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Diverse Applications of Electrostimulation and its Future Prospects

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Abstract

Electrostimulation is one of the fastest evolving medical technologies. The vast array of applications in diverse segments makes it worth field investing in. EMS involves application of specific intensity of electric currents in the targeted pain area. The application leads to contraction and relaxation causing blood flow and pain relief. The technology is now being utilized for Pain, Neuromodulation, Veterinary treatment and different other related segments of orthopaedic pain relief. The article explores the potential ways in which this technology can benefit mankind in multiple ways.

Keywords: Electrotherapy for muscular & joint pain relief; Electrotherapy for Veterinary pain relief; Electrotherapy in Parkinson's disease; Electrostimulation for Neuromodulation; Electrostimulation as a biotic/abiotic stress regulation mechanism in Plants

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Introduction

Brief history of electrotherapy

In ancient times Electrical eels were used to relieve pain & improve blood circulation. Later, a student at the University of Halle in Germany discovered that electricity caused an improvement in paralysis. The application led to regularity in the heart rate & sleep patterns and also induced significant improvement in paralytic patients. The results in different arenas instigated an interest in the scientist of the era to investigate the mechanism lying behind it.

The gate control theory of pain relief electrical stimulation

Post-Kratzenstein, John Wesley in 1747, and Giovanni Aldini attempted to cure insanity with electricity. Ronald Melzeck and Patrick Wall came up with "Pain Mechanisms: A New Theory" which described the Gate-Control theory [1]. The theory explained that pain signals travel through the spinal cord and travel across the nerve gate channels made of fibers. The electricity transferred via electrodes can block the GATE and stop the pain sensation.

Diverse Potential Applications of Electrotherapy

Muscle pain relief

The application of electrical impulses in the pain area disrupts the pain sensation signaling. The pain receptors in the brain & spinal cord are blocked. The blocking eventually eliminates the pain sensation. The stimulation also promotes the release of endorphins (pain-relieving hormones). The electrical impulse stimulates contraction and relaxation of muscles and is highly beneficial in cases of Muscle atrophy, Fibromyalgia & Muscle Spasm.

Healing & tissue recovery

Cell is an electrical unit. An injured tissue is susceptible to infection if the healing does not occur at a specific time interval. Electrical stimulation catalyses the wound healing process. The process imitates the natural electrical current at the injured site. The application increases p42/44 mitogen-activated protein (MAP) kinase activation, essential to initiate cell responses [2] and cause cell proliferation. The application of Electrical stimulation to injured tissue increases stimulates fibroblasts and migration of macrophages thus promoting stimulated wound healing.

Labour pain management

The labour pain lasts for more than 14-15 hours. Different kinds of pain killers and sedatives are administered for quick relief. However, there are cases where such chemical sedatives & pain killers have caused a serious side-effect to the mother & new-born [3]. Trans cutaneous Electrical Electrostimulation is a potential method to minimize the labour pain without any major side-effects.

Anxiety & insomnia management

Cranial Electrical Stimulation is an advanced therapy to reduce & manage Anxiety & Insomnia. The application of minor electrical waves through the Vagus nerve causes release of relaxing hormones like endorphins, serotonin and epinephrine and nor-epinephrine. The mild stimulation helps in restoring disturbed sleep patterns and overcoming anxiety.

Veterinary pain management

Veterinary Pain Management is another major application of Electrostimulation. The Technique has been popular since the mid-18th century. Electrical stimulation is used for a variety of orthopedic or neurological injuries and diseases. Often, pets like dogs & cats are unable to use their limbs in several specific conditions of atrophy. This may happen due to insufficient muscle mass [4]. Applying electrical stimulation causes significant increase in muscle mass, strength and helps in maintaining flexibility.

Aesthetic Applications

Electrical stimulation has a variety of aesthetic applications too. Micro current technology increases ATP production. The rejuvenating nature of mild electrical impulses causes substantial reduction in the number of dead cells and improves blood circulation. Enhanced blood circulation eliminates fine lines, wrinkles and improves overall aesthetic appearance.

What Makes Electrotherapy A Better Analgesic Than Conventional Pain Medications?

Conventional Pain Medication is the leading cause of different major ailments. Around 50% of the pain medications are “Over-the-Counter" products that are exploited exorbitantly. Indigestion, Ulcers, Constipation, Anxiety, Mood Swings, Nausea and liver cancers are some of the common side-effects that one may encounter on consuming Pain-meds for a very long time. On the other hand, Electrotherapy does not interrupt the body's metabolism. The non-invasive pain relief [5] does not reportedly have any major side-effects. The application is done via carbon electrodes on the affected area. The body releases endorphins to provide a relaxing sensation. The mild stimulation by TENS, IFT, Russian, Faradic, Galvanic and different other modalities does not have any direct impact on the body’s biochemistry. In addition to bodily benefits, the treatment is more cost-effective and non-Addictive.

