals to the brain to activate the 'fight or flight' response, preparing us to either confront or escape the perceived threat. However, chronic activation of this response can lead to health problems.

Moreover, the Vagus Nerve also plays a role in the 'rest and digest' response, which counteracts the 'fight or flight' response. It lowers heart rate, promotes digestion, and induces a state of calm and relaxation. Hence, maintaining a healthy Vagus Nerve function is crucial for stress management.

The Hypothalamic-Pituitary-Adrenal (HPA) Axis and Stress

The Hypothalamic-Pituitary-Adrenal (HPA) Axis is another essential component of the body's stress response system. It involves a complex set of interactions between the hypothalamus (a part of the brain), the pituitary gland, and the adrenal glands.

When we're under stress, the hypothalamus releases Corticotropin-Releasing Hormone (CRH). This hormone signals the pituitary gland to secrete Adrenocorticotropic Hormone (ACTH), which then triggers the adrenal glands to produce cortisol, the primary stress hormone. Cortisol helps the body respond to stress by increasing glucose levels, suppressing the immune system, and preparing the body for potential injury.

However, chronic stress can lead to an overactive HPA Axis and excessive cortisol production, leading to various health problems like impaired cognitive performance, suppressed thyroid function, and increased abdominal fat.

What is Pulsed Electromagnetic Field (PEMF) Therapy?

Pulsed Electromagnetic Field (PEMF) therapy is a non-invasive, drug-free modality that uses low-frequency electromagnetic fields to enhance cell function, promote healing, and improve overall well-being. It re-energizes the mitochondrial energy inside a cell, revitalizing the body's cells to restore regular cell communication.

PEMF therapy has been supported by numerous scientific studies and has been found effective for various health conditions, including pain, inflammation, and mental health issues. It has also been shown to improve sleep, relaxation, focus, and cognitive function.

How Does PEMF Regulate The Vagus Nerve?

PEMF therapy has been shown to stimulate the Vagus Nerve effectively. The electromagnetic fields produced by PEMF devices can penetrate deep into the body, reaching the Vagus Nerve and influencing its function. By modulating the activity of the Vagus Nerve, PEMF therapy can enhance the 'rest and digest' response, promoting relaxation and reducing stress.

PEMF therapy can also improve Vagal Tone, a measure of the health of the Vagus Nerve. Higher Vagal Tone is associated with better physical and emotional well-being, while lower Vagal Tone is linked to stress, inflammation, and poor cardiovascular health.

By enhancing Vagal Tone, PEMF therapy can improve the body's stress response, promote relaxation, and contribute to overall well-being.

PEMF and Its Effect on The HPA Axis

PEMF therapy can also influence the function of the HPA Axis, helping to regulate the body's stress response. By affecting cellular communication and enhancing the body's healing processes, PEMF can help to modulate cortisol levels and optimize the function of the HPA Axis.

Additionally, PEMF therapy can enhance the body's resilience to stress, helping to prevent the negative effects of chronic stress and excessive cortisol production.

Why Choose PEMF for Stress Management?

Choosing PEMF therapy for stress management offers several advantages:

Scientifically Supported: PEMF therapy is supported by extensive scientific research, demonstrating its effectiveness in managing stress and improving overall well-being.

Non-Invasive and Drug-Free: PEMF therapy is a non-invasive, drug-free modality, making it a safe and natural option for stress management.

Holistic Approach to Wellness: PEMF therapy offers a holistic approach to wellness, targeting both physical and mental aspects of well-being.

Easy to Use: PEMF devices are user-friendly and can be easily incorporated into daily routines.

Conclusion: PEMF therapy offers a promising approach to managing stress and improving overall well-being. By influencing the function of the Vagus Nerve and the HPA Axis, PEMF can help to regulate the body's stress response, promote relaxation, and enhance overall health. It's always recommended to consult with a healthcare professional before starting any alternative therapies.

Frequently Asked Questions

How Does PEMF Therapy Work?

PEMF therapy works by delivering low-frequency electromagnetic fields to the body's cells to enhance cell function and promote healing.

Is PEMF Therapy Safe?

Yes, PEMF therapy is considered safe. However, it's not recommended for individuals with certain conditions, such as pregnancy, tuberculosis, malignancy, or those with implanted electrical devices like pacemakers.

How Long Does It Take for PEMF to Work?

The effects of PEMF therapy can be felt immediately after a session. However, for long-term benefits, regular sessions are recommended.

Can PEMF Therapy Help with Anxiety?

Yes, several research studies suggest that PEMF therapy can help reduce symptoms of anxiety and improve mental health.

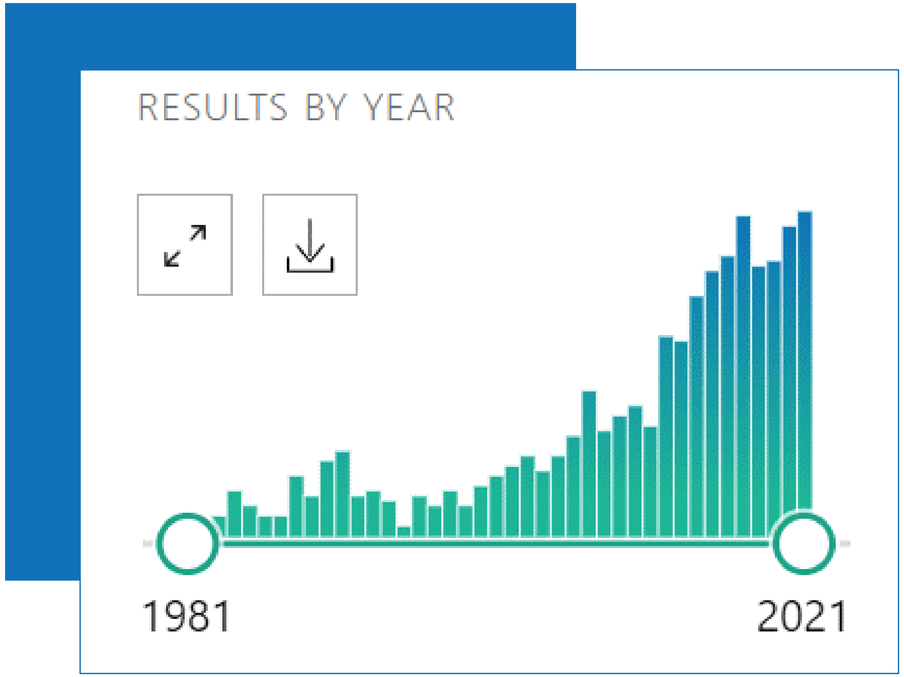
WHAT IS PEMF?

WHAT IS PEMF?

Pulsed Electro-Magnetic Field Therapy is a noncontact, noninvasive, non-pharmacological modality that is used to promote optimal cellular function so that your body can do what it is designed to do: heal.

PEMF and associated therapies do not claim to diagnose, treat or cure any disease.

When we first started to dive into the published literature on Pulsed Electromagnetic Field Therapy (PEMF), we were surprised to learn of its long history and the sheer volume of data that has been published. From historic bone healing (which has been studied since the 1800s) to depression, disc pain to water treatment options, there is a trove of research to explore.



THE DATA (BY YEAR) & SUMMARY

2021

Bademoğlu G, Erdal N, Uzun C, Taşdelen B. The effects of pulsed electromagnetic field on experimentally induced sciatic nerve injury in rats. Electromagn Biol Med. 2021; 40(3):408-419. doi:10.1080/15368378.2021.1907403

ABSTRACT - “Some experimental research indicates that low-frequency pulsed electromagnetic field (PEMF) stimulation may accelerate regeneration in sciatic nerve injury. However, little research has examined the electrophysiological and functional properties of regenerating peripheral nerves under PEMF. The main aim of the present study is to investigate the effects of PEMF on sciatic nerve regeneration in short- and long-term processes with electrophysiologically and functionally after crushing damage. Crush lesions were performed using jewelery forceps for 30 s. After crush injury of the sciatic nerves, 24 female Wistar-Albino rats were divided into 3 groups with 8 rats in each group: SH(Sham), SNI (Sciatic Nerve Injury), SNI+PEMF(Sciatic Nerve Injury+Pulsed Electromagnetic Field). SNI+PEMF group was exposed to PEMF (4 h/day, intensity; 0.3mT, low-frequency; 2 Hz) for 40-days. Electrophysiological records (at the beginning and 1st, 2nd, 4th and 6th weeks post-crush) and functional footprints (at 1st, 2nd, 3rd, 4th, 5th and 6th weeks post crush) were measured from all groups during the experiment. The results were compared to SNI and SNI+PEMF groups, it was found that amplitude and area parameters in the first-week were significantly higher and latency was lower in the SNI+PEMF group than in the SNI group ($p < 0,05$). However, the effect of PEMF was not significant in the 2nd, 4th, 6th weeks. In addition, in the 1st and 2nd weeks, the SSI parameters were significantly higher in SNI+PMF group than SNI group ($p < .05$). These results indicate that low-frequency PEMF is not effective for long-periods of application time while PEMF may be useful during the short-term recovery period.”

Celik C, Franco-Obregón A, Lee EH, Hui JH, Yang Z. Directionalities of magnetic fields and topographic scaffolds synergise to enhance MSC chondrogenesis. Acta Biomater. 2021;119:169-183. doi:10.1016/j.actbio.2020.10.039

THE DATA (BY YEAR) & SUMMARY

ABSTRACT - “We have previously shown that brief, low-amplitude pulsed electromagnetic fields (PEMFs) differentially enhance mesenchymal stem cell (MSC) chondrogenesis in scaffold-free pellet cultures versus conventional tissue culture plastic (TCP), indicating an interplay between magnetism and micromechanical environment. Here, we examined the influence of PEMF directionality over the chondrogenic differentiation of MSCs laden on electrospun fibrous scaffolds of either random (RND) or aligned (ALN) orientations. Correlating MSCs' chondrogenic outcome to pFAK activation and YAP localisation, MSCs on the RND scaffolds experienced the least amount of resting mechanical stress and underwent greatest chondrogenic differentiation in response to brief PEMF exposure (10 min at 1 mT) perpendicular to the dominant plane of the scaffolds (Z-directed). By contrast, in MSC-impregnated RND scaffolds, greatest mitochondrial respiration resulted from X-directed PEMF exposure (parallel to the scaffold plane), and was associated with curtailed chondrogenesis. MSCs on TCP or the ALN scaffolds exhibited greater resting mechanical stress and accordingly, were unresponsive, or negatively responsive, to PEMF exposure from all directions. The efficacy of PEMF-induced MSC chondrogenesis is hence regulated in a multifaceted manner involving focal adhesion dynamics, as well as mitochondrial responses, culminating in a final cellular response. The combined contributions of micromechanical environment and magnetic field orientation hence will need to be considered when designing magnetic exposure paradigms.”

Chan AK, Ballatori A, Nyayapati P, et al. Pulsed Electromagnetic Fields Accelerate Sensorimotor Recovery Following Experimental Disc Herniation. Spine. 2021; 46(4): E222-E233. doi:10.1097/BRS.0000000000003762

ABSTRACT - “These data demonstrate that PEMF accelerates sensorimotor recovery in a rodent model of disc herniation, suggesting that PEMF may be reasonable to evaluate for the clinical management of patients with herniation-associated radiculopathy.”

Li W, Huang C, Ma T, et al. Low-frequency electromagnetic fields combined with tissue engineering techniques accelerate intervertebral fusion. Stem Cell Res Ther. 2021;12(1):143. Published 2021 Feb 17. doi:10.1186/s13287-021-02207-x

THE DATA (BY YEAR) & SUMMARY

ABSTRACT - “EMF accelerated intervertebral fusion by improving the osteogenic capacity of BMSCs seeded on scaffolds and might boost the paracrine function of BMSCs to promote osteogenic differentiation of the homing BMSCs at the injured site. EMF combined with tissue engineering techniques may become a new clinical treatment for LDD.”

Mansourian M, Shanei A. Evaluation of Pulsed Electromagnetic Field Effects: A Systematic Review and Meta-Analysis on Highlights of Two Decades of Research In Vitro Studies. BioMed Research International. July 2021:1-22. doi:10.1155/2021/6647497

ABSTRACT - “According to the obtained data, most of the experiments were carried out on human cells, and out of 2,421 human cell experiments, cell changes were observed in 51.05% of the data. In addition, the results pointed out the potential effects of PEMFs on some human cell types such as MG-63 human osteosarcoma cells (p value < 0.001) and bone marrow mesenchymal stem cells. However, human osteogenic sarcoma SaOS-2 (p < 0:001) and human adipose-derived mesenchymal stem cells (AD-MSCs) showed less sensitivity to PEMFs. Nevertheless, the evidence suggests that frequencies higher than 100 Hz, flux densities between 1 and 10 mT, and chronic exposure more than 10 days would be more effective in establishing a cellular response. This study successfully reported useful information about the role of cell type and signal characteristic parameters, which were of high importance for targeted therapies using PEMFs. Our findings would provide a deeper understanding about the effect of PEMFs in vitro, which could be useful as a reference for many in vivo experiments or preclinical trials.”

"PEMF plays a role in enhancing angiogenesis, and its clinical application may go far beyond the current scope.“

Peng L, Fu C, Wang L, Zhang, Q, Liang Z, He C and Wei Q. The Effect of Pulsed Electromagnetic Fields on Angiogenesis. Bioelectromagnetics. 2021; 42: 250-258. https://doi.org/10.1002/bem.22330

THE DATA (BY YEAR) & SUMMARY

ABSTRACT - “A pulsed electromagnetic field (PEMF) has been used to treat inflammation-based diseases such as osteoporosis, neurological injury, and osteoarthritis. Numerous animal experiments and in vitro studies have shown that PEMF may affect angiogenesis. For ischemic diseases, in theory, blood flow may be richer by increasing the number of blood vessels which supply blood to ischemic tissue. PEMF plays a role in enhancing angiogenesis, and their clinical application may go far beyond the current scope. In this review, we analyzed and summarized the effects and possible mechanisms of PEMF on angiogenesis. Most studies have shown that PEMF with specific parameters can promote angiogenesis, which is manifested by an increased vascular growth rate and increased capillary density. The potential mechanisms consist of promoting vascular endothelial cell proliferation, migration, and tube formation, and increasing the expression level of vascular endothelial growth factor (VEGF), fibroblast growth factor 2 (FGF2), angiopoietin-2 (Ang-2), and other angiogenic growth factors. Additionally, PEMF has an impact on the activation of voltage-gated calcium channels (VGCC).”

Tabakan I, Yuvacı AU, Taştekin B, Öcal I, Pelit A. The healing effect of pulsed magnetic field on burn wounds. Burns. 2021; S0305-4179(21)00154-6. doi:10.1016/j.burns.2021.06.001

ABSTRACT - “In this study, the effect of PEMF on cutaneous wound healing in an animal burn model was evaluated and the dose and duration of the magnetic field should be discussed for this effect to occur. Animals were divided into five groups including eight each (n = 40) (Groups 1, 2, 3, 4, 5).Group 1 was the control group; received no treatment after second-degree burn wound. Group 2 received daily wound care with saline. Group 3 received daily wound care with pomade containing mupirocin. Group 4 received Pulsed Electromagnetic Field signal for 60 min (1.5 m T and 40 Hz for seven days) and Group 5 also received PEMF signal for 60 min the same frequency and intensity for 14 days. Microscopically, second-degree burn wounds were successfully detected in all rats. Histopathological examination results in no significant difference between groups in neutrophil infiltration. The difference between the groups in vascularization was statistically significant between Group II and Group V ($p < 0.001$) and between Group I and Group V ($p = 0.005$) Epithelialization was present in 75% of the rats in Group V, while no epithelialization was observed in any of the other groups. In conclusion, we observed a significant improvement in the stasis zone of the group receiving Pulsed Electromagnetic Field for two weeks.”

