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A theoretical study on treatment methods using electrical stimulation, A review

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Abstract

This article deals with a theoretical study of electrical stimulation therapy methods, which is one of the physical treatments used to treat pain and increase the strength of weak muscles. The treatment is carried out by connecting electrodes to the patient, which in turn deliver electrical pulses through nerve pathways at specific time intervals. The relationship between electrical stimulation methods and types of electric current was also clarified in this review, as stimulation methods were divided according to the type of current used, where direct current is used in the case of galvanism with high frequency and low current. Methods (Micro-current), H-wave, Faradic, Leduc, Trabert use pulse current with a frequency not exceeding 1000 Hz, methods such as transcutaneous electrical nerve stimulation (TENS), quadrupolar interference, bipolar interference, isothermal interference, neuromuscular, bipolar interference. The electrode is staggered, using diadynamic alternating current with a frequency between (3600 Hz - 10000 Hz) and the current value is between(50 mA - 140 mA).The most important effect or use of electrical stimulation is to reduce pain (analgesic effect), as well as the effect of bipolar interference and 4 electrodes on muscle dilation and spasm. Finally, there are many studies that show that there are no long-term side effects of electrical stimulation, only some temporary effects resulting from misuse of the electrodes of the stimulation device or resulting from the use of High currents.

Keywords: physical therapy, stimulation, electric current,electrodes

Introduction.

Electrical stimulation is one of the types of electrical therapy, which is a method of physical therapy, which is done by using electric current, which helps to strengthen muscles, reduce pain and improve blood circulation. (Laura & Mohamad, 2022)

When performing any movement, the mind is the one who issues commands (nervous signals) to the main muscles to do the movement and at the same time it gives instructions to other muscles to do the work of assistance and stabilization and on the contrary, some muscles work against the main muscles to protect the individual from the force of contraction of the main muscles and thus the occurrence of injury Which has spread recently in a striking way, especially back injuries due to lack of movement and lethargy. (Johnson, 2017)

As a result of technological progress and scientific development, many means and devices have been introduced in order to speed up the rehabilitation and treatment of injuries, and electrical stimulation had a great role in the rehabilitation of some injuries. What we notice clearly when an individual is exposed to an electrical short, the

muscles work involuntarily and the use of stimulation maintains the functional efficiency of the muscle and nerve. (Nussbaum & et. al., 2017)

In addition to that it works to disrupt the pain signals emanating from the brain by finding an alternative sensory mechanism in the field of sports injuries, research has confirmed the important role that electrical stimulation plays in that it works to avoid the lack of muscle strength and muscular atrophy, and its contribution to reducing the treatment period. (Adams, 2018)

Electric therapy has been found since ancient times, so the sources refer to the use of the torpedo fish, also known as the electric ray to treat head pain and gout diseases, as this fish issues electric shocks (these creatures are capable of producing between 8 and 220 volts of electricity), and this case is the first use of electricity in treatment. As a result of the tremendous

Technological progress, specialized and advanced electrical devices have been manufactured that help speed rehabilitation to reach the deep tissues, and among these devices, electrical stimulation that stimulates blood and lymph circulation as a result of the secretion of histamine in the tissues. (Chalovich & Joseph, 2012).

Article objectives:

The research aims to study the types of electric current used in electrical stimulation. The methods were classified according to the type of current andits frequency.

Importance of the article:

The importance of the article lies in two aspects: the theoretical aspect, which studies electric current from a physical perspective, and the parameters of this current such as frequency, resistance, and others. The article also focused on the practical aspect of how to use this current in physical therapy formany medical conditions.

Previousstudies.

- - Medical electrotherapy was used in London in 1767 at Middlesex Hospital using a special apparatus. Several years later, another device appeared at St. Bartholomew's Hospital. Then Guy's Hospital published many cases that were treated with electricity. (Steavenson &William, 2017), (Hung, 2012).

- - In 1959, the journal Science published a research showing the use of direct current in the treatment of cancer, as it completely destroyed thetumor in 60% of patients (Humphrey & Seal, 1952).

