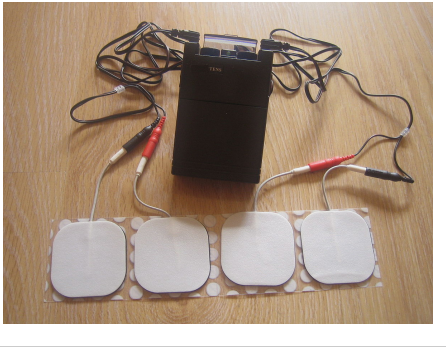


Transcutaneous electrical nerve stimulation

Transcutaneous electrical nerve stimulation	
<i>Intervention</i>	
	
A four-lead TENS unit.	
MeSH	D004561 ^[1]

Transcutaneous electrical nerve stimulation (acronym TENS) is the use of electric current produced by a device to stimulate the nerves for therapeutic purposes. TENS by definition covers the complete range of transcutaneously applied currents used for nerve excitation although the term is often used with a more restrictive intent, namely to describe the kind of pulses produced by portable stimulators used to treat pain.^[2] The unit is usually connected to the skin using two or more electrodes. A typical battery-operated TENS unit is able to modulate pulse width, frequency and intensity. Generally TENS is applied at high frequency (>50 Hz) with an intensity below motor contraction (sensory intensity) or low frequency (<10 Hz) with an intensity that produces motor contraction.^[3]

History

Electrical stimulation for pain control was used in ancient Greece, 63 A.D. It was reported by Scribonius Largus that pain was relieved by standing on an electrical fish at the seashore.^[4] In the 16th through the 18th century various electrostatic devices were used for headache and other pains. Benjamin Franklin was a proponent of this method for pain relief. In the nineteenth century a device called the electreat, along with numerous other devices were used for pain control and cancer cures. Only the electreat survived into the twentieth century, but was not portable, and had limited control of the stimulus.

The first modern, patient-wearable TENS was patented in the United States in 1974.^[5] It was initially used for testing the tolerance of chronic pain patients to electrical stimulation before implantation of electrodes in the spinal cord dorsal column.^[6] The electrodes were attached to an implanted receiver, which received its power from an antenna worn on the surface of the skin. Although intended only for testing tolerance to electrical stimulation, many of the patients said they received so much relief from the TENS itself that they never returned for the implant.

A number of companies began manufacturing TENS units after the commercial success of the Medtronic device became known. The neurological division of Medtronic, founded by Don Maurer, Ed Schuck and Dr. Charles Ray, developed a number of applications for implanted electrical stimulation devices for treatment of epilepsy, Parkinson's disease, and other disorders of the nervous system. Maurer founded Empi, Inc., in 1977, and in the late 1980s purchased the TENS product line from Medtronic.

Today many people confuse TENS with Electro Muscle Stimulation (EMS). EMS and TENS devices look similar, with both using long electric lead wires and electrodes. TENS is for blocking pain, where EMS