THE DATA (BY YEAR) & SUMMARY

Varani K, Vincenzi F, Pasquini S, et al. Pulsed Electromagnetic Field Stimulation in Osteogenesis and Chondrogenesis: Signaling Pathways and Therapeutic Implications. Int J Mol Sci. 2021; 22(2):809. doi:10.3390/ijms22020809

ABSTRACT - “Mesenchymal stem cells (MSCs) are the main cell players in tissue repair and thanks to their self-renewal and multi-lineage differentiation capabilities, they gained significant attention as cell source for tissue engineering (TE) approaches aimed at restoring bone and cartilage defects. Despite significant progress, their therapeutic application remains debated: the TE construct often fails to completely restore the biomechanical properties of the native tissue, leading to poor clinical outcomes in the long term. Pulsed electromagnetic fields (PEMFs) are currently used as a safe and non-invasive treatment to enhance bone healing and to provide joint protection. PEMFs enhance both osteogenic and chondrogenic differentiation of MSCs. Here, we provide extensive review of the signaling pathways modulated by PEMFs during MSCs osteogenic and chondrogenic differentiation. Particular attention has been given to the PEMF-mediated activation of the adenosine signaling and their regulation of the inflammatory response as key player in TE approaches. Overall, the application of PEMFs in tissue repair is foreseen: (1) in vitro: to improve the functional and mechanical properties of the engineered construct; (2) in vivo: (i) to favor graft integration, (ii) to control the local inflammatory response, and (iii) to foster tissue repair from both implanted and resident MSCs cells.”

THE DATA (BY YEAR) & SUMMARY

2020

Alzayed KA, Alsaadi SM. Efficacy of Pulsed Low-Frequency Magnetic Field Therapy on Patients with Chronic Low Back Pain: A Randomized Double-Blind Placebo-Controlled Trial. Asian Spine J. 2020; 14(1):33-42. doi:10.31616/asj.2019.0043 RESULTS: “The treatment group experienced a more rapid improvement in both pain and disability compared with the placebo group. The analysis showed a significant improvement in the pain intensity and disability scores in the treatment group at week 3 ($p < 0.05$), whereas an improvement in the placebo group was detected at week 6. The significant improvement in both groups was sustained for weeks 6, 9, and 13. There was no difference between the groups in scores of pain intensity and disability at weeks 6 and 13.”

"Low-frequency magnetic therapy in complex rehabilitation contributes to the regression of respiratory disorders.“

Bodrova RA, Kuchumova TV, Zakamyrdina AD, et al. Efficacy of Low-Frequency Magnetic Therapy in Patients with COVID-19 Pneumonia. Vopr Kurortol Fizioter Lech Fiz Kult. 2020; 97(6):11-16. doi:10.17116/kurort20209706111

ABSTRACT - “The inclusion of low-frequency magnetic therapy in complex rehabilitation contributes to the regression of respiratory disorders, reduces the level of anxiety and depression, reduces pain and discomfort, thereby improving the patient's quality of life.”

Khami A, Roostayi MM, Parhampour B, Heidari Z, Baharlouei H, Hoorfar H. Effect of Pulsed Electromagnetic Fields on Clinical Signs and Quality of Life in Patients with Hemophilic Arthropathy of the Knee Joint: A Randomized Controlled Trial. Adv Biomed Res. 2020; 9:81. doi:10.4103/abr.abr_244_18

THE DATA (BY YEAR) & SUMMARY

ABSTRACT - “In the PEMF group, a significant difference before and after intervention in terms of clinical signs, QoL, and pain intensity ($P < 0.05$) was founded. Between-group analysis showed a significant improvement in clinical signs (except for atrophy, strength, and swelling duration), QoL, and pain intensity in the PEMF versus control group ($P < 0.05$). PEMF can improve the clinical signs, QoL, and pain intensity of severe hemophilia patients with moderate knee hemophilic arthropathy.”

Cadossi R; Massari L, Racine-Avila J, Aaron RK. Pulsed Electromagnetic Field Stimulation of Bone Healing and Joint Preservation: Cellular Mechanisms of Skeletal Response. JAAOS Global Research & Reviews. 2020; 4(5): e19.00155. doi:10.5435/JAAOSGlobal-D-19-00155.

ABSTRACT - "The US FDA has approved pulsed electromagnetic fields (PEMFs) as a safe and effective treatment for nonunions of bone. Despite its clinical use, the mechanisms of action of electromagnetic stimulation of the skeleton have been elusive. Recently, cell membrane receptors have been identified as the site of action of PEMF and provide a mechanistic rationale for clinical use. This review highlights key processes in cell responses to PEMF as follows: (1) signal transduction through A2A and A3 adenosine cell membrane receptors and (2) dose-response effects on the synthesis of structural and signaling extracellular matrix (ECM) components. Through these actions, PEMF can increase the structural integrity of bone and cartilage ECM, enhancing repair, and alter the homeostatic balance of signaling cytokines, producing anti-inflammatory effects. PEMFs exert a pro-anabolic effect on the bone and cartilage matrix and a chondroprotective effect counteracting the catabolic effects of inflammation in the joint environment. Understanding of PEMF membrane targets, and of the specific intracellular pathways involved, culminating in the synthesis of ECM proteins and reduction in inflammatory cytokines, should enhance confidence in the clinical use of PEMF and the identification of clinical conditions likely to be affected by PEMF exposure."

THE DATA (BY YEAR) & SUMMARY

Kim CH, Wheatley-Guy CM, Stewart GM, Yeo D, Shen WK, Johnson BD. The impact of pulsed electromagnetic field therapy on blood pressure and circulating nitric oxide levels: a double blind, randomized study in subjects with metabolic syndrome. Blood Press. 2020; 29(1):47-54. doi:10.1080/08037051.2019.1649591

CONCLUSION: “PEMF may increase plasma nitric oxide availability and improve blood pressure at rest and during exercise. This beneficial effect appears to be more pronounced in subjects with existing hypertension.”

Larsen ER, Licht RW, Nielsen RE, et al. Transcranial pulsed electromagnetic fields for treatment-resistant depression: A multicenter 8-week single-arm cohort study. Eur Psychiatry. 2020; 63(1): e18. doi:10.1192/j.eurpsy.2020.3

CONCLUSION: “The findings indicate a potential beneficial role of T-PEMF therapy as an augmentation treatment to ongoing pharmacotherapy in treatment-resistant depression.”"PEMFs inhibit neuroinflammation in N9 cells ... and may be relevant to treat a variety of diseases characterized by neuroinflammation.“

Merighi S, Gessi S, Bencivenni S, et al. Signaling pathways involved in anti-inflammatory effects of Pulsed Electromagnetic Field in microglial cells. Cytokine. 2020; 125:154777. doi:10.1016/j.cyto.2019.154777

THE DATA (BY YEAR) & SUMMARY

ABSTRACT - “PEMFs reduced the LPS-increased production of TNF-α and IL-1β in N9 cells, through a pathway involving JNK1/2. Furthermore, they decreased the LPS-induced release of IL-6, by a mechanism not dependent on AC, PLC, PKC-ε, PKC-δ, p38, ERK1/2, JNK1/2, Akt and caspase 1. Importantly, a significant effect of PEMFs in the reduction of crucial cell functions specific of microglia like ROS generation, cell invasion and phagocytosis was found. PEMFs inhibit neuroinflammation in N9 cells through a mechanism involving, at least in part, the activation of JNK MAPK signaling pathway and may be relevant to treat a variety of diseases characterized by neuroinflammation.”

Miller, CP, Prener, M, Dissing, S, Paulson, OB. Transcranial low-frequency pulsating electromagnetic fields (T-PEMF) as post-concussion syndrome treatment. Acta Neurol Scand. 2020; 142: 597– 604. https://doi.org/10.1111/ane.13300

RESULTS: “Compliance was high as all subject completed the full treatment. Two patients however experienced a worsening of their concussion symptoms during the course of treatment. The remaining patients had some discomfort in relation to treatment, mainly headache, but passing and less for each treatment. The majority (n = 5) had a reduction in symptoms overall, up to 61% (2%-61%) based on the Rivermead Post-Concussion Symptoms Questionnaire. Further studies on T-PEMF as a treatment option for post-concussion syndrome are warranted.”

Nayak BP, Dolkart O, Satwalekar P, et al. Effect of the Pulsed Electromagnetic Field (PEMF) on Dental Implants Stability: A Randomized Controlled Clinical Trial. Materials (Basel). 2020; 13(7):1667. Published 2020 Apr 3. doi:10.3390/ma13071667

ABSTRACT - “A pulsed electromagnetic field (PEMF) has been shown to contribute to heightening bone regeneration in a range of clinical areas, including dentistry. Due to the scarcity of studies using PEMF in oral implantology, the present experiment scrutinized the effect of PEMF can lead to improving the stability of the implant.

THE DATA (BY YEAR) & SUMMARY

A total of 19 subjects (40 implants in total) were selected to participate in the current study and were randomly allocated to either the PEMF group or control group. Subjects in the PEMF group received an activated miniaturized electromagnetic device (MED) while the control group received a sham healing cup. Implants stability was assessed by resonance frequency analyses (RFA) via implant stability quotient (ISQ) calculations. RFA were recorded as following: immediately after procedure, and then 2, 4, 6, 8 and 12 weeks later. Radiographic analysis was performed at baseline, 6 and 12 weeks after implant placement. Proinflammatory cytokines were evaluated in peri-implant crevicular fluid (PICF). The PEMF group presented higher ISQ mean values when compared to the control group. The primary stability time frame (the first 2 weeks) MED group depicted an increase in stability of 6.8%, compared to a decrease of 7.6% in the control group related to the baseline. An overall stability increase of 13% was found in MED treated group ($p = 0.02$), in contrast, the overall stability in the control group decreased by 2% ($p = 0.008$). TNF-α concentration during first 4 weeks was lower in the MED treated group. The data strongly suggests that MED generated continuing a PEMF may be considered as a new way to stimulate the stability of the implants at the early healing period.”

"Pulsed electromagnetic field has been shown to contribute to heightening bone regeneration in a range of clinical areas, including dentistry.“

Parate D, Kadir ND, Celik C, et al. Pulsed electromagnetic fields potentiate the paracrine function of mesenchymal stem cells for cartilage regeneration. Stem Cell Res Ther. 2020; 11(1):46. Published 2020 Feb 3. doi:10.1186/s13287-020-1566-5

ABSTRACT - “The findings reported here demonstrate that PEMF stimulation is capable of modulating the paracrine function of MSCs for the enhancement and re-establishment of cartilage regeneration in states of cellular stress. The PEMF-induced modulation of the MSC-derived paracrine function for directed biological responses in recipient cells or tissues has broad clinical and practical ramifications with high translational value across numerous clinical applications.”

THE DATA (BY YEAR) & SUMMARY

Qiu XS, Li XG, Chen YX. Pulsed electromagnetic field (PEMF): A potential adjuvant treatment for infected nonunion. Med Hypotheses. 2020;136:109506. doi:10.1016/j.mehy.2019.109506

ABSTRACT - “Infected nonunion is still a challenge for orthopaedic surgeons. The goal of treatment is to eliminate infection and achieve bone union. Surgery is the only effective method currently. However, it is invasive and the results are still unsatisfactory. Therefore, seeking a noninvasive and effective method to resolve infected nonunion is necessary. Pulsed electromagnetic field (PEMF) has been used for the treatment of nonunion for more than 40 years. PEMF could promote bone formation at tissue, cell and subcellular levels. Furthermore, our study showed that PEMF had bactericidal effect. The hypothesis we proposed herein is that PEMF may be an adjuvant treatment for infected nonunion by controlling infection and inducing bone formation.”

Ross C, Overholt T, Xu R, et al. Pulsed electromagnetic field (PEMF) as an adjunct therapy for pain management in interstitial cystitis/bladder pain syndrome [published online ahead of print, 2021 Jun 8]. Int Urogynecol J. 2021; 10.1007/s00192-021-04862-3. doi:10.1007/s00192-021-04862-3

ABSTRACT - “The use of PEMF has been evaluated as a therapeutic strategy for pain management in several clinical scenarios. Randomized, double-blinded, placebo-controlled trials have reported positive efficacy and safety profiles when PEMF was used to treat non-specific low back pain, patellofemoral pain syndrome, chronic post-operative pain, osteoarthritis-related pain, rheumatoid arthritis-related pain, and fibromyalgia-related pain. Based on these positive outcomes in a variety of pain conditions, clinical trials to evaluate whether PEMF can provide a safe, non-invasive therapeutic approach to improve symptoms of chronic pain and fatigue in patients with IC/BPS are warranted.”

THE DATA (BY YEAR) & SUMMARY

Tai YK, Ng C, Purnamawati K et al. Magnetic fields modulate metabolism and gut microbiome in correlation with Pgc-1α expression: Follow-up to an in vitro magnetic mitohormetic study. The FASEB Journal. 2020; 34: 11143– 11167. https://doi.org/10.1096/fj.201903005RR

ABSTRACT - "The combination of PEMFs and exercise for 6 weeks enhanced running performance and upregulated muscular and adipose Pgc-1α transcript levels, whereas exercise alone was incapable of elevating Pgc-1α levels. The gut microbiome Firmicutes/Bacteroidetes ratio decreased with exercise and PEMF exposure, alone or in combination, which has been associated in published studies with an increase in lean body mass. After 2 months, brief PEMF treatment alone increased Pgc-1α and mitohormetic gene expression and after >4 months PEMF treatment alone enhanced oxidative muscle expression, fatty acid oxidation, and reduced insulin levels. Hence, short-term PEMF treatment was sufficient to instigate PGC-1α-associated transcriptional cascades governing systemic mitohormetic adaptations, whereas longer-term PEMF treatment was capable of inducing related metabolic adaptations independently of exercise.“

Tenuta, M, Tarsitano, MG, Mazzotta, P, et al. Therapeutic use of pulsed electromagnetic field therapy reduces prostate volume and lower urinary tract symptoms in benign prostatic hyperplasia. Andrology. 2020; 8: 1076–1085. https://doi.org/10.1111/andr.12775

RESULTS: “PEMF was able to reduce PV after 28 days of therapy. Symptoms improved in a short time, with high compliance and no effects on hormonal and sexual function or any side effects. Patients with moderate-severe LUTS and without MetS seem to benefit more from this treatment.”

"PEMF therapy has clinically significant effects on pain in patients with osteoarthritis.“

THE DATA (BY YEAR) & SUMMARY

Yang X, He H, Ye W, Perry TA, He C. Effects of Pulsed Electromagnetic Field Therapy on Pain, Stiffness, Physical Function, and Quality of Life in Patients With Osteoarthritis: A Systematic Review and Meta-Analysis of Randomized Placebo-Controlled Trials. Phys Ther. 2020;100(7):1118-1131. doi:10.1093/ptj/pzaa054

IMPACT: "Our study suggests that PEMF therapy has clinically significant effects on pain in patients with OA. The current evidence was limited to the short-term effects of PEMF therapy.“

2019

Alvarez LX, McCue J, Lam NK, Askin G, Fox PR. Effect of Targeted Pulsed Electromagnetic Field Therapy on Canine Postoperative Hemilaminectomy: A Double-Blind, Randomized, Placebo-Controlled Clinical Trial. J Am Anim Hosp Assoc. 2019; 55(2):83-91. doi:10.5326/JAAHA-MS-6798

ABSTRACT - “The present prospective, double-blind, placebo-controlled trial evaluated targeted PEMF therapy administered to 53 client-owned dogs who underwent hemilaminectomy for naturally occurring disk extrusion intervertebral disc disease … Dogs receiving PEMF therapy following postoperative hemilaminectomy demonstrated improved wound scores at 6 wk and reduced mean number of owner-administered pain medications compared with the control group therapy.”