- - In a study presented by (Cancer Research magazine in 1985), it was mentioned that 98% of the animals shrunk the tumor by using continuous current for five days and an average of five hours per day.

- - Recently, many studies have been presented that demonstrate the importance of electrostimulation therapy, (Lynne, Sheffler & John, in 2007) they presented a study on the use of neuromuscular electrical stimulation in neurological rehabilitation.

- - (Bronfort & et. al., 2009), studied the use of non-surgical physical therapy in the treatment of types of chronic recurrent headaches. The study indicates that there are several methods used in the treatment of migraine headaches, including: Pulsating Electromagnetic Fields, Transcutaneous Electrical Nerve Stimulation (TENS), Therapeutic Touch, Cranial Electrotherapy, and a combination of self- massage/ TENS/stretching are used. The study also found that these methods have few side effects.

- - (Aziz, Flemming, Cullum & Olyaee, 2010) Electromagnetic therapy for treating pressure ulcers was study by,

Sores on the skin known as pressure ulcers are brought on by rubbing or pressure. They typically afflict people with limited mobility on their bony body parts, such as the elbows, heels, and hips, and they are slow to heal. Since the goal of Electromagnetic Therapy (ET) is to promote healing, it does not involve radiation or heating. Instead, it employs an electromagnetic field. The evaluation of studies found no conclusive evidence, nevertheless, to support either the benefit or harm of electromagnetic therapy for pressure ulcer healing.

- - (Aziz, Cullum, Flemming, 2013), studied electromagnetic therapy fortreating venous leg ulcers.
- - (Castillo, 2015) showed effectiveness of neuromuscular electrical stimulation in the functional knee rehabilitation in soldiers.
- - (Jheng, & et. al. 2019), presented a systematic study on the effectiveness of electrical stimulation in improving arm function after the brain attack.
- - (Shiyu & et.al., 2020) demonstrate the use of Functional Electrical Stimulation to cause muscular contractions during rehabilitation exercises following spinal cord damage.
- - (Cesar & Milos, 2020) published a review on the use of functional electrical stimulation therapy for restoration of motor function after spinal cord injury and stroke.
- - (Alberto, Jose & David, 2021) study mirror therapy simultaneously combined with electrical stimulation for upper limb motor function recovery after stroke was as a systematic review. Insomnia, Anxiety, and Depression are just a few of the clinical illnesses that can be treated using Cranial Electrotherapy Stimulation (CES), a neuro-modulation technique.
- - (Brunyé & et.al., 2021) introduces study about the effects of CES on mood, physiology, and behavior in healthy, non-clinical sample has only lately been the subject of a small number of investigations.
- - (Saranya, Rajendran & et. al, 2021) The use of electrical stimulation as a therapeutic method for wound healing has been researched by researchers., the study showed that electrical stimulation speeds up wound healing.
- - (Akhlasur & et. al., 2022), A study on the application of electrical stimulation for spinal rehabilitation following spinal cord damage was presented by a team of experts.

Types of current used in electrotherapy

Direct current or (galvanic current):

This current represents a continuous flow of energy in a specific direction, and is symbolized by DC in this sense (direct current). It is used in case of iontophoresis and trophic stimulating effect (hyperemia). One of the harmful effects of using direct current is tissue damage under the electrodes, which results from the chemical reaction of hydrochloric acid that is formed under the soda solution or the anode that arises under the negative electrode (cathode). (Bhargava and Kulshrishtha, 1983)

Pulsed direct current (PDC):

An electric current that varies in energy but has constant polarity and direction. There are many examples of PDC such as didynamo (which is a mixture of direct pulse current and galvanic current) Rectangular (e.g. Trabert's Current), Triangular and one-polarity exponentially pulse. This current has a stimulating, nourishing and analgesic effect depends upon intensity and frequency the user. One of the dangers of direct current with variable intensity is the abrasion of the skin surface and therefore the patient must be carefully monitored when using this type of current treatment. (Jeszenszky & Sándor, 2012).