Discussion

Future Prospects of Electrostimulation

Alternative pain treatment for Parkinson's disease: CES

The chronic musculoskeletal pain associated with Parkinson’s disease is chronic issue. Scientists, supporters and fund raisers actively initiate ideas for alleviating the atrocities of this disorder. Currently, medication is the only cure for such pain but scientists reveal an effective alternative solution for such pain in PD patients.

What is Parkinson's disease?

Parkinson's is a neurodegenerative disorder resulting in loss of balance and functionality in different parts of the body. The disease does not occur spontaneously, it's a deteriorating disorder that occurs in a stepwise manner, as the disease progresses the control is entirely lost. Shallow appearances of symptoms include tremors followed by severe symptoms like difficulty in walking and movement instability.

Why is it caused?

Genetics

Genes play a very crucial role in Parkinson's disease, mostly the population having a history of Parkinson's is known to be highly susceptible to Parkinson's disease.

Dopamine loss

Dopamine is the mood-regulating hormone causing an array of disorders and diseases on imbalance. The imbalance created might disturb the overall functioning of the body. Excessive release or zero release of dopamine are equally hazardous for the health of an individual.

Excessive release of dopamine can lead to:

- Irregular heartbeat
- Fast heart rate
- Chest Pain
- Headache
- Nausea and vomiting

Minimal or low volume release of dopamine can lead to:

- Muscle cramps
- Aches & Pains
- Loss of balance
- constipation
- Eating and swallowing disorder
- Frequent pneumonia
- Weight loss
- Low sex drive
- Lack of self-consciousness

Environment

The environment plays a crucial role in determining whether the disease is picked from surroundings or not. The excessive manganese content in water is one of the notable causes of Parkinson's disease. Hence, it can be concluded that the cause of the disease isn't only genetic, it can also be picked from the surrounding environment.

Age & Gender

Advanced age is one of the prime factors causing Parkinson's disease. The cases of this disease are much more prominent amongst the male members than the female members.

Lewy bodies

Abnormal protein clumps in the brain stem of people cause degeneration in the balance of the body. Eventually, long-term deposition of the Lewy bodies causes highly retrogressive exposure that eventually led to Parkinson's disease.

Occupations

The research suggests that people in some occupations who have higher exposure to toxic chemicals are much more susceptible to Parkinson's disease than others. Some common professions where chances of being exposed to chemicals are higher are agriculture, welding, and industrial work.

Cranial Electrical Stimulation (CES) in alleviating the pain in Parkinson's disease

The research reveals antiparkinsonian medications to be highly disastrous in the long run. Initially, the pain might be light but as the disease progresses the pain becomes chronic, it may take a bigger form or occur in a wider area of the body as the disease progresses. Approximately 34 -85% of the people suffering from Parkinson's disease suffer from chronic musculoskeletal pain which does not have a proven cure [6]. The musculoskeletal pain in the lower body can be reduced or eliminated over time by the application of CES. The studies and trials conducted in patients as suggested in the authorized Journal showed enough evidence to establish CES as a potential option to alleviate pain in patients with Parkinson's disease. Also, since the process does not involve any drugs, chemicals, or invasive application it's the safer process. The patients of this disease suffer from extreme conditions of body balance resulting in depression too. CES application is known to boost the secretion of healthy hormones including epinephrine, nor-epinephrine, serotonin, and Beta-endorphin to acclimatize the depressive state too.

Role of Electrostimulation in Plant Growth

Electrostimulation has also been analysed as one of the most potential techniques to enhance agricultural yield. Like human tissues, electrical stimulation has also been proven successful in helping the plant tissues to grow significantly. The methods have been proven successful in inducing the activation of ion channels and ion transport, gene expression, activation of enzymatic systems, accelerating the repair of damaged cells.

Enhancing the Mushroom yield through Electrical Stimulation

The edible mushroom cultivation doubled up by the application of electrical field. Researchers have come up with two key reasons for the same. The first one being the hyphae of the mycelia breakdown resulting in multiplied yield. The second reason being application of high volt electric field led to stimulation of several enzymes that led to substantial growth & multiplication.

Enhancing the Thermotolerance of *Zea mays* (Maize) with Electrical Stimulation

Electrical signalling is a common phenomenon that occurs in plant & animal cells. The application of exogenous electric fields improves the internal metabolism of the plant or animal body. The electric field interacts with the hydraulic, chemical (Ca2+, ROS), and hormone signalling (ABA and JA) in plants. The overall impact has been significant growth along with development of stress tolerance in plants. Some of the most significant positive observations have been made in specific varieties of Wheat, Cucurbita, Tomato and Maize.

Conclusion

Electrical stimulation is one of those technologies whose potential has not yet been completely explored. There are numerous ways in which technology can be harnessed for the betterment of mankind. Conventional medication for pain relief has numerous side-effects. The pain medication often causes blotting, nausea and headache. Electro stimulation as a technology has immense potential to revolutionize the pain management industry. Along with the Medical & therapeutic use, the technology also has a significant potential to replace chemical fertilizers in agriculture and improve biotic & abiotic tolerances of the major crops.

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