Cottrill E, Pennington Z, Ahmed AK, et al. The effect of electrical stimulation therapies on spinal fusion: a cross-disciplinary systematic review and meta-analysis of the preclinical and clinical data. J Neurosurg Spine. 2019; 1-21. doi:10.3171/2019.5.SPINE19465

THE DATA (BY YEAR) & SUMMARY

CONCLUSIONS: “The authors found that electrical stimulation devices may produce clinically significant increases in arthrodesis rates among patients undergoing spinal fusion. They also found that the pro-arthrodesis effects seen in preclinical studies are also found in clinical populations, suggesting that findings in animal studies are translatable. Additional research is needed to analyze the cost-effectiveness of these devices.”

Galli C, Pedrazzi G and Guizzardi S. The cellular effects of Pulsed Electromagnetic Fields on osteoblasts: A review. Bioelectromagnetics. 2019; 40: 211-233. https://doi.org/10.1002/bem.22187

ABSTRACT - "Electromagnetic fields (EMFs) have long been known to interact with living organisms and their cells and to bear the potential for therapeutic use. Among the most extensively investigated applications, the use of Pulsed EMFs (PEMFs) has proven effective to ameliorate bone healing in several studies, although the evidence is still inconclusive. This is due in part to our still-poor understanding of the mechanisms by which PEMFs act on cells and affect their functions and to an ongoing lack of consensus on the most effective parameters for specific clinical applications. The present review has compared in vitro studies on PEMFs on different osteoblast models, which elucidate potential mechanisms of action for PEMFs, up to the most recent insights into the role of primary cilia, and highlight the critical issues underlying at least some of the inconsistent results in the available literature.“

"A significant improvement was found in the neck pain, disability, depression, anxiety, and quality of life scores of both [physical therapy and PEMF] groups after treatment when compared to those before treatment.“

Hattapoğlu E, Batmaz İ, Dilek B, Karakoç M, Em S, Çevik R. Efficiency of pulsed electromagnetic fields on pain, disability, anxiety, depression, and quality of life in patients with cervical disc herniation: a randomized controlled study. Turk J Med Sci. 2019; 49(4):1095-1101. doi:10.3906/sag-1901-65

THE DATA (BY YEAR) & SUMMARY

RESULTS: "A significant improvement was found in the neck pain, disability, depression, anxiety, and quality of life scores of both groups after treatment when compared to those before treatment. However, in the comparison between changes within groups, significant improvements were determined only in the VAS and Nottingham Health Profile sleep subparameter in the 12th week after treatment compared to those before treatment. PEMF therapy in cervical disc herniation can be used safely in routine treatment in addition to conventional physical therapy modalities.“

Ehnert, Sabrina; Schröter, Steffen; Aspera-Werz, Romina H.; Eisler, Wiebke; Falldorf, Karsten; Ronniger, Michael; Nussler, Andreas K. Translational Insights into Extremely Low Frequency Pulsed Electromagnetic Fields (ELF-PEMFs) for Bone Regeneration after Trauma and Orthopedic Surgery. Journal of Clinical Medicine. 2019; 8(12): 2028. doi:10.3390/jcm8122028.

ABSTRACT - "The finding that alterations in electrical potential play an important role in the mechanical stimulation of the bone provoked hype that noninvasive extremely low frequency pulsed electromagnetic fields (ELF-PEMF) can be used to support healing of bone and osteochondral defects. This resulted in the development of many ELF-PEMF devices for clinical use. Due to the resulting diversity of the ELF-PEMF characteristics regarding treatment regimen, and reported results, exposure to ELF-PEMFs is generally not among the guidelines to treat bone and osteochondral defects. Notwithstanding, here we show that there is strong evidence for ELF-PEMF treatment. We give a short, confined overview of in vitro studies investigating effects of ELF-PEMF treatment on bone cells, highlighting likely mechanisms. Subsequently, we summarize prospective and blinded studies, investigating the effect of ELF-PEMF treatment on acute bone fractures and bone fracture non-unions, osteotomies, spinal fusion, osteoporosis, and osteoarthritis. Although these studies favor the use of ELF-PEMF treatment, they likewise demonstrate the need for more defined and better controlled/monitored treatment modalities. However, to establish indication-oriented treatment regimen, profound knowledge of the underlying mechanisms in the sense of cellular pathways/events triggered is required, highlighting the need for more systematic studies to unravel optimal treatment conditions."

THE DATA (BY YEAR) & SUMMARY

"Our findings suggest a potential role for the pulsed EMF for the amelioration of cognition impairment.“

Li Y, Zhang Y, Wang W, et al. Effects of pulsed electromagnetic fields on learning and memory abilities of STZ-induced dementia rats. Electromagn Biol Med. 2019; 38(2):123-130. doi:10.1080/15368378.2019.1591437

ABSTRACT - “Our findings indicate that the pulsed EMF exposure can improve the ability of learning and memory in STZ-induced dementia rats and this effect may be related to the process of IGF signal transduction, suggesting a potential role for the pulsed EMF for the amelioration of cognition impairment.”

Malling ASB, Morberg BM, Wermuth L, Gredal O, Bech P, Jensen BR. The effect of 8 weeks of treatment with transcranial pulsed electromagnetic fields on hand tremor and inter-hand coherence in persons with Parkinson's disease. J Neuroeng Rehabil. 2019; 16(1):19. Published 2019 Jan 31. doi:10.1186/s12984-019-0491-2

ABSTRACT - “The T-PEMF treatment decreased the inter-hand coherence in the PD group with unilateral postural tremor. The PD group with unilateral postural tremor was less clinically affected by the disease than the PD group with bilateral postural tremor. However, no differences between T-PEMF and placebo treatment on either intensity related or coherence related measures were found when all persons with PD were included in the analyses. The peak power decreased and the tremor intensity tended to decrease in both treatment groups.”

Miyamoto H, Sawaji Y, Iwaki T, Masaoka T, Fukada E, Date M and Yamamoto K. Intermittent pulsed electromagnetic field stimulation activates the mTOR pathway and stimulates the proliferation of osteoblast-like cells. Bioelectromagnetics. 2019; 40: 412-421. https://doi.org/10.1002/bem.22207

THE DATA (BY YEAR) & SUMMARY

ABSTRACT - “Continuous PEMF stimulation induced a transient phosphorylation of the mTOR pathway, whereas intermittent PEMF stimulation (1 cycle of 10 min stimulation followed by 20 min of stimulation pause) revitalized the reduced phosphorylation. Moreover, PEMF stimulation stimulated cell proliferation (bromodeoxyuridine incorporation) rather than differentiation (alkaline phosphatase activity), with a more notable effect in the intermittently stimulated cells. These results suggest that intermittent PEMF stimulation may be effective in promoting bone fracture healing by accelerating cell proliferation, and in shortening stimulation time.”

Mohammad Alizadeh MA, Abrari K, Lashkar Blouki T, Ghorbanian MT, Jadidi M. Pulsed electromagnetic field attenuated PTSD-induced failure of conditioned fear extinction. Iran J Basic Med Sci. 2019; 22(6):650-659. doi:10.22038/ijbms.2019.32576.7797

RESULTS: “Using 14-day PEM attenuates the PTSD-induced failure of conditioned fear extinction and exaggerated sensitized fear, and this might be related to the neuroprotective effects of magnetic fields on the hippocampus.”

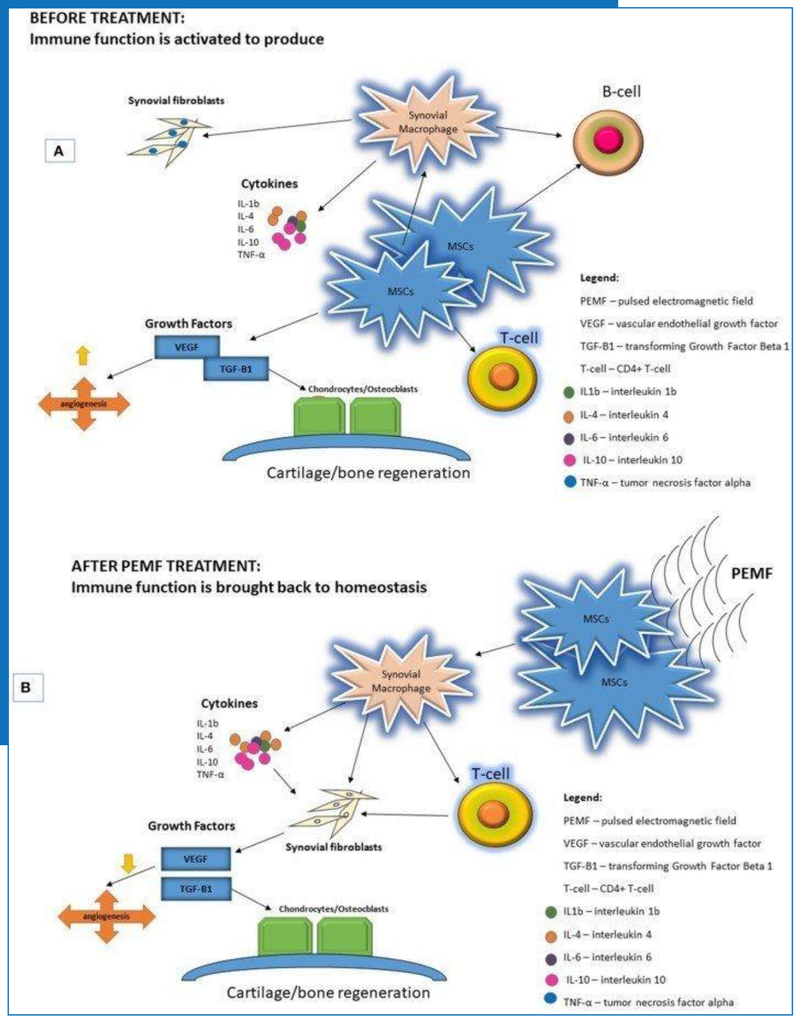
Ross CL, Ang DC, Almeida-Porada G. Targeting Mesenchymal Stromal Cells/Pericytes (MSCs) With Pulsed Electromagnetic Field (PEMF) Has the Potential to Treat Rheumatoid Arthritis. Front Immunol. 2019; 10:266. doi:10.3389/fimmu.2019.00266

ABSTRACT - “Rheumatoid arthritis (RA) is a systemic autoimmune disease characterized by chronic inflammation of synovium (synovitis), with inflammatory/immune cells and resident fibroblast-like synoviocytes (FLS) acting as major players in the pathogenesis of this disease. The resulting inflammatory response poses considerable risks as loss of bone and cartilage progresses, destroying the joint surface, causing joint damage, joint failure, articular dysfunction, and pre-mature death if left untreated. At the cellular level, early changes in RA synovium include inflammatory cell infiltration, synovial hyperplasia, and stimulation of angiogenesis to the site of injury. Different angiogenic factors promote this disease, making the role of anti-angiogenic therapy a focus of RA treatment.

THE DATA (BY YEAR) & SUMMARY

“While recent evidence reports that MSCs found in joint tissues can differentiate to repair damaged tissue, this repair function can be repressed by the inflammatory milieu. Extremely-low frequency pulsed electromagnetic field (PEMF), a biophysical form of stimulation, has an anti-inflammatory effect by causing differentiation of MSCs. PEMF has also been reported to increase the functional activity of MSCs to improve differentiation to chondrocytes and osteocytes. Moreover, PEMF has been demonstrated to accelerate cell differentiation, increase deposition of collagen, and potentially return vascular dysfunction back to homeostasis. The aim of this report is to review the effects of PEMF on MSC modulation of cytokines, growth factors, and angiogenesis, and describe its effect on MSC regeneration of synovial tissue to further understand its potential role in the treatment of RA.”

Ross CL, Zhou Y, McCall CE, Soker S, Criswell TL. The Use of Pulsed Electromagnetic Field to Modulate Inflammation and Improve Tissue Regeneration: A Review. Bioelectricity. 2019; 1(4):247-259. doi:10.1089/bioe.2019.0026



THE DATA (BY YEAR) & SUMMARY

ABSTRACT - “Pulsed electromagnetic field (PEMF) is emerging as innovative treatment for regulation of inflammation, which could have significant effects on tissue regeneration. PEMF modulates inflammatory processes through the regulation of pro- and anti-inflammatory cytokine secretion during different stages of inflammatory response. Consistent outcomes in studies involving animal and human tissue have shown promise for the use of PEMF as an alternative or complementary treatment to pharmaceutical therapies. Thus, PEMF treatment could provide a novel nonpharmaceutical means of modulating inflammation in injured tissues resulting in enhanced functional recovery. This review examines the effect of PEMF on immunomodulatory cells (e.g., mesenchymal stem/stromal cells [MSCs] and macrophages [MΦ]) to better understand the potential for PEMF therapy to modulate inflammatory signaling pathways and improve tissue regeneration. This review cites published data that support the use of PEMF to improve tissue regeneration. Our studies included herein confirm anti-inflammatory effects of PEMF on MSCs and MΦ.”

"These results further establish PEMFs anti-inflammatory activity, and may inform potential future clinical uses for management of inflammation associated with disc degeneration.“

Tang X, Coughlin D, Ballatori A, et al. Pulsed Electromagnetic Fields Reduce Interleukin-6 Expression in Intervertebral Disc Cells Via Nuclear Factor-κβ and Mitogen-Activated Protein Kinase p38 Pathways. Spine (Phila Pa 1976). 2019; 44(22):E1290-E1297. doi:10.1097/BRS.0000000000003136

CONCLUSION: “Our data indicate that the previously-reported inhibitory effect of PEMF treatment on disc inflammation is mediated by NF-κβ and phosphorylated p38-MAPK signaling pathways. These results further establish PEMFs anti-inflammatory activity, and may inform potential future clinical uses for management of inflammation associated with disc degeneration.”

THE DATA (BY YEAR) & SUMMARY

2018

Gaynor JS, Hagberg S, Gurfein BT. Veterinary applications of pulsed electromagnetic field therapy. Res Vet Sci. 2018; 119:1-8. doi:10.1016/j.rvsc.2018.05.005

ABSTRACT - “Pulsed electromagnetic field (PEMF) therapy can non-invasively treat a variety of pathologies by delivering electric and magnetic fields to tissues via inductive coils. The electromagnetic fields generated by these devices have been found to affect a variety of biological processes and basic science understanding of the underlying mechanisms of action of PEMF treatment has accelerated in the last 10 years. Accumulating clinical evidence supports the use of PEMF therapy in both animals and humans for specific clinical indications including bone healing, wound healing, osteoarthritis and inflammation, and treatment of post-operative pain and edema. While there is some confusion about PEMF as a clinical treatment modality, it is increasingly being prescribed by veterinarians. In an effort to unravel the confusion surrounding PEMF devices, this article reviews important PEMF history, device taxonomy, mechanisms of action, basic science and clinical evidence, and relevant trends in veterinary medicine. The data reviewed underscore the usefulness of PEMF treatment as a safe, non-invasive treatment modality that has the potential to become an important stand-alone or adjunctive treatment modality in veterinary care.”