Alternating current (alternating current AC):

Depending on the electrical system used, the electrical current sometimes reverses and oscillates back and forth 50 or 60 times per second. Only an alternating current generator is capable of producing this current according to Faraday's law. Alternating current (AC) is considered safer and more tolerable by the patient, and can be used for a long time in the case of patients who have devices implanted in their bodies, such as pacemakers. The use of alternating current in electrotherapy causes very little damage to the tissue under the electrode compared to direct current. (Zebrinowski and Plathy. 2009). Figure 1 shows the different types of electric current used in electrotherapy.

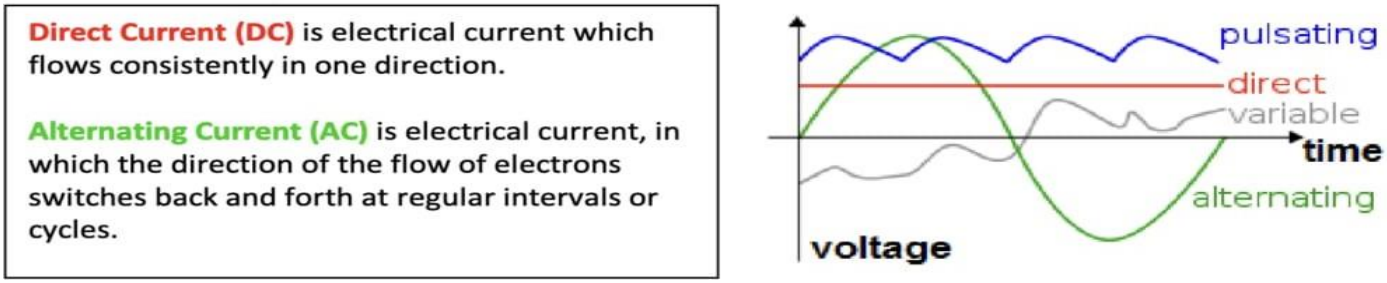


Figure (1): types of electric current.

In this type of current, the capacitive component of the skin resistance, which determines the patient's tolerance to the current, must be taken into account. There are several methods of treatment that use alternating current, including (Mohammed, 2017):

1. Electrical Nerve Stimulation Transcutaneous (TENS)

It is a treatment method to relieve

Pain that uses low voltage electric currents based on alternating current, so there is no chemical reaction with the tissues. These current used to stimulate of nerve fibers and stimulation of not boneless muscles. A battery

-powered device that transmits electrical impulses

Through electrodes positioned on the skin's surface is what makes up an Transcutaneous Electrical Nerve Stimulation (TENS) device (Gibson and el. at., 2021).The electrodes are positioned at trigger points or in or close to the nerves where there is pain, as shown in figure (2).

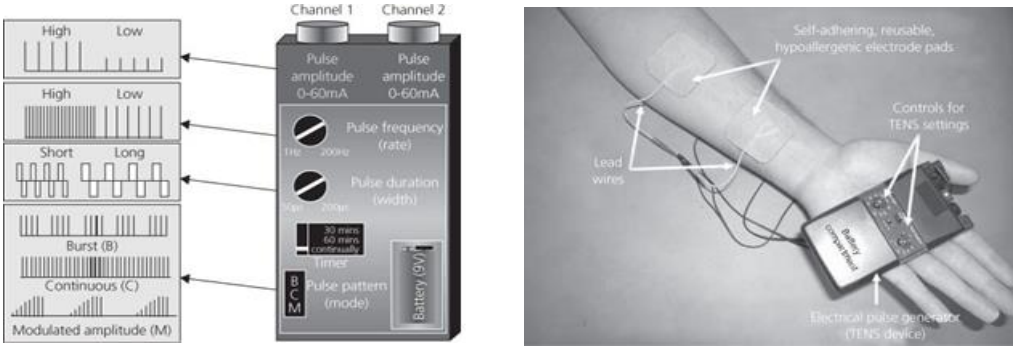


Figure (2): Transcutaneous Electrical Nerve Stimulation (TENS) apparatus.

According to a study by Banerjee & Johnson, 2013 on how TENS works, there are two competing theories. The electrical current is thought to stimulate neurons that block the passage of pain signals, changing how painful stimuli are perceived. According to a different concept, nerve stimulation increases levels of natural pain-relieving endorphins in the body. Endorphins then inhibit the perception of pain. Table [1] shows the medical conditions in which transcutaneous electrical nerve stimulation can be used and the conditions in which the use of electrical stimulation is not permitted. (Johnson ME, 2014)

Cases used TENS	Cases not used TENS
Osteoarthritis	An implantable device
Fibromyalgia	In case of pregnancy
Tendinitis	Cancer
Bursitis	Epilepsy
Low back pain	Deep vein thrombosis
Chronic pelvic pain	A bleeding (hemorrhagic) disorder
Diabetes related neuropathy	heart disease, arrhythmias
Peripheral artery disease	IN infected tissues

Table [1]: cases that use and not use Transcutaneous Electrical NerveStimulation (TENS).

There are three types of transcutaneous electrical nerve stimulation, depending on the waveform of the current (den Adel & Luykx, 2005):

-Symmetrical: the negative pulse comes right after the positive one.

-Alternate: The negative and positive pulse exchange regularly.

-Asymmetrical: An exponential pulse with a negative polarity followsa positive rectangular pulse.

The basic parameters of the current pulse used for TENS therapy can be determined, such as frequency, pulse length and pause between TENS frequency as in the figure (3).

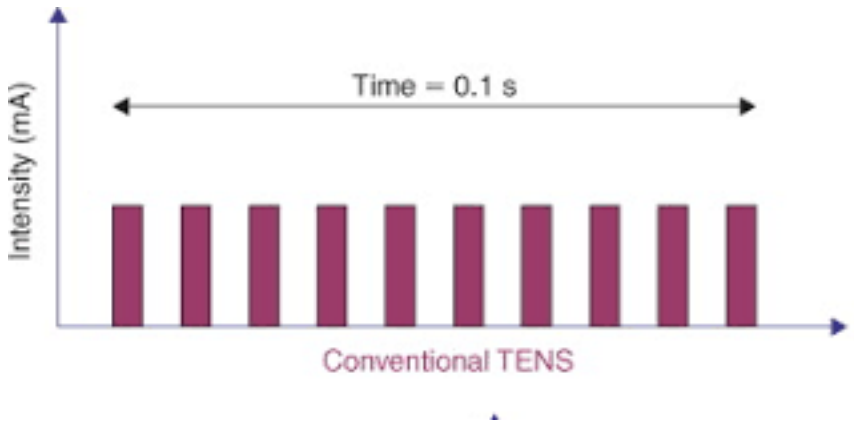


Figure (3): the parameters of TENS pulse.

It is one of the methods of Interferential Therapy (IFT) is a method of electrotherapy using low frequency currents without harm, this is done by using four electrodes and two channels.Two electrical circuits of different frequency are used, where an interference occurs between a sinusoidal current circuit with a frequency of F1 with another circuit of frequency F2, as the frequency of the first circuit is less than the second circuit to produce a low- frequency pulse current of about 50 Hz. (Ozcan, Ward & Roberson, 2004)Symmetric pulse Alternating pulse Asymmetric pulse The pulses previously modified in terms of amplitude and frequency are overlapped inside the patient's skin [figure (4)]

Figure (4): Bipolar Method

Impacts to Electrostimulation TherapyPainkilling Impact:

Being in pain is an unpleasant sensory and e motional feeling that leads to actual or potential tissue damage. There are two types of pain (Laura, 2020):

1. Sharp ache: low term (extending over a few weeks or days) and resulting from mechanical damage to tissues or disease. This type of pain comes following an agonizing stimulation and subsiding with the disappearance of this stimulus, and the acuity of the pain depends on the severity of the factor causing the pain.