Sorrell RG, Muhlenfeld J, Moffett J, Stevens G, Kesten S. Evaluation of pulsed electromagnetic field therapy for the treatment of chronic postoperative pain following lumbar surgery: a pilot, double-blind, randomized, sham-controlled clinical trial. J Pain Res. 2018; 11:1209-1222. Published 2018 Jun 22. doi:10.2147/JPR.S164303

RESULTS: “PEMF therapy (42-μs pulse width) was associated with trends for a reduction in pain, compared to sham treatment. Secondary endpoints were consistent with an overall beneficial effect of the PEMF 42-μs pulse width device.”

THE DATA (BY YEAR) & SUMMARY

Huegel J, Choi DS, Nuss CA, et al. Effects of pulsed electromagnetic field therapy at different frequencies and durations on rotator cuff tendon-to-bone healing in a rat model. J Shoulder Elbow Surg. 2018; 27(3):553-560. doi:10.1016/j.jse.2017.09.024

RESULTS: "Overall, our results suggest that PEMF therapy has a positive effect on rat rotator cuff healing for each electromagnetic fundamental pulse frequency and treatment duration tested in this study."

Piyadasa C, Yeager TR, Gray SR, Stewart MB, Ridgway HF, Pelekani C and Orbell JD. Antimicrobial effects of pulsed electromagnetic fields from commercially available water treatment devices – controlled studies under static and flow conditions. J. Chem. Technol. Biotechnol. 2018; 93: 871-877. https://doi.org/10.1002/jctb.5442

ABSTRACT - “The effect of the electromagnetic fields generated by the same two commercial devices on the bacterial culturability of Escherichia coli and Pseudomonas fluorescens under flow conditions has been contrasted with previous static results. It has been found that the effectiveness of PEMF exposure depends on waveform, extent of flow, type of bacteria and PEMF exposure duration.”

"Our data suggest that PEMF may have a role in the clinical management of patients with chronic low back pain.“

"Tang X, Alliston T, Coughlin D, Miller S, Zhang N, Waldorff EI, Ryaby JT and Lotz JC. Dynamic imaging demonstrates that pulsed electromagnetic fields (PEMF) suppress IL-6 transcription in bovine nucleus pulposus cells. J Orthop Res. 2018; 36: 778-787. https://doi.org/10.1002/jor.23713

THE DATA (BY YEAR) & SUMMARY

ABSTRACT - “Imaging and PCR data demonstrated that the inductive effect of IL-1α on IL-6 expression could be significantly inhibited by PEMF treatment in a time-dependent manner (early as 2 h of stimulus initiation). Our data suggest that PEMF may have a role in the clinical management of patients with chronic low back pain. Furthermore, this study shows that the MS2-tagged GFP reporter system is a useful tool for visualizing the dynamic events of mechanobiology in musculoskeletal research.”

Terahetz - All about the Hertz

The Dawning Age of Terahertz in Science and Medicine

The field of science and medicine is continually evolving, with new technological advancements and discoveries pushing the boundaries of our understanding. One such area of exploration is the use of Terahertz (THz) frequencies and Pulsed Electromagnetic Field (PEMF) therapies. This article delves into the rising significance of Terahertz and PEMF frequencies in science and medicine, focusing on the legitimacy they are gaining within the scientific community.

The Emergence of Terahertz

Terahertz, often abbreviated as THz, refers to electromagnetic waves within the frequency range of 0.1 to 10 THz. Terahertz frequencies sit at the intersection of microwaves and infrared waves on the electromagnetic spectrum, representing an untapped region of potential scientific exploration.

The Power of Terahertz Frequencies

Terahertz frequencies possess unique properties that make them enticing for scientific and medical applications. These frequencies can penetrate a wide range of non-conducting materials such as clothing, paper, and plastic, enabling non-destructive probing of hidden objects. The non-ionizing nature of Terahertz radiation also makes it safe for biological tissues, opening up possibilities for medical imaging and therapeutic applications.

Pulsed Electromagnetic Field (PEMF) Therapy

PEMF therapy is a non-invasive approach that uses magnetic fields to stimulate the body's healing process. It involves directing powerful, pulsed energy waves towards damaged or injured areas of the body.

The Role of PEMF in Medicine

PEMF therapy has been found beneficial in treating various medical conditions. It has been used to promote wound healing, bone repair, and pain relief. The therapy has also shown promise in managing depression and anxiety.

The Intersection of Terahertz and PEMF Frequencies

Terahertz and PEMF frequencies, though different in nature, share common ground in their application in medicine and science. Both have the potential to revolutionize diagnostic and therapeutic techniques, paving the way for non-invasive and more efficient treatment modalities.

Terahertz in Medical Imaging

Terahertz technology holds significant promise in the field of medical imaging. Its ability to differentiate between healthy and diseased tissue could lead to improved detection of cancers and other diseases. Moreover, since Terahertz radiation is non-ionizing, it poses less risk to patients compared to traditional imaging methods like X-rays.

PEMF in Biofield Therapy

PEMF is emerging as a prominent player in biofield therapy, a field of medicine that manipulates the energy fields around the body to stimulate healing. The bio-electromagnetic nature of PEMF aligns with the idea of the human 'biofield,' and studies suggest that PEMF therapy can modulate these biofields, leading to improved health outcomes.

The Growing Legitimacy of Terahertz and PEMF Frequencies

The rise of Terahertz and PEMF frequencies in scientific and medical fields is backed by a growing body of research attesting to their potential benefits. As more studies provide empirical evidence of their efficacy, these technologies are slowly gaining acceptance and legitimacy within the scientific community.

Scientific Studies Supporting Terahertz

Numerous studies have demonstrated the potential of Terahertz radiation in various scientific applications. Researchers have explored its use in spectroscopy, imaging, and telecommunications, among others. The body of evidence supporting the utility and safety of Terahertz radiation continues to grow, bolstering its legitimacy in the scientific community.

Clinical Trials and PEMF Therapy

Similarly, PEMF therapy has been the subject of multiple clinical trials, with results indicating its effectiveness in managing pain, promoting wound healing, and enhancing overall well-being. These findings have contributed to the growing acceptance of PEMF therapy in mainstream medicine.

Overcoming Hurdles: The Path to Widespread Acceptance

Despite their potential, Terahertz and PEMF technologies face several challenges that hinder their widespread adoption. These include technical difficulties in generating and detecting Terahertz radiation, lack of standardized protocols for PEMF therapy, and skepticism from parts of the scientific and medical community.

Standardization and Skepticism in PEMF Therapy

PEMF therapy, on the other hand, faces the challenge of standardization. The lack of standardized treatment protocols hampers the consistency and reproducibility of results. Additionally, skepticism from some healthcare professionals often stems from a lack of understanding or exposure to this form of therapy.

The Future of Terahertz and PEMF Frequencies in Science and Medicine

The future of Terahertz and PEMF frequencies in science and medicine looks promising. As technology advances and our understanding deepens, these frequencies are poised to revolutionize our approach to diagnostics and treatment.

Terahertz Technology: An Untapped Resource

As technological advancements make Terahertz radiation more accessible, its applications in science and medicine will likely proliferate. From non-invasive cancer detection to high-speed wireless communication, the untapped potential of Terahertz frequencies is immense.

PEMF Therapy: A New Paradigm in Healing

Similarly, PEMF therapy is poised to become a key player in the future of medicine. As more healthcare professionals recognize its benefits and more patients seek non-invasive and drug-free treatment options, PEMF therapy could usher in a new paradigm in healing.

Conclusion

The rising significance of Terahertz and PEMF frequencies in science and medicine marks an exciting era of discovery and innovation. As these fields continue to evolve, they hold the promise of transforming our understanding of human health and disease, leading to more effective and personalized treatment strategies. The journey towards their widespread acceptance and application may be challenging, but the potential benefits make it a journey worth pursuing.

Unveiling the Potential and Benefits of Terahertz Waves

1. History of Terahertz Waves:

The journey of Terahertz waves begins with their theoretical discovery by physicist Erwin Schrödinger in 1926. However, it wasn't until the mid-20th century that technological advancements allowed for their experimental exploration. The first direct detection of THz waves occurred in 1962 when researchers successfully observed these waves emitted by molecular gases. Over subsequent decades, advancements in THz wave generation, detection, and manipulation technologies have propelled this field into the forefront of scientific research.

2. Properties of Terahertz Waves:

Terahertz waves possess distinctive properties that make them particularly intriguing for various applications. They exhibit a non-ionizing nature, meaning they do not carry enough energy to ionize atoms or molecules, making them safe for biological applications. Moreover, THz waves can penetrate various materials, including clothing, plastics, and biological tissues, opening up opportunities for non-invasive imaging and sensing.

3. Terahertz Waves in Imaging and Sensing:

One of the most prominent applications of Terahertz waves is in imaging and sensing. Due to their ability to penetrate materials, THz waves enable non-invasive imaging of hidden structures, such as concealed weapons, pharmaceutical tablets, and even art beneath layers of paint. In the medical field, THz imaging holds promise for detecting skin cancers and monitoring hydration levels in tissues.

4. Advancements in Health and Wellness:

In recent years, researchers have explored the potential health and wellness benefits of Terahertz waves, extending beyond traditional applications. The following sections delve into how THz waves can positively impact various aspects of human health.

5. Stress Reduction and Cognitive Enhancement:

Preliminary studies suggest that exposure to Terahertz waves may have stress-reducing effects and enhance cognitive function. The non-invasive nature of THz waves makes them an attractive candidate for exploring their potential in promoting relaxation and mental clarity. Incorporating THz wave technologies into wellness practices or therapeutic environments may contribute to stress management and cognitive enhancement.

6. Skin Health and Wound Healing:

Terahertz waves have shown promise in promoting skin health and wound healing. Research indicates that THz exposure can influence cellular processes related to collagen production and tissue regeneration. This has implications for dermatological applications, wound care, and cosmetic

interventions aimed at improving skin conditions.

7. Musculoskeletal Health:

Terahertz waves may play a role in addressing musculoskeletal issues, such as bone density improvement and tendon regeneration. Preliminary studies suggest that THz exposure can stimulate osteoblast activity, contributing to bone health, and promote cellular regeneration in connective tissues. These findings open avenues for exploring THz technologies in the context of orthopedic and rehabilitation practices.

8. Immunomodulation and Disease Management:

Emerging research suggests that Terahertz waves may have immunomodulatory effects, influencing the activity of immune cells. This opens up possibilities for exploring THz technologies in disease management and immune system support. While this area is in the early stages of investigation, the potential applications for immunomodulation hold promise for enhancing overall health and well-being.

9. Cardiovascular Health Improvement:

Terahertz waves have shown potential in improving cardiovascular health by influencing blood flow and endothelial function. Studies suggest that THz exposure can enhance vasodilation, reduce inflammation, and contribute to better overall cardiovascular function. This has implications for managing conditions such as hypertension and promoting heart health.

10. Respiratory Health Support:

Preliminary research indicates that Terahertz waves may have applications in respiratory health. THz exposure could potentially influence lung function and respiratory conditions. While this area is in the early stages of exploration, the non-invasive nature of THz waves makes them a candidate for investigating respiratory health support, especially in conditions like asthma and chronic obstructive pulmonary disease (COPD).

11. Neurological Disorders and Cognitive Decline:

Terahertz waves have been studied for their potential neuroprotective effects, suggesting applications in addressing neurological disorders and cognitive decline. While the understanding of these effects is still evolving, the exploration of THz technologies in neurology holds promise for conditions such as Alzheimer's disease and other neurodegenerative disorders.

12. Pain Management and Analgesic Effects:

Terahertz exposure has been associated with analgesic effects, providing a potential avenue for pain management. The modulation of neural pathways and influence on neurotransmitters could contribute to pain relief. Exploring the use of THz waves in complementary pain management strategies may offer non-pharmacological alternatives for individuals dealing with chronic pain.

13. Metabolic Support and Weight Management:

Research suggests that Terahertz waves may influence metabolic processes, opening up possibilities for applications in weight management. The potential to modulate cellular energy production and metabolic rate indicates that THz technologies could play a role in addressing obesity-related health issues and supporting overall metabolic health.

14. Menstrual Health and Reproductive Well-being:

Terahertz waves have been explored for their effects on cellular processes, including those related to reproductive health. While still in the early stages of investigation, THz exposure may offer insights into applications for menstrual health and reproductive well-being. This area holds potential for addressing conditions such as dysmenorrhea and supporting women's reproductive health.

15. Enhanced Nutrient Absorption and Digestive Health:

Terahertz waves may play a role in enhancing nutrient absorption and promoting digestive health. The potential to influence cellular processes in the

gastrointestinal tract suggests applications in addressing nutrient deficiencies and supporting digestive well-being. This could be particularly relevant for individuals with malabsorption issues or gastrointestinal disorders.

16. Holistic Stress Management Programs:

Terahertz waves, with their stress-reducing effects, can be integrated into holistic stress management programs. Combining THz technologies with mindfulness practices, relaxation techniques, and lifestyle interventions may create comprehensive stress management programs. This holistic approach addresses not only physical but also mental and emotional well-being.

17. Antimicrobial Properties:

Preliminary studies suggest that Terahertz waves may possess antimicrobial properties. Research indicates that THz exposure could influence bacterial and viral activity. While further investigation is needed, this potential opens up avenues for exploring Terahertz technologies in antimicrobial applications, supporting infection control and immune system health.

17. Vision and Ophthalmic Health:

17.1 Ocular Surface Health:

PEMF devices have shown promise in promoting ocular surface health. By influencing cellular processes and supporting the maintenance of a healthy tear film, PEMF applications may contribute to alleviating dry eye symptoms and enhancing overall ocular surface well-being. This benefit is particularly relevant for individuals experiencing discomfort due to digital device use or environmental factors.

17.2. Ocular Blood Flow Improvement:

PEMF applications have been studied for their potential to improve blood circulation, and this property extends to ocular blood flow. Enhanced blood circulation can support the delivery of nutrients and oxygen to the eyes, promoting overall ocular health. This benefit may be particularly relevant for

individuals at risk of conditions associated with compromised blood flow, such as retinal artery or vein occlusions.

17.3. Visual Fatigue Reduction:
In the digital age, visual fatigue due to prolonged screen time is a common concern. PEMF devices, with their stress-reducing effects and potential impact on ocular surface health, may contribute to reducing visual fatigue. Integrating PEMF into eye care routines may be beneficial for individuals who spend extended periods on digital devices.

17.4. Neuroprotection for Optic Nerve Health:
Terahertz waves and PEMF have shown neuroprotective effects in various contexts. In the realm of eye health, this property may be relevant for preserving optic nerve health. Protecting the optic nerve from damage or degeneration is crucial for maintaining vision, and the neuroprotective potential of THz and PEMF technologies adds a layer of preventative care.

17.5. Reduced Inflammation and Ocular Allergies:
Both Terahertz waves and PEMF have demonstrated anti-inflammatory effects. In the context of eye health, this property can be beneficial for individuals with ocular allergies or inflammatory conditions. By modulating inflammation, these technologies may contribute to reducing redness, itching, and discomfort associated with allergic reactions or inflammatory responses in the eyes.

18. Sports Medicine and Performance Optimization:
Terahertz waves may find applications in sports medicine for injury prevention and performance optimization. The potential to support tissue regeneration and enhance muscle function could be beneficial for athletes. THz technologies may contribute to the development of non-invasive interventions in sports rehabilitation and performance enhancement.

19. Addiction and Behavioral Disorders Support:

The modulation of neural pathways by Terahertz waves suggests potential applications in addressing addiction and behavioral disorders. While still in the early stages of investigation, THz technologies could be explored as complementary tools in addiction recovery programs and behavioral therapy, contributing to improved mental health outcomes.

20. Hair and Scalp Health:

Terahertz waves have been studied for their potential effects on hair and scalp health. THz exposure may influence cellular processes related to hair growth and scalp conditions. This could lead to applications in dermatology and cosmetology, offering non-invasive approaches to promoting healthy hair and scalp.

21. Cancer Detection and Treatment Support:

Terahertz wave imaging has shown promise in detecting certain types of cancer. THz radiation interacts differently with cancerous and healthy tissues, allowing for potential applications in early cancer detection. Additionally, THz waves may play a role in cancer treatment support by contributing to targeted therapies and monitoring treatment responses.

22. Sleep Disorders Management:

Terahertz waves, with their potential influence on sleep patterns, may find applications in managing sleep disorders. THz exposure could be explored as a non-pharmacological intervention for improving sleep quality and addressing conditions such as insomnia and sleep-related disorders.

23. Respiratory and Allergic Conditions:

Terahertz waves may have applications in respiratory health beyond general support. THz technologies could be investigated for their potential in managing respiratory and allergic conditions, providing non-invasive interventions for individuals dealing with asthma, allergies, and related disorders.

24. Anti-Aging and Skin Rejuvenation:

Terahertz waves, with their potential effects on collagen production and tissue regeneration, may find applications in anti-aging and skin rejuvenation. THz exposure could contribute to cosmetic interventions aimed at promoting youthful skin and addressing age-related skin changes.

25. Cognitive Enhancement for Learning and Memory:

Terahertz waves have been explored for their potential cognitive-enhancing effects, including improvements in learning and memory. Research suggests that THz exposure may influence synaptic plasticity, contributing to enhanced cognitive function. This opens up possibilities for applications in educational settings, supporting students in memory retention and cognitive tasks.

26. Enhanced Supplement Delivery and Pharmacotherapy:

Terahertz waves may play a role in improving nutrient and supplement delivery methods. THz technologies could assist in optimizing supplement formulations, enhancing supplement absorption rates, and contributing to more effective integration of all nutritional prodcuts. This has implications for personalized medicine and the development of targeted natural health product delivery systems.

27. Psychological Therapies and Mental Well-being:

Beyond stress reduction, Terahertz waves could be integrated into psychological therapies to support mental well-being. The potential calming effects of THz exposure may complement therapeutic interventions for anxiety disorders, mood disorders, and other mental health conditions, enhancing the overall effectiveness of psychological treatments.

28. Accelerated Physical Rehabilitation:

Terahertz waves may contribute to accelerated physical rehabilitation by promoting tissue regeneration and reducing inflammation. This can be particularly beneficial in orthopedic rehabilitation settings, where faster healing of muscles, tendons, and ligaments is crucial for optimal recovery and improved mobility.

.29. Regenerative Medicine Support:

The regenerative properties of Terahertz waves make them relevant in the field of regenerative medicine. THz exposure could support cellular regeneration and tissue engineering efforts, contributing to advancements in regenerative therapies for organ repair and replacement.

30. Mental Performance Optimization in Athletes:

Athletes seeking to optimize their mental performance could benefit from Terahertz wave applications. THz exposure may have neuroenhancing effects, potentially improving focus, reaction times, and cognitive performance. This has implications for sports psychology and training strategies to enhance athletic achievements.

31. Terahertz Waves: The Energetic Resonance of Fire:

Terahertz waves, a form of electromagnetic radiation, have captured the attention of researchers for their unique properties. It is intriguing to draw parallels between the qualities attributed to the Fire element in Chinese medicine and the potential effects of Terahertz waves on the human body. Much like the warming and transformative nature of fire energy, Terahertz waves are explored for their ability to penetrate tissues and influence cellular processes non-invasively.

32. Clearing the Lymphatic System:

In Chinese medicine, the lymphatic system is often associated with the Metal element, responsible for maintaining boundaries and eliminating waste. However, the purifying influence of the Fire element is also pertinent to the lymphatic system. Terahertz waves, with their ability to penetrate tissues, hold the potential to stimulate lymphatic flow and assist in the removal of toxins and waste products. This resonates with the Chinese medicine philosophy of promoting smooth energy circulation and eliminating stagnation.

33. Powering the Kidneys:

The kidneys, essential in Chinese medicine for their role in storing vital essence (Jing) and supporting overall vitality, benefit from the warmth and transformative energy akin to the Fire element. Terahertz waves, by influencing cellular processes and potentially enhancing blood circulation, may contribute to the energetic balance associated with kidney function. This aligns with the holistic approach of Chinese medicine, where the harmonious interplay of elements is crucial for optimal health.

The benefits of Terahertz waves in health and wellness are extensive and diverse, spanning cognitive enhancement, drug delivery optimization, psychological therapies, radiation-free medical imaging, accelerated rehabilitation, regenerative medicine support, mental performance optimization in athletes, , and therapeutic applications in neurological disorders. As research and technological advancements continue, the potential for Terahertz wave applications in improving human health we'll continue to see more and more applications to everyday problems with profound outcomes.

Terahertz Science

Terahertz Science

Terahertz waves used to regenerate severed spinal cords in rats:

Results:

After THz irradiation, the inflammatory response, the behavioral function, and the severity of SCI recovered well, indicating that THz irradiation can effectively promote the repair of SCI. GO and KEGG results show that genes related to inflammation, immune regulation, and IL-17 signaling pathway may play an important role in this process.

Conclusions:

THz irradiation can effectively promote the repair of SCI. Genes related to inflammation, immune regulation, and IL-17 signaling pathway may play an important role in this process.

https://pubmed.ncbi.nlm.nih.gov/36702395/

Scientific Explanation of Terahertz

More to Light than Meets the Eye

Light carries information in ways you may not realize. Cell phones use light to send and receive calls and messages. Wireless routers use light to send pictures of cats from the internet to your computer. Car radios use light to receive music from nearby radio stations. Even in nature, light carries many kinds of information.

The electromagnetic spectrum describes all the wavelengths of frequency, both seen and unseen. The light we can see, made up of the individual colors of the rainbow, represents only a very small portion of the electromagnetic spectrum. Most of the light in the universe is invisible to our eyes.

Light travels in waves, much like the waves you find in the ocean. As a wave, light has several basic properties that describe it. One of which is frequency. On one end of the electromagnetic spectrum are radio waves, which have wavelengths billions of times longer than those of visible light. On the other end of the spectrum are gamma rays, with wavelengths billions of times smaller than those of visible light.

In between these are what's known as the "terahertz" frequency range, or "THz Gap". It is called a "gap" because the technology for its generation and manipulation is still in its infancy. This band of electromagnetic frequency lies within the region between microwave and far-infrared.

Almost every molecule has a 'fingerprint' spectrum in the terahertz frequency range. Terahertz frequency is non-ionizing, meaning it doesn't cause harm like ionizing radiation. Ionizing radiation has a higher frequency and shorter wavelength than non-ionizing radiation, and can be a serious health hazard: exposure to it can cause burns, radiation sickness, many kinds of cancer, and genetic damage. Non-ionizing terahertz frequency is safe as opposed to ionizing radiation/frequency.

How Does It Work?

Frequency Determines Physiology

Our bodies are made up of an array of materials. Beyond the organic flesh and blood that first come to mind lie the inorganic crystalline-based mineral structures.

The skin is the body's largest organ. The dermis comprises a dense network of mechanoreceptors, in addition to nerve endings that penetrate the epidermis and together provide the senses of touch, pressure, vibration, pain, and heat. It works as the body's thermoregulator, controlling blood flow within a few millimeters of the body surface and aids the sense of balance to modulate posture and gait.

The way in which the Terahertz frequency vibrations travel through our crystalline structures within us determines the fundamental properties of the material, i.e., you!

Piezoelectricity is the electric charge that accumulates in certain solid materials—such as crystals, certain ceramics, and biological matter such as bone, DNA, and various proteins—in response to applied mechanical stress.

The word piezoelectricity means electricity resulting from pressure and latent heat.

The Terahertz frequency vibrates at the same molecular level as our DNA, RNA, and Proteins thus influencing our health in a positive manner.

Hydro-Electric Machines

Just as the earth is roughly 70% water, so too are our bodies. There can be no doubt that water is life. In addition, we have over 100 “ion channels” in the human body that relay information in the form of frequency. They synchronize an array of biological processes, (such as Ca2+, Na+, K+ -ATPase) thus maintaining membrane voltage.

“Water is the driving force of all nature.” - Leonardo da Vinci

“If you want to find the secrets of the universe, think in terms of energy, frequency, and vibration.” - Nikola Tesla

One of the ways the Terahertz Frequency works is through hydrogen bonds and water channels called aquaporins. The water around proteins absorbs more terahertz than pure water, which helps our proteins fold correctly.

The correct folding of proteins is essential for cellular homeostasis and the prevention of disease.

Molecular vibrations of hydrogen bonds in proteins are important because they regulate the function of proteins. The capacity of DNA, RNA, and Proteins to catalyze energetic reactions in the body and convey information depends on their vibrational states accessible using TERAHERTZ.

IN OTHER WORDS, You are a Hydro-Electric Being, and terahertz DIVINE FREQUENCY targets these mechanisms in you!

The Terahertz DNA Damage Response

The prime objective for every life form is to deliver its genetic material, intact and unchanged, to the next generation. This must be achieved despite

constant assaults by endogenous and environmental agents on the DNA.

To counter this threat, life has evolved several systems to detect DNA damage, signal its presence and mediate its repair. Such responses, which impact a wide range of cellular events, are biologically significant because they prevent diverse human diseases.

Studies show that terahertz frequency waves enhance hydrogen bond vibrations leading to openings between the DNA strands.

This then triggers the DNA Damage Response (DDR).

This is a good thing because it triggers a reaction that upregulates genes and pathways that actually guard your genome, such as the gene called P53.

How does this work?

Water is well known as a substance of the highest importance for the stability and functioning of biological macromolecules. Deoxyribonucleic acid (DNA) is not an exception.

Terahertz stimulus allows for breaks in the hydrogen bonds on DNA inducing the DNA Damage Response.

Each of the 10 trillion cells in the human body receives tens of thousands of DNA lesions per day. These lesions can block genome replication and transcription, and if they are not repaired or are repaired incorrectly, they lead to mutations or wider-scale genome aberrations that threaten our health.

Terahertz frequency induces a short duration of the DNA Damage Response which initiates DNA Repair to take place.

Heat Therapy

Heat therapy works by improving circulation and blood flow to a particular area due to increased temperature. Increasing the temperature of the afflicted area even slightly can soothe discomfort and increase muscle flexibility. Heat therapy can relax and soothe muscles and assist the body to help heal damaged tissue.

“Those who cannot be cured by medicine can be cured by surgery. Those who cannot be cured by surgery can be cured by fire [hyperthermia]. Those who cannot be cured by fire, they are indeed incurable.” — Hippocrates

Applying heat to a body part stimulates blood circulation to the injury site. This oxygen-rich blood brings nutrients to the affected area, promoting healing. Heat also helps to remove lactic acid buildup from overtaxed muscles, which allows them to “un-clench.“

“If there’s a way to heat the bones, then all diseases can be treated.” — Hippocrates

Researchers have discovered that heat applied to the bone keeps stem cells healthy. The enhanced activity of the heat helps rebalance the cells’ state of equilibrium or homeostasis. The recovery of protein homeostasis by enhanced heat activation was shown in both mouse and human hematopoietic stem cells. Protein damage impairs stem cells during aging and likely contributes to disrupting blood and immune cell production in older people.

In summary, the Terahertz frequency enhances hydrogen bond vibrations leading to enhanced protein folding and induces the DNA Damage Response which triggers the expression of the “Guardian of the Genome” P53. It also synchronizes an array of hydro-electrical voltage properties such as Aquaporin water channels, Ca2+, Na+, K+ -ATPase ion channels thus maintaining membrane voltage. Our body and cells need a specific amount of energy (or voltage) to work. Without proper voltage, your body can't heal. Finally, the heat application using the Terahertz Device has been shown in research to assist the body in the healing process.

Terahertz modulated infrared radiation in the complex treatment of patients in the acute period of ischemic stroke

https://pubmed.ncbi.nlm.nih.gov/34223749/

“"Results: The inclusion in the complex treatment of IR radiation with THz modulation on the projection of the IS focus in the acute period contributed to a significant regression of neurological deficit, a complete recovery of cognitive functions and an increase in daily activity due to the restoration of adequate blood supply on the side of the affected hemisphere."

Advances of terahertz technology in neuroscience: Current status and a future perspective

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8683584/

In this study they stimulated the Bai Hui acupuncture point on the top of the head, which is one of the most critical areas for regulating neurovascular activity.

Results "Patients in the THz group regained consciousness and resolved neurological symptoms faster than those in the control group.“

The complex correction of the pathophysiological disorders in the patients presenting with orthopedic and traumatological problems with the application of the electromagnetic waves of the terahertz range at the radiation frequencies of nitric oxide

https://pubmed.ncbi.nlm.nih.gov/30499487/

“Experimental and clinical studies have shown that a skeletal trauma causes a whole complex of pathophysiological disorders, both local and systemic.

“Experimental and clinical studies have shown that a skeletal trauma causes a whole complex of pathophysiological disorders, both local and systemic. The main factors determining the severity of the trauma, as well as the nature of the course of the post-traumatic period, are the degree of hypoxia (acidosis), hypercoagulation and immune disorders. To influence these pathophysiological disorders in the patients presenting the with skeletal traumas, various approaches have been proposed, including the use of antihypoxants and antioxidants, the methods and means for the stimulation and support of the immune system, medications to regulate hemostasis. According to the literature publications, terahertz-frequency therapy is presently regarded as a promising method the minimally invasive interference in the metabolic processes proceeding in the tissues of the musculoskeletal system. The analysis of the literature data and clinical observations indicate that electromagnetic waves of the terahertz range are efficient in the treatment of many chronic diseases when applied both as monotherapy and in combination with other physical methods and medications strengthening and consolidating the therapeutic effect of the latter. The electromagnetic waves of the terahertz range are currently used in medicine as a biophysical factor for the correction of the microcirculatory disorders. It has been shown that the use of these waves for the combined restorative treatment of the patients suffering fractures of the limb bones not only improves the dynamics of fracture consolidation symptoms but also contributes to the prevention of posttraumatic complications (thrombosis, ossification of soft tissues). However, the experience with the application of the electromagnetic waves of the terahertz range waves in clinical traumatology and orthopedics is rather modest. The analysis of the results of fundamental research and experience with the application of electromagnetic waves in the terahertz range has shown that the systemic effects produced by the waves of this range promote the correction of such pathophysiological disorders as hypoxia, hypercoagulation, and impaired immunity. Given that these disorders develop during the post-traumatic period in the patients presenting with severe multiple and combined traumas, it can be assumed that the use of electromagnetic waves of the terahertz range for the the combined treatment of these patients provides a very promising tool for the stimulation of the reparative processes especially bearing in mind that the first results described in the literature, look quite optimistic. The investigation into the mechanisms regulating the regenerative capacity of connective tissue, the creation of the scientifically-sound foundations for its management with the help of the modern electronics devices is a promising task for the developers of the new biomedical technologies.”

Exposure Effects of Terahertz Waves on Primary Neurons and Neuron-like Cells Under Nonthermal Conditions

https://www.besjournal.com/article/doi/10.3967/bes2019.094

THz Wave Exposure Affects Neurotransmitters

In this study significant decreases in glutamate were observed while significant increases in glycine and alanine occurred after Terahertz exposure.