2. Enduring ache: prolonged term (in excess of 90 days) and its severity does not depend on the severity of the pain stimulus.

According to the idea of pain perception, there is a sensor system that uses neural pathways to transmit data through sensory nerves towards the central nervous. Electrotherapy acts as a pain reliever by increasing the producing internal endorphins.

Also, the painkilling impact of electrostimulation therapy appears from the trophic effects of the flow current. Electrotherapy helps to relieve the pain caused by muscle hypertonia and calm the muscles as well as the pain of the muscle fascia. Low frequency currents, in the range of 50-100 Hz, are used to relieve acute and cross sectional pain, such as stimulating thick bet

a and delta nerve fibers. As for chronic painful syndrome, it is preferable to use currents with low frequencies of 2-8 Hz, that is, to stimulate type C thin fibers. The currents used to relieve pain are: Galvanic current, Diadynamics currents, trabert current, ENST,two-pole interfere, four-pole interfere, Isoplaner interference and Dipole vector fields.

Spasmolytic and myorelaxant impact:Use two-pole interfere current with frequency 100-200 Hz as well as 4-pole interference current with ultrasonic and high voltage therapy. Paraffin is utilized as a therapeutic tool for tiny superficial muscles, particularly on the hands. (Rampazo & Liebano, 2022)Trophic impact:The use of physiotherapy methods leads to hyperemia, so caution should be exercised when using electrical stimulation therapy. In general, it is recommended to use galvanization, which is a treatment method use direct current with low-voltage up to 80 V, and a low current value of 50 mA.Anti-edematous impact:This type of influence is also related to increased capillary permeability, eutonisation of the vessels, and hyperemia, Therefore, the use of galvanizing is also appropriate in this case.fantasy medication impact: A person experiences the fantasy medication impact when their physical or mental health seems to get better after receiving a placebo or "delusive" treatment. A treatment that seems to be real but is intended to have no therapeutic benefit is known as a placebo, which is derived from the Latin phrase "I shall accept.".Delaying impact:At a troublesome patient has normally received 10 treatments, they are frequently only invite for the examination after this point, when they "hopefully will be well." Unfortunately, the majority of physical therapy prescriptions currently in use fitinto this category, despite the fact that it is unethical and defamatory to a professional.

In some procedures, patients are even informed that the recommended physical therapy won't start to work for them for several months, indicating that the doctor is completely reliant on the body's capacity for self-healing. Therefore, When the prognosis is uncertain, as in cases of periarthritis humeroscapularis, etc., the recommendation for physiotherapy shouldn't be entirely based on

the diagnosis.It is necessary for the specialist in electrical stimulation therapy to be familiar with the information about the injury, that is, to know the type of pain, functional or organic dysfunction, the affected area, as well as the type of treatment that is appropriate for the pathological condition and that there is no danger to the patient's life. The kind, setting, level, regularity, actual number, also in relation to them of treatments, the date of the patient's assessment, should be decided by the doctor using these responses. (Melzack & Wall, 1965)5- Contraindications to Electrostimulation Therapy Electrical stimulation therapy is not used in the following cases ((Alberto, Jose & David, 2021)