Glutamate excitotoxicity

In excitotoxicity, nerve cells suffer damage or death when the levels of otherwise necessary and safe neurotransmitters such as glutamate become pathologically high, resulting in excessive stimulation of receptors. For example, when glutamate receptors such as the NMDA receptor or AMPA receptor encounter excessive levels of the excitatory neurotransmitter, glutamate, significant neuronal damage might ensue.

Again, THZ waves decrease glutamate!

Glutamate excitotoxicity may be involved in cancers, spinal cord injury, stroke, traumatic brain injury, hearing loss (through noise overexposure or ototoxicity), and in neurodegenerative diseases of the central nervous system such as multiple sclerosis, Alzheimer's disease, amyotrophic lateral sclerosis (ALS), Parkinson's disease, alcoholism, alcohol withdrawal or hyperammonemia and especially over-rapid benzodiazepine withdrawal, and also Huntington's disease. Other common conditions that cause excessive glutamate concentrations around neurons are hypoglycemia.

Increased extracellular glutamate levels leads to the activation of Ca2+ permeable NMDA receptors on myelin sheaths and oligodendrocytes, leaving oligodendrocytes susceptible to Ca2+ influxes and subsequent excitotoxicity

Glycine

In the brain, glycine is inhibitory, which helps to calm and heal the brain. Glycine improves sleep, reduces anxiety, and improves cognition. Glycine assists GABA.

Alanine

Alanine has consistently demonstrated that it increases neurotrophins in the hippocampus of the brain, such as BDNF, which has an anti-anxiety effect and relates to higher brain function. Alanine can also increase brain carnosine concentrations which further increases GABA.

The brain is considered one of the most sensitive organs to electromagnetic radiation. In 2011, a case-control study of 221 central nervous system tumors showed that occupational exposure to extremely low frequency electromagnetic fields might play a role in the occurrence of meningioma. In 2017, a review summarized many recent observations of harmful effects in the brain associated with mobile phone electromagnetic field exposure, and the results of several studies indicated an increase in cortical excitability with EMF exposure.

In the brain, the most important mechanism of synaptic transmission is neurochemical transmission, which requires neurotransmitters. Neurotransmitters bind to corresponding postsynaptic membranes and change the excitation states of neurons. Neurotransmitters include excitatory neurotransmitters and inhibitory neurotransmitters. Glu depolarizes the postsynaptic membrane to produce excitatory postsynaptic currents (EPSCs), while Gly and Ala cause postsynaptic membrane hyperpolarization to produce inhibitory postsynaptic currents (IPSCs).

Quantum Quorum Sensing

Quantum Quorum Sensing

E. coli aggregation and impaired cell division after terahertz irradiation

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8516962/

Researchers found that E. coli aggregation and impaired cell division occurred after terahertz irradiation. THz radiation was shown to have adverse effects on bacterial populations.

Prospects for the study of biological systems with high power sources of terahertz radiation

https://indico.elettra.eu/event/22/contributions/118/attachments/20/38/Prospects%20for%20the%20study%20of%20biological%20systems%20with%20high%20power%20sources%20of%20terahertz%20radiation.pdf

Bacteria are sensitive to sound and also emit sound and, in an extension of the Frohlich hypothesis, Norris and Hyland have shown that these results can be explained in terms of intercellular integration mediated by THz modes.

They suggest that enzymes can emit radiation in this range and that the chromosomes that receive these waves alter gene activity. They identify a particular subunit of RNA polymerase as a candidate for the emitter of electromagnetic waves in the sender bacterial population.

A Multiphysics Modeling of Electromagnetic Signaling Phenomena at kHz-GHz Frequencies in Bacterial Biofilms

https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9749281

Besides natural THz emission by biological organs, the THz frequency band has also been examined extensively for intra-body communication networks and sensing applications.

The self-assembly process of the amyloid nanofibers of bacteria biofilms involves backbone hydrogen bonding, to which the THz frequency has been shown extensively to have the ability to modulate.

The charged nanofibrils can vibrate due to thermal motions, variable stresses and potentially due to some metabolic processes and consequently they radiate detectable EM waves. Thus, amyloid nanofibrils potentially play a role as nanoscale antennas capable of emitting and receiving the EM signals replicating some of the metallic and semiconducting assemblies.

These charged amyloid nanofibrils may play the role of mechanical antennas within biofilms to which the THz frequency wave may alter. As a result of this, EM signals will be created at the frequency and harmonics of the cell's resonant vibration frequencies. The intensity of the induced electric field is proportional to the vibration amplitude of the nanonanofibril.

Terahertz vibrational properties of water nanoclusters relevant to biology

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3285730/

Terahertz Charged water creates Buckyball water which helps proteins fold correctly.

"Dynamic Jahn–Teller coupling of these "hydrated-electron" orbitals to the THz vibrations promotes such water clusters as vibronically active "structured water" essential to biomolecular function such as protein folding. In biological microtubules, confined water-cluster THz vibrations may induce their

“quantum coherence” communicated by Jahn–Teller phonons via coupling of the THz electromagnetic field to the water clusters’ large electric dipole moments.

Prominent among the magic-number water clusters that have been identified are ones having the “buckyball-like” pentagonal dodecahedral structure.

While liquid water is not usually thought of as an “active” substance, hydrated-electron water nanoclusters are another matter, due to the effectively large reactive cross sections of the cluster “surface” molecular orbitals.

Pentagonal water clusters have been experimentally identified as being key to the hydration and stabilization of biomolecules [1, 2]. Such examples indicate the tendency of water pentagons to form closed geometrical structures at biomolecular interfaces including amino acids (Fig. 5) and nucleotides (DNA, RNA).

The “restructuring” or clustering of water molecules may even determine biological cell architecture [20]. Approximately 70% of the human body is water by weight. Much of that water is believed to be restructured or nanostructured [2], which affects biomolecular processes including protein stability, enzyme activity, and proton transfer. Some diseases (e.g., Alzheimer’s, Parkinson’s, type II diabetes, and cataracts) are associated with the “misfolding” of proteins. Water—“restructured” as nanoclusters of the above-described type—plays a key role in the proper folding of proteins. The misfolding of proteins, making them dysfunctional and disease-causing, is likely associated with the failure of water molecules to congregate in clusters that properly interact with the protein. The development of drugs to treat such diseases should therefore be focused on the restoration of water clustering at the protein interfaces. Water cluster “surface” THz vibrational modes like the ones shown above are especially important because they couple or “resonate” with THz-frequency “bending” vibrations of the amino-acid residues in proteins.

This may lead to the “quantum coherence” or “Bose–Einstein-like” condensation of interacting water clusters confined to microtubules.

While the human body is 70% water by weight, the normal human brain is approximately 90% water. It is possible that this quantum-coherent dynamical Jahn–Teller system of water clusters and the quantized THz electromagnetic field confined within the hollow inner cores of brain microtubules may be relevant to conscious thought processes, consistent with controversial ideas promoted by Hameroff and Penrose."

"This could lead to important applications in nanotech and biotech areas, including drug delivery where researchers can "imprison" the polar drug molecules inside a hollow structure.“

Use of Terahertz Electromagnetic Waves for Correcting Hemostasis Functions (Blood Clots)

https://link.springer.com/article/10.1007/s10527-010-9145-1

“No considerable changes in the faulty indicators of hemostasis and fibrinolysis were observed for 5-min exposure duration. In case of 15-min exposure, partial normalization of indicators characterizing the coagulation cascade and fibrinolysis was observed. The influence of terahertz radiation on the specified frequencies within 30 min caused full normalization of hemocoagulation and fibrinolysis as the studied indicators of a coagulation link of the system of hemostasis and fibrinolysis.

A 30-min exposure proved to be especially effective for restoration of the indicators of hemocoagulation and fibrinolysis activity of blood.”

Terahertz Light Pulses Change Gene Expression in Stem Cells

https://www.technologynetworks.com/genomics/news/terahertz-light-pulses-change-gene-expression-in-stem-cells-341483

“Terahertz pulses can generate a strong electric field without touching or damaging cells,” says Hirori. “We tested their effect on iPSCs and discovered

that the activity of some gene networks changes as a result of terahertz light exposure.”

For example, they found the pulses activated genes involved in motor neuron survival and mitochondrial function. They also deactivated genes involved in cell differentiation, the process in which stem cells change into specialized body cells.

Further investigation found that these genes were influenced by zinc-dependent transcription factors. The scientists believe the terahertz pulses generate an electric field that causes zinc ions to move inside cells, impacting the function of transcription factors, which in turn activate or deactivate the genes they are responsible for.

Hirori says the findings could aid efforts to develop a technology that can manipulate iPSC differentiation into specific cells by turning off specific genes while keeping others on, paving the way for regenerative therapies for a wide range of diseases.

Water Dynamics in the Hydration Shells of Biomolecules

https://pubs.acs.org/doi/10.1021/acs.chemrev.6b00765

Terahertz (THz) directly affects DNA by amplifying natural vibrations (the so-called "breathing" mode) of the hydrogen bonds that bind together the two strands of DNA. As a result, "bubbles" or openings in DNA strands form inducing a short DNA Damage Response, which then calls up DNA Repair mechanisms.

THz photons, like their longer wavelength cousins in the microwave range, are not energetic enough to break the chemical bonds that bind DNA together in the nucleus of cells. These waves, however, have just the right frequency to energize water molecules, causing them to vibrate and produce heat. The hydrogen bond network is generally considered to play an important role in the thermodynamic properties of water.

In a first-of-its-kind study, the Canadian researchers exposed laboratory-grown human skin tissue to intense pulses of THz electromagnetic radiation and have detected the telltale signs of DNA damage through a chemical marker known as phosphorylated H2AX. At the same time, they observed THz-pulse-induced increases in the levels of multiple tumor suppressors and cell-cycle regulatory proteins that facilitate DNA repair.

Energy exchange between a biomolecule and its hydration shell plays a central role in both the relaxation of excitations and the energetics of biochemical reactions.

One primary function of the hydration shell in the first aspect of this exchange consists in accepting vibrational energy and affecting its equilibration in space and time.

In other words, when terahertz frequency vibrates the hydration shell of a cell/molecule/DNA etc, it assists them in their proper intended function.

THz exposure affects primary hippocampus neuron gene expression via alternating transcription factor binding

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8221933/

The frequency of THz waves matches the vibration of biomolecules, which may excite the energy levels of vibration and rotation of biological macromolecules, resulting in changes of molecular conformation and affecting the interactions among other biological macromolecules.

Recently, Tachizaki et al. reported that the gene networks in human induced pluripotent stem cells could be altered by THz irradiation. They found that many of those altered genes were regulated by zinc-dependent transcription factors.

In the study they found 1199 genes were up-regulated and 1170 were down-regulated by THz irradiation.

Use of terahertz electromagnetic radiation at nitric oxide frequencies for the correction of thyroid functional state during stress

https://www.semanticscholar.org/paper/Use-of-terahertz-electromagnetic-radiation-at-oxide-Vf-Aa/a8a3b822bc1a5b02731fa7c60b95a860a3cb0e84

Terahertz Normalizes Thyroid

“It is shown that terahertz radiation totally normalizes thyroid activity in stressed animals within 30 min after application.”

Dance Of Water With Proteins

What determines the function of a protein?

The way that the protein folds determines its function.

What determines the fold?

WATER!

Studies show that thousands of water molecules organize milliseconds BEFORE the protein folds.

How can we assist to make sure the protein folds correctly?

Terahertz frequency!!!

The role of water in the functioning of proteins has been a hot topic over the years. Understanding the dance of water molecules is key to understanding how all of life works.

We now appreciate that it is virtually impossible to grasp almost anything at the molecular level about biology, without understanding how water molecules interact with biomolecules within cells.

The intermolecular vibrations of the small spaces between the water molecules determines how the water molecules interact with the protein.

Protein folding is crucial for normal physiology including development and healthy aging, and failure of this process is related to the pathology of diseases including neurodegeneration and cancer.

In fact, the "Unfolded Protein Response" is literally involved with EVERY SINGLE DISEASE!!!

The Unfolded stress response (UPR) is a conserved cellular pathway involved in protein quality control to maintain homeostasis under different conditions and disease states characterized by cell stress.

Terahertz frequency is the frequency of LIFE!

References:

Dance Of Water With Proteins: Disco Becomes A Minuet

https://www.sciencedaily.com/releases/2007/12/071221224910.htm

Terahertz Dance of Proteins and Sugars with Water

https://link.springer.com/article/10.1007/s10762-009-9514-6

How two water molecules dance together

https://phys.org/news/2019-08-molecules.html

Water molecules dance in three

https://www.eurekalert.org/news-releases/490628

The Water Dance

https://new.nsf.gov/news/water-dance

The impact of the unfolded protein response on human disease

https://rupress.org/jcb/article/197/7/857/36873/The-impact-of-the-unfolded-protein-response-on

Terahertz vibrations of Dopamine

Dopamine (DA) is an essential neurotransmitter and hormone of the nervous system, its structural and conformational properties play critical roles in biological functions and signal transmission processes.

Results suggest that each THz resonant absorption peak of DA corresponds to specific vibrational modes, and the collective vibration also exists in the broadband THz range.

The results indicate the dominant role of Terahertz waves in Dopamine is hydrogen bonding.

In another study about THz and Dopamine researchers found that THz wave could reduce the affinity of major side effects of antipsychotics by 71%!!!

Broadband terahertz signatures and vibrations of dopamine

https://pubs.rsc.org/en/content/articlelanding/2020/an/d0an00771d

Physicochemical Insights on Terahertz Wave Diminished Side Effects of Drugs from Slow Dissociation

https://pubmed.ncbi.nlm.nih.gov/35438483/

The Propeller of Energy

Piezoelectricity is the electric charge that accumulates in biological matter such as bone, DNA and various proteins.

Piezoelectricity is exploited in a number of useful applications, such as the production and detection of sound.

It also finds everyday uses such as acting as the ignition source for cigarette lighters, push-start propane barbecues, used as the time reference source in quartz watches, and in amplification pickups for some guitars.

The PIEZO genes are mechanically-activated ion channels that link mechanical forces to biological signals.

They are the actual PROPELLERS that move energy from the zero point energy field into biological matter.

In other words, energy and electric signals, sometimes referred to zero point energy, flow through the PIEZO genes to transmit signals into your DNA, bones, and proteins.

In 1942 the famous scientist Dr. Nikola Tesla said,. "If you want to find the secrets of the Universe, think in terms of energy, frequency and vibration."

This is also, in part, why and how Quantun Terahertz Devices work, by transmitting signals to biological matter....YOU!

"Direct evidence of the piezoelectric effect of lysozyme in monoclinic and tetragonal aggregate films of lysozyme has now been captured by researchers. The sufficiently high piezoelectric coefficient is several times higher than that of the classical quartz piezoelectricity, which makes it possible to use this material for various biomedical purposes, for example, to generate electric charges in cells"

https://www.sciencedaily.com/releases/2017/11/171127094954.htm

Terahertz Vascular System Enhancement

Although veins may sometimes look blue through your skin, it's not because your blood is blue. The deceptive color of your veins results from the way different wavelengths of light penetrate your skin, are absorbed, and reflect back to your eyes — that is, only high-energy (blue) light can make it all the way to your veins and back.

Your vascular system is your body's network of blood vessels. It includes your: Arteries, which carry oxygen-rich blood from your heart to your tissues and organs; Veins, which carry the blood and waste products back to your heart; Capillaries, which are tiny blood vessels that connect your small arteries to your small veins.

This vast system of blood vessels - arteries, veins, and capillaries - is over 60,000 miles long. That's long enough to go around the world more than twice! What's more, the capillaries, which are the smallest of the blood vessels, would make up about 80 percent of this length.

If the red blood cells from one person were to be stacked in the sky, they would reach 31,000 miles.