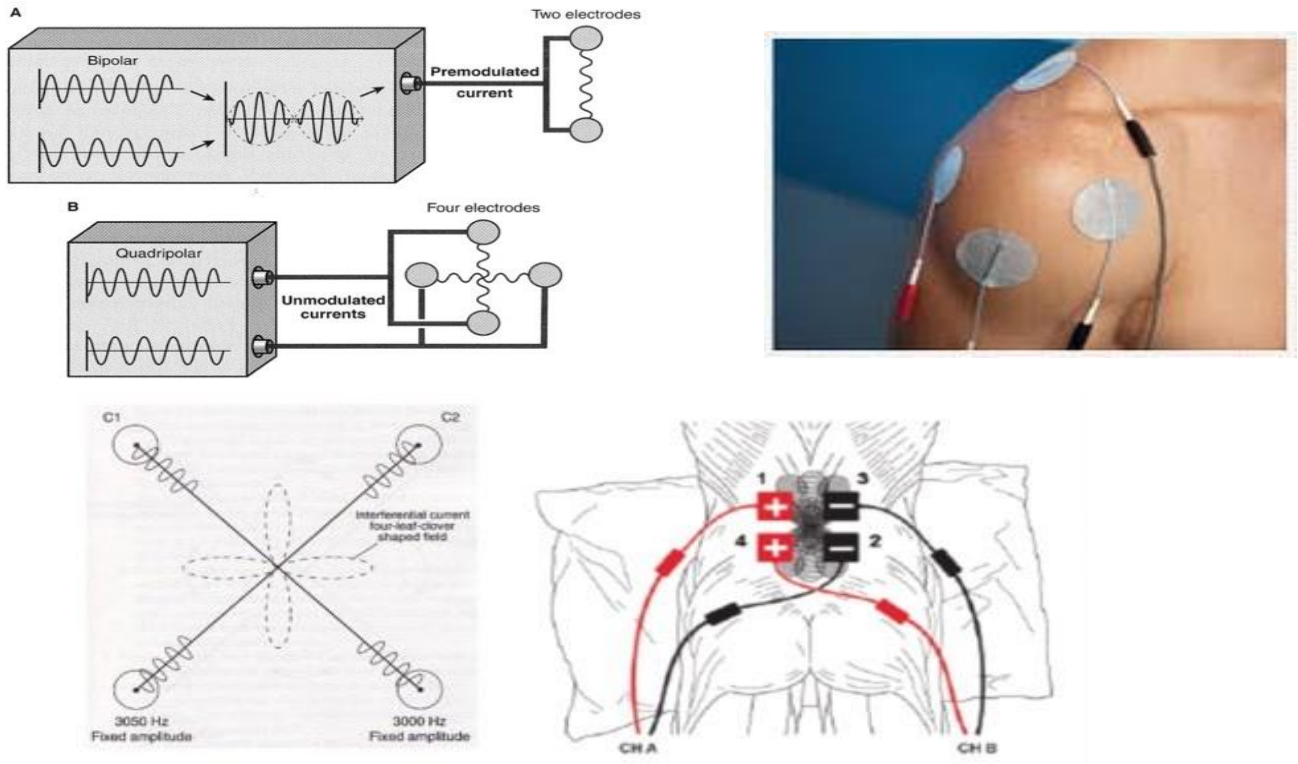


Figure (5): types of Electrostimulation Therapy

Figure (6): Quadripolar Method

Contraindications to Electrostimulation Therapy

Electrical stimulation therapy is not used in the following cases((Alberto, Jose & David, 2021)

- Patients with tuberculosis.
- If the patient is sensitive to the liquids used to wet the spongy pads which cover the electrodes.
- Avoid applying electrostimulation therapy near heart or eyes.
- Pacemakers.
- Cardiovascular Diseases.
- Implantation Cochlear.
- The presence of a metal implant or malignant tumors in the area to which the current is to be applied.
- Inflammation and skin flaws.
- Bleeding, Menses and Pregnancy
- Carcinoma.
- Allergy problems that appear in the places where the electrodes are placed.
- Organic psychoses and psychopathological syndrome.
- Multiple Sclerosis.
- Vein and Lymphatic path
- inflammation.

Figure (7): types of Electrical stimulation therapy cases

Discussion

Therapeutic electrical stimulation does not currently have any documented longterm, harmful side effects. A few adverse effects are temporary. Spasticity may actually increase if electrodes are positioned improperly. Muscle pain can be caused by stimulation that is applied too vigorously. Immediately after the treatments are stopped, these side effects will go away. Occasionally, instances of skin discomfort brought on by the electrodes have been made. If

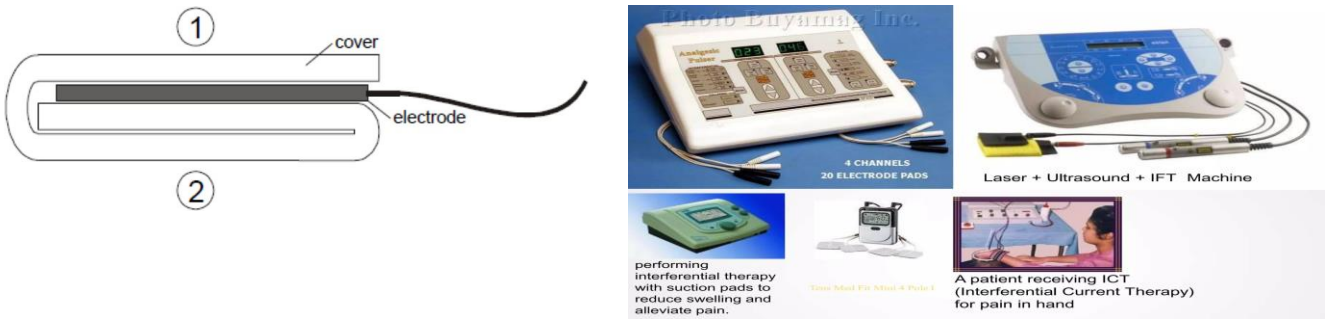
someone has a skin lesion or sunburn, skin irritation is more likely to happen (such as chicken pox). While such lesions heal, it is advised that treatment be discontinued. (Pelaez1 & Taniguchi, 2015)

According to Table (3), electrical stimulation methods have been divided into several types depending on the type of current. The galvanic method uses a constant current of (65 mA) and a high frequency (8000 Hz). This method is used to stimulate muscles with damaged nerves. We also notice arise in the current values in the methods that use the pulsed current, where the current values range between (86-140 mA), while the frequency is low (0.1-143 Hz) compared to the direct and alternating current. One of the methods that use the faradic pulse current that is used to stimulate the muscles with healthy nerves. Alternating current values range between (50-140 Ma) and frequencies (0.2-10000 Hz), one of the ways that uses alternating current TENS Which is used to stimulate the muscles superficially, that is, used for back, knee and neck pain.

Recommendations about Electrostimulation Therapy

Use sponge covers with water that have been moistened for plate electrodes (or, in the case of iontophoresis, by therapeutic solution). The covers must initialbe rinsed in lukewarm water before being used. Patients are kept from burning by moistening blankets or sponges. Put the first side of the sponge-covered electrodes to the patient's body to generate low energy currents transcutaneous electrical nerve stimulation [see figure (7)].The electrode will be in close proximity to the patient's skin, separatedby one ply of the sponge cover. Applied the second side of the sponge

-covered electrodes to the patient's body to provide powerful current (recommend for all currents other than



TENS).

Figure (8): Electrode electrostimulation device.

Conclusion

Electrical stimulation therapy is one of the physiotherapy methods used in the treatment of many diseases such as Parkinson's and muscle spasms through deep brain stimulation, improving motor coordination, reducing pain and arthritis, and also used in the case of facial nerve paralysis.There are three main types of current used in electrical stimulation, they are direct current, pulsed current, and alternating current. Each method of stimulation uses a specific type of current, but most methods use alternating current, so it can be considered the best for stimulation.

One of the ways that uses alternating current electrical nerve stimulation transcutaneous (TENS), 4-Pole interference, 2-Pole interference, Diadynamics. There are several effects of treatment using electrical stimulation, such as analgesic effect, myorelaxation and spasmolytic effect, trophic effect, antiedematous effect, placebo e ffect and delaying effect. The use of electrical stimulation is prohibited in several cases, including: tuberculosis, pacemakers, cardiovascular diseases, implantation cochlear, inflammation and skin flaws, bleeding, menses and pregnancy. The most important recommendations that must be followed when using electrical stimulation for treatment is to moisten the electrodes by immersing the surrounding sponge with water or a special solution to prevent skin irritation as well as to improve the quality of treatm ent.

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