The walls of the capillaries are thin and leaky, to allow for an exchange of materials between your tissues and blood. Vascular diseases are conditions that affect your vascular system.

The human circulatory system fights disease and helps maintain homeostasis within the body.

Terahertz vascular therapy is known for its distinctive ability to target the body’s microcirculation to help users improve their blood flow and increase their performance, recovery, and overall wellness.

Terahertz therapy is truly incredible and its ability to improve the human function of microcirculation is so helpful. Being able to target this system and increase its efficiency can be incredibly helpful in keeping our bodies working well and recovering quickly.

Because the therapy improves blood circulation, it can offer benefits to almost anyone who uses it. By supporting healthy blood flow, it helps to build resiliency in the body over time.

It’s designed to support the self-regulatory processes of the human body to improve blood flow, nutrient and oxygen delivery, waste removal, strength, endurance, stamina, energy, muscle conditioning, stress response and help with the user’s quality of sleep.

Here’s the thing…

We are evolved to run – but not to exercise.

You heard that right!

Harvard evolutionary scientist says humans evolved to avoid unnecessary physical activity.

When people don’t exercise, we label them as lazy, but they are actually doing what we evolved to do - which is to avoid unnecessary physical activity.

The biggest myth is that it is normal to exercise. Our hunter-gatherer and farming ancestors never ran or walked several miles a day just for health.

If you ever watched the gorillas or chimps in Dublin Zoo, they spend a lot of time inactive, sitting around grooming or feeding.

Our deeply embedded human instinct during downtime is to be as inactive as possible. To conserve energy for when the saber tooth tiger shows up that we might escape.

The average hunter-gatherer men and women walk about six miles a day, respectively, in order to hunt or collect food. Our ancestors evolved to be endurance walkers but only when necessary.

Persistence hunting seems to have been widespread. This involves humans running and walking after prey, never letting it cool down, and tracking it until it overheats and exhausts itself.

Walking and running are essential to switch on repair and maintenance in our bodies. Exercise breaks down muscles and triggers inflammation, but this in turn switches on anti-inflammatory and repair mechanisms. The long-term effect is less inflammation all over the body. Exercise also keeps off belly fat, which in itself is a major cause of inflammation and other problems. We evolved to be physically active. It is important for almost every system in the body, especially our vascular system!

We all know exercise is good for us. But our natural instinct is not to exercise.

It’s been said that before the invention of the automobile people would walk from one end of the United States and back in the course of a year.

Imagine what that would have done for microcirculation!

Terahertz therapy - a new method of treatment of cardiovascular pathology

https://ieeexplore.ieee.org/document/1572533

Endotelial Dysfunction of Cavernosal Arteries: Role of Nitrogen Oxide, Influence of Long Range Infra-Red Radiation

“The article provides survey of bibliography related with biological effect of nitrogen oxide. The survey covers issues of endothelial dysfunction of cavern arteries and methods of its identification. In particular, interaction of interagency range infra-red radiation with biological objects of various complexity has been considered. Data collection demonstrates that effects of terahertz range infra red waves in biological systems is possible on molecular, cell, organ and system level of regulation.”

https://lupinepublishers.com/urology-nephrology-journal/fulltext/endotelial-dysfunction-of-cavernosal-arteries-role-of-nitrogen-oxide.ID.000134.php

Terahertz pulse-altered gene networks in human induced pluripotent stem cells via Zinc signal

Zinc-finger proteins (ZNFs) are one of the most abundant groups of proteins and have a wide range of molecular functions. Given the wide variety of zinc-finger domains, ZNFs are able to interact with DNA, RNA, PAR (poly-ADP-ribose) and other proteins. Thus, ZNFs are involved in the regulation of several cellular processes. In fact, ZNFs are implicated in transcriptional regulation, ubiquitin-mediated protein degradation, signal transduction, actin targeting, DNA repair, cell migration, and numerous other processes.

THz-regulated genes were driven by zinc–finger transcription factors. Combined with a consideration of the interactions of metal ions and a THz electric field, these results imply that the local intracellular concentration of metal ions, such as Zn2+, was changed by the effective electrical force of the THz pulse.

THz pulse excitation has excellent potential to manipulate living cells in a non-invasive manner, because it drives the intra- and intermolecular vibrational modes of biological molecules, such as DNA, RNA, or proteins without physically disrupting the cell membrane.

These effects are believed to cause changes in intracellular ions, such as metal ions and pH, gene expression, protein folding, biomolecule interactions, electron transfer, and enzymatic activity.

THz irradiation modulated cytoskeleton arrangement to facilitate adhesion for hiPSCs.

In particular, Zn2+ plays an important role in regulating the activity of transcription factors and in controlling gene expression. ZNFs are known to be the most abundant protein superfamily in the mammalian genome. The THz electric field allows the acceleration of electrical charges, including those of free electrons in vacuum and metal ions, by providing a large ponderomotive energy (kinetic energy of a charged particle in an oscillating electric field). This suggests a model in which THz pulses drive metal ions in a cell to alter gene expression.

Gene expression was induced nonthermally by the electric field of the THz pulse.

The genes that were strongly affected by THz irradiation were identified to be regulated ZNFs. This suggests that the unipolar THz pulse causes movement of Zn2+. ZNFs are one of the most abundant proteins and play important roles in a range of cellular functions, including physiological and pathological conditions.

Functionally, modulation of Nanog expression by Zfp281 is an efficient mechanism to fine-tune reprogramming activity.

https://opg.optica.org/ol/fulltext.cfm?uri=ol-45-21-6078&id=442130

Quantum Terhertz Device helps balance the autonomic nervous system to improve the condition of white cells, which helps raise Immunity.

The autonomic nervous system is a component of the peripheral nervous system that regulates involuntary physiologic processes including heart rate,

blood pressure, respiration, and digestion.

The autonomic nervous system is activated in response to infection or injury and its products have major effects on immune function and inflammation. The parasympathetic nervous system also modulates inflammation by acting as an anti-inflammatory neural circuit.

Terahertz frequency application impacts the autonomic nervous system through Mechanotransduction.

In cellular biology, mechanotransduction is any of various mechanisms by which cells convert mechanical stimulus into electrochemical activity.

Today it is known that mechanical forces influence the growth, shape and behavior of nearly every cell, tissue and organ of the human body. Cells can sense and respond to a wide range of external chemical and physical signals and, consequently, change their morphology, dynamics and behavior. As such, mechanotransduction has become a topic of increasing awareness and consequently scientific interest in many fields of research.

Receptors detect a wide range of mechanical stimuli, including light brush of the skin, texture, vibration, touch and noxious pressure.

Mechanosensory cells detect force from signals such as touch, sound, vibration, and strain and convert these signals into ionic currents via mechanically activated ion channels.

Piezo ion channels are sensors of mechanical forces and mediate a wide range of physiological mechanotransduction processes.

Mechanosensation of cyclical force by PIEZO1 is essential for innate immunity (study)

https://pubmed.ncbi.nlm.nih.gov/31435009/

The ability of innate immune cells to sense and respond to the physical environment is critical for their function.

Through the study of mechano-immunology, it is now increasing understood that mechanical cues are just as important as biochemical cues for determining immune cell activation.

Stretching the Function of Innate Immune Cells

https://www.frontiersin.org/articles/10.3389/fimmu.2021.767319/full

Terahertz pulses cause DNA damage while inducing DNA repair

Researchers at the University of Alberta (Edmonton, AB, Canada) and the University of Lethbridge (Lethbridge, AB, Canada) have found that short but powerful bursts of terahertz radiation may both cause DNA damage and increase the production of proteins that help the body fight cancer.

Terahertz photons are not energetic enough to break the chemical bonds that bind DNA together in the nucleus of cells. But recent theoretical studies suggest that intense terahertz pulses of picosecond duration may directly affect DNA by amplifying natural vibrations of the hydrogen bonds that bind together the two strands of DNA. As a result, bubbles or openings in DNA strands can form.

They observed terahertz pulse-induced increases in the levels of multiple tumor suppressor and cell-cycle regulatory proteins that facilitate DNA repair. This may suggest that DNA damage in human skin arising from intense picosecond terahertz pulse exposure could be quickly and efficiently repaired, therefore minimizing the risk of carcinogenesis.

The researchers confirmed that these cellular repair mechanisms were taking place by detecting an elevated presence of multiple proteins that play vital roles in DNA repair, including protein p53 (often called the guardian of the genome; p21, which works to stop cell division to allow time for repair; protein Ku70, which helps reconnect the broken DNA strands; and several other important cell proteins with known tumor-suppressor roles.

These observations indicate that exposure to intense terahertz pulses activates cellular mechanisms that repair DNA damage.

Study: Terahertz pulses cause DNA damage while inducing DNA repair
https://www.laserfocusworld.com/biooptics/biomedicine/article/14191851/terahertz-pulses-cause-dna-damage-while-inducing-dna-repair

Terahertz frequency vibrates to the same tune as the Golden Spiral of Life
The bioeffects of terahertz (THz) frequency has received growing attention because of its influence on the interactions between biomolecules.

THz frequency facilitates the transport of small molecules by promoting cellular clathrin mediated endocytosis.

It was shown that certain vibration modes and complex intramolecular interactions of macromolecules including proteins, DNA, RNA, lipids, and polysaccharides can resonate with terahertz waves.

Many small molecule drugs and natural herbs etc., which target intracellular proteins must cross the plasma membrane to exert their clinical effect.

It was reported that high-frequency THz radiation-induced transient cell membrane permeabilization and promoted nanoparticle uptake.

Continuous THz waves facilitate the transmembrane transport of small molecules via promoting clathrin-mediated endocytosis.

Clathrin is a protein that plays a major role in the formation of coated vesicles.

The endocytosis and exocytosis of vesicles, through Clathrin, allows cells to communicate, to transfer nutrients, to import signaling receptors, to mediate an immune response after sampling the extracellular world, and to clean up the cell debris left by tissue inflammation. The endocytic pathway can be hijacked by viruses and other pathogens in order to gain entry to the cell during infection.

Clathrin forms a triskelion shape in the body. The spiral design can be based on interlocking Archimedean spirals.

The Archimedean spiral is also known as the Golden spiral, or Golden ratio, or Fibonacci number.
What does all this mean?

This means that Terahertz frequency vibrates to the same tune as the Golden Spiral of Life!

Continuous wave irradiation at 0.1 terahertz facilitates transmembrane transport of small molecules

https://www.sciencedirect.com/science/article/pii/S258900422200236X

Glutathione (GSH) presents rich characteristic absorption peaks in the terahertz range.

"Lattice vibrations and hydrogen bonds of GSH could effectively resonate with THz waves. The different THz absorption peaks of GSH corresponded to different collective or local molecular vibrations which were closely related to the hydrogen bonding interactions."

https://www.sciencedirect.com/science/article/abs/pii/S1872204020600536

Terahertz Frequency & Actin

Actin is a highly abundant intracellular protein present in all eukaryotic cells and has a pivotal role in muscle contraction as well as in cell movements. Actin also has an essential function in maintaining and controlling cell shape and architecture. Actin participates in many important cellular processes, including muscle contraction, cell motility, cell division and cytokinesis, vesicle and organelle movement, cell signaling, and the establishment and maintenance of cell junctions and cell shape.

Many of these processes are mediated by extensive and intimate interactions of actin with cellular membranes.

In other words, actin is involved with how cells move and divide.

A cell's ability to dynamically form microfilaments provides the scaffolding that allows it to rapidly remodel itself in response to its environment or to the organism's internal signals, for example, to increase cell membrane absorption or increase cell adhesion in order to form cell tissue.

Actin, therefore, contributes to processes such as the intracellular transport of vesicles and organelles as well as muscular contraction and cellular migration. It, therefore, plays an important role in embryogenesis, the healing of wounds, and the invasivity of cancer cells.

Lastly, actin plays an important role in the control of gene expression. A large number of illnesses and diseases are caused by mutations in alleles of the genes that regulate the production of actin or of its associated proteins.

The production of actin is also key to the process of infection by some pathogenic microorganisms. Mutations in the different genes that regulate actin production in humans can cause muscular diseases, variations in the size and function of the heart as well as deafness.

The make-up of the cytoskeleton is also related to the pathogenicity of intracellular bacteria and viruses, particularly in the processes related to evading the actions of the immune system.

The actin in the cytoskeleton is involved in the pathogenic mechanisms of many infectious agents, including HIV. The actin cytoskeleton is a key target of numerous microbial pathogens, including protozoa, fungi, bacteria, and viruses.

Terahertz (THz) waves are a novel method of modulating actin polymerization. Results suggest that THz waves could be applied for manipulating biomolecules and cells.

Because filamentous actin has pivotal roles in the functions of normal and pathological cells, including metastasis of cancer cells, various chemical compounds affecting actin polymerization have been analyzed for research and therapeutic purposes. Findings of the enhancement of actin polymerization by THz irradiation suggest a novel possibility of artificial manipulation of biomolecules and living cells using THz waves.

Actin polymerization is activated by terahertz irradiation

https://www.nature.com/articles/s41598-018-28245-9

THz irradiation inhibits cell division by affecting actin dynamics

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8328307/

These results also indicate that the THz frequency could be applicable for nondestructive manipulation of cellular functions by modulation of actin filaments.

Other sources:

https://en.wikipedia.org/wiki/Actin

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7247010/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5053997/

https://academic.oup.com/femspd/article/73/9/ftv078/2467524

Propagation of THz irradiation energy through aqueous layers: Demolition of actin filaments in living cells

https://www.nature.com/articles/s41598-020-65955-5

Terahertz Radiation Can Disrupt Proteins in Living Cells – Contradicting Conventional Belief

https://scitechdaily.com/terahertz-radiation-can-disrupt-proteins-in-living-cells-contradicting-conventional-belief

Ras signaling, or Ras GTPase, is involved in transmitting signals within cells (cellular signal transduction). When Ras is 'switched on' by incoming signals, it subsequently switches on other proteins, which ultimately turn on genes involved in cell growth, differentiation, and survival. Mutations in Ras genes can lead to the production of permanently activated Ras proteins, which can cause unintended and overactive signaling inside the cell, even in the absence of incoming signals.

Because these signals result in cell growth and division, overactive Ras signaling can ultimately lead to cancer. The three Ras genes in humans (HRAS, KRAS, and NRAS) are the most common oncogenes in human cancer; mutations that permanently activate Ras are found in 20 to 25% of all human tumors and up to 90% in certain types of cancer (e.g., pancreatic cancer). For this reason, Ras inhibitors are being studied as a treatment for cancer and other diseases with Ras overexpression.

“Intense terahertz pulses inhibit Ras signaling and other cancer-associated signaling pathways in human skin tissue models.

The Ras signaling pathway, in particular the canonical RAS–RAF–MEK–ERK axis, is one of the most well-characterized signaling cascades in molecular biology.

The THz-downregulation of the KRAS oncogene, associated signaling genes, and subsequent prediction of inhibition of Ras signaling activity indicates that intense THz pulses may find potential therapeutic application for some cancers, with the goal of targeted inhibition of pro-mitotic signaling in diseased tissue.

These observations suggest a potential therapeutic mechanism of intense THz pulses.”

Link to study: Intense terahertz pulses inhibit Ras signaling and other cancer-associated signaling pathways in human skin tissue models

https://iopscience.iop.org/article/10.1088/2515-7647/abf742

Terahertz water as a natural eco-friendly bioinsecticide.

For general pest control, the terahertz-based functional mineral water must be sprayed directly where the pests are found.

Study: Toxicity of Terahertz-Based Functional Mineral Water (Plant-Derived) to Immature Stages of Mosquito Vectors

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7998476/

Potassium channels play important roles in vital cellular signaling processes.

They repolarize nerve cell action potentials. There are many types of potassium channel proteins, and potassium channels allow potassium ions to specifically pass through the cell membrane, thereby maintaining the resting potential of nerve cells.

Changes in K(+) channel function have been associated with cardiac hypertrophy, cardiac arrhythmias and failure, apoptosis and oncogenesis, and various neurodegenerative and neuromuscular disorders.

Loss of the modulatory channels is tightly associated with a number of brain diseases such as Alzheimer’s disease, epilepsy, fragile X syndrome (FXS), Parkinson’s disease, chronic pain, tinnitus, and ataxia.

Approximately 50% of permanent neonatal diabetes mellitus are associated with β-cell potassium channel defects.

Downregulation of potassium signaling results in hyperexcitability.

Permeability enhancement of the KcsA (Potassium) channel under radiation of a terahertz wave (Study)

"Potassium ion channels are essential elements in cellular electrical excitability and help maintain a resting potential in nonexcitable cells. Their universality is based on a unique combination of strong selectivity for K^{+} ions and near-diffusion-limited permeation efficiency. Understanding how the channel regulates the ion conduction would be instructive to the treatment of ion channelopathies. In this work, by means of molecular dynamics simulations, we demonstrate the significantly enhanced permeation of KcsA channel in reaction to an external terahertz wave, due to the effective response of the K^{+} ions in the selectivity filter regions of the channel. Compared to the case without external terahertz wave, a fourfold increase in the ion current through the channel is found."

In other words, the WAVE of LIFE Terahertz Frequency increases Potassium channel function FOUR-FOLD!

Permeability enhancement of the KcsA channel under radiation of a terahertz wave

https://pubmed.ncbi.nlm.nih.gov/35291137/

Molecular dynamics simulation of effect of terahertz waves on the secondary structure of potassium channel proteins

https://wulixb.iphy.ac.cn/en/article/doi/10.7498/aps.70.20211725

Terahertz Wave Enhances Permeability of the Voltage-Gated Calcium Channel

A deficiency of Ca2+ fluxes arising from dysfunctional voltage-gated calcium channels has been associated with a list of calcium channelopathies such as epilepsy, hypokalemic periodic paralysis, episodic ataxia, etc. Apart from analyzing the pathogenic channel mutations, understanding how the channel regulates the ion conduction would be instructive to the treatment as well. In the present work, in relating the free energetics of Ca2+ transport to the calcium channel, we demonstrate the importance of bridging Ca2+ hydration waters, which form hydrogen bonds with channels.

By firing a terahertz waves, which resonates with the stretching mode of the channels, significant enhancement was obtained on the conductance of Ca2+ channels.

The Ca2+ free energy negatively grows nearly 5-fold with terahertz waves. The direct evidence is the reinforced hydrogen bonds.

Since the resonant terahertz field could manipulate the conduction of calcium channels, it has potential applications in therapeutic intervention such as rectifying a Ca2+ deficiency in degraded calcium channels, and inducing apoptosis of tumor cells with overloaded calcium etc.

https://pubs.acs.org/doi/10.1021/jacs.0c09401

Life emits light. There is even proof our eyes emit light. To a physicist this is possible since all receivers are also transmitters—a radio antenna can send or receive the same signal.

We could not have organic life without cells, chemicals, light, electricity, or the ecosystems of the Earth and Sun.

These all just happen to be the same frequency of light that the TERAHERTZ FREQUENCY EMITS!

https://www.youtube.com/watch?v=byqsJE4ZHxM

Terahertz wave on Ca2+ transport in the calcium channel

Nerve fibers can be regarded as dielectric waveguides transmitting THz and mid-infrared waves.

So nerve fibers are essentially THz waves!

Studies showed that THz waves can regulate neural activity.

As stated in my last post we are essentially a Hydro-Electric unit.

It is well known that the Ca2+ channel mainly consists of a central water channel.

Ca2+ transport across the membrane in the form of hydration will generate strong local electric field.

With the increase in temperature, the thermal movement of ions intensifies, making the terahertz spectrum shift to a higher frequency.

Which also makes you shift to a higher frequency.

The time it takes for Ca2+ to cross the channel decreases with the increase of the frequency of the THz wave.

Theoretical investigation on the effect of terahertz wave on Ca2+ transport in the calcium channel
https://www.sciencedirect.com/science/article/pii/S2589004221015315

DNA Damage Response

"THz pulses for ten minutes leads to a significant induction of H2AX phosphorylation, indicating that THz pulse irradiation may cause DNA damage in exposed skin tissue. At the same time, we find a THz-pulse-induced increase in the levels of several proteins responsible for cell-cycle regulation and tumor suppression, suggesting that DNA damage repair mechanisms are quickly activated."

Terahertz frequency induces localized openings (bubbles) in the DNA strands. This triggers the DNA Damage Response which then recruits all the DNA Repair genes to activate.

In case you're wondering this is ABSOLUTELY FANTASTIC for ANY health related issue!

The Immune System Responds to DNA Damage

DNA damage sensors play a role in the detection of foreign DNA in the cytoplasm leading to the activation of immune signaling.

Induction of the DNA Damage Response in immune signaling triggers inflammation which is a protective response mediating the elimination of injurious agents, the removal of necrotic cells, and the initiation of tissue repair.

Acute inflammation triggers the healing.

Intense THz pulses cause H2AX phosphorylation and activate DNA damage response in human skin tissue

https://opg.optica.org/boe/fulltext.cfm?uri=boe-4-4-559&id=250843

GODS WAVEBAND targets Calcium signaling.

Calcium ions (Ca2+) impact nearly every aspect of cellular life.

Every single dis-ease has a component of deregulated Calcium signaling to it. In fact, every malady I've ever researched always leads back to calcium signaling in some way.

In the brain, calcium is fundamental in the control of synaptic activity and memory formation.

Calcium (Ca2+) plays fundamental and diversified roles in neuronal plasticity. As second messenger of many signaling pathways, Ca2+ as been shown to regulate neuronal gene expression, energy production, membrane excitability, synaptogenesis, synaptic transmission, and other processes underlying learning and memory and cell survival.

Terahertz (THz) waves can interact with ions in channels of nerve cells and can inhibit calcium signaling.

THz waves have been proved to have great potential for application in the field of neural research.

Nerve fibers can be regarded as dielectric waveguides transmitting THz and mid-infrared waves.

Studies showed that THz waves can regulate neural activity and calcium transport.

Results show that the Ca2+ transmembrane transport is a rapid signal change process on a short timescale, and its spontaneous radiation spectrum is mainly concentrated in the THz range.

Dysfunctional voltage-gated calcium channels has been associated with a list of calcium channelopathies such as epilepy, autism, and neurodegenerative diseases.

The terahertz field could manipulate the conduction of calcium channels which has a wide range of potential applications in therapeutic intervention.

Neurons rely on the action potential (AP) to deliver information from integrating the synapses and cell body, and the neurite outgrowth also needs the action potential to send growth information.

THz exposure promotes neurite outgrowth and increases the expression of synaptic-associated proteins.

Along with neurons, there are other non-neuronal cells in the central nervous system (CNS) that support neuronal function. Oligodendrocytes (OLs) are the myelinating cells in the CNS and form myelin structures on the axons, which insulates axons and increases the propagation rate of electrical impulses along the nerves.

Of note, the myelination process is also enhanced after THz exposure.

THz exposure enhances oligodendrocyte differentiation and myelination.

GOD'S WAVEBAND

“The Future Medicine will be the Medicine of Frequencies.” — Albert Einstein

“If you want to find the secrets of the universe, think in terms of energy, frequency, and vibration.” — Nikola Tesla

The Terahertz Frequency DICTATES THE FREQUENCY OF LIFE.

https://iopscience.iop.org/article/10.1088/2515-7647/abf742

https://ieeexplore.ieee.org/document/8509862

https://www.sciencedirect.com/science/article/pii/S2589004221015315

https://www.sciencedirect.com/science/article/pii/S2589004221014565

https://www.frontiersin.org/articles/10.3389/fphar.2012.00061/full

https://www.frontiersin.org/articles/10.3389/fncel.2017.00427/full

The application experience of terahertz radiation for osteoarthritis of the knee

https://www.researchgate.net/publication/346776630_The_application_experience_of_terahertz_radiation_for_osteoarthritis_of_the_knee

The ubiquitination system functions in a wide variety of cellular processes, including:

Antigen processing

Apoptosis

Biogenesis of organelles

Cell cycle and division

DNA transcription and repair

Differentiation and development

Immune response and inflammation

Neural and muscular degeneration

Maintenance of pluripotency

Morphogenesis of neural networks

Modulation of cell surface receptors, ion channels and the secretory pathway

Response to stress and extracellular modulators

Ribosome biogenesis

Viral infection

The "Wave of Life" Terahertz frequency has been shown to help modify the ubiquitination system.

The terahertz dance of water with the proteins: the effect of protein flexibility on the dynamical hydration shell of ubiquitin

https://pubs.rsc.org/en/content/articlelanding/2009/fd/b804734k

Studying the influence of 3.1 THz irradiation on the endocytosis of neuronal cells

https://opg.optica.org/josab/abstract.cfm?uri=josab-39-1-129

Continuous wave irradiation at 0.1 terahertz facilitates transmembrane transport of small molecules

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8914550/

Terahertz frequency increases in the transcription of a few genes, including the transcriptional regulator PPARG.

PPARG is a HUUUUUUUGE DEAL people!!!!!!!!

No DNA damage response and negligible genome-wide transcriptional changes in human embryonic stem cells exposed to terahertz radiation

https://www.nature.com/articles/srep07749

The interaction between electromagnetic fields at megahertz, gigahertz and terahertz frequencies with cells, tissues and organisms: risks and potential

https://royalsocietypublishing.org/doi/10.1098/rsif.2017.0585

A promising diagnostic method: Terahertz pulsed imaging and spectroscopy.

https://europepmc.org/article/pmc/pmc3080051

Toward cancer treatment using terahertz radiation: demethylation of cancer cells

"Carcinogenesis involves DNA methylation, a primary alteration in DNA, in the development of cancer before genetic mutation. Because abnormal DNA methylation is found in most cancer cells, the assessment and manipulation of DNA methylation using terahertz radiation can be a novel optical method to detect and control cancer. By directly observing the methylation via terahertz spectroscopy at approximately 1.65 THz, this epigenetic chemical change can be manipulated to the state of demethylation using high-power terahertz radiation. Demethylation of cancer DNA is a key issue in epigenetic cancer therapy, and our results may lead to the treatment of cancer using electromagnetic waves."

https://spie.org/Publications/Proceedings/Paper/10.1117/12.2557655?SSO=1&

"On the physical level, energy delivered by TH waves induces atoms' vibrations, incapable to degrade biomacromolecules, such as nucleic acids and proteins. However, theoretical research suggests that picosecond TH pulses may enhance hydrogen bonds vibrations leading to openings between the DNA strands, subsequently triggering an increase in the multiple tumor suppressor proteins levels, ceasing cell-cycle progression. This strategy could be beneficial in ceasing of tumorogenesis and subsequently in cancer therapy. Moreover, TH waves exhibit a potential affecting protein folding dynamics, deterioration of which is the major hallmark of a wide range of diseases, particularly of the most neurodegenerative diseases."

https://www.ariel.ac.il/wp/mlnb/detailed-description/

Terahertz exposure enhances neuronal synaptic transmission and oligodendrocyte differentiation *in vitro*

“In addition, we tested the ability of oligodendrocyte to form myelin on neuronal cultures after THz irradiation. Neuron cultures were irradiated with THz from 2 to 4 DIV under long-term irradiation protocol and purified OPCs were added into neurons at 5 DIV; the co-cultures were irradiated for two more days and subjected to immunostaining at 14 DIV (Figure 7E). We noticed that, in the control cultures at 14 DIV, only few OLs formed long myelin alone axons, most OLs synthesized short myelin around the cell body at this time point (Figure 7F). However, THz irradiation significantly promoted myelination and long myelins were prominent in the co-cultures (Figures 7F and 7G). These observations suggest that THz irradiation enhances the cross talk between neurons and oligodendrocytes, then accelerates the process of myelination.”

Ok,

So WHAT DOES THIS MEAN?

Simple terms:

Terahertz waves drastically upregulates myelination and re-myelination of nerves!!!!

What is the myelin sheath?

"Myelin is **an insulating layer, or sheath that forms around nerves, including those in the brain and spinal cord**. It is made up of protein and fatty substances. This myelin sheath allows electrical impulses to transmit quickly and efficiently along the nerve cells. If myelin is damaged, these impulses slow down."

Think of it this way.....

You've got trillions of "wires" (neurons) in the brain.

If their "rubber coating" around the outside of these "wires" is stripped away (heavy metals and numerous other things do this) - then that means the wires literally "spark and short circuit" each other.....

Akin to having a bunch of Christmas tree lights where the cat has chewed away all the protective rubber coating on the wires.

Terahertz waves signal the body to "re-coat" these "wires" with a protective coating - kind of like putting electrical tape over the places the cat chewed through the Christmas Tree lights.

So if you're wondering why you're seeing such a reduction in "nerve pain" and "neuropathy" and "neurological improvements"

It's because you're putting "the cat back in the bag" so to speak - and fixing the damage that darn kitty did chewing holes in the insulation of the wires of your brain.

https://www.sciencedirect.com/science/article/pii/S2589004221014565

Advances of terahertz technology in neuroscience:

Current status and a future perspective

SUMMARY

Terahertz (THz) waves are ranged between microwave and infrared region in the electromagnetic spectrum. THz technology has been demonstrated promising potential for biomedical applications. Exploration of biological effects of THz waves has emerged as a critical new area in life sciences. It is critical to uncover the effectsof THz waves on complex biological systems in order to lay out the framework for THz technology development and future applications. Specifically, THz radiation has been shown to affect the nervous system, including the structure of nerve cell membranes, genes expressions, and cytokines level. In this review, we primarily discuss the biological impacts and mechanismsofTHz waves on the nervous system at the organisms, cellular, and molecular levels. The future application perspectives of THz technologies in neuroscience are also highlighted and proposed.

https://www.researchgate.net/publication/356754250_Advances_of_terahertz_technology_in_neuroscience_Current_status_and_a_future_perspective

Exposure Effects of Terahertz Waves on Primary Neurons and Neuron-like Cells Under Nonthermal Conditions

Objective This study aimed to explore the potential effects of terahertz (THz) waves on primary cultured neurons from 4 rat brain regions (hippocampus, cerebral cortex, cerebellum, and brainstem) and 3 kinds of neuron-like cells (MN9D, PC12, and HT22 cells) under nonthermal conditions. **Methods** THz waves with an output power of 50 (0.16 THz) and 10 (0.17 THz) mW with exposure times of 6 and 60 min were used in this study. Analysis of temperature change, neurite growth, cell membrane roughness, micromorphology, neurotransmitters and synaptic-related proteins (SYN and PSD95) was used to evaluate the potential effects. **Results** Temperature increase caused by the THz wave was negligible.

THz waves induced significant neurotransmitter changes in primary hippocampal, cerebellar, and brainstem neurons and in MN9D and PC12 cells. THz wave downregulated SYN expression in primary hippocampal neurons and downregulated PSD95 expression in primary cortical neurons. **Conclusion** Different types of cells responded differently after THz wave exposure, and primary hippocampal and cortical neurons and MN9D cells were relatively sensitive to the THz waves. The biological effects were positively correlated with the exposure time of the THz waves.

https://www.besjournal.com/en/article/doi/10.3967/bes2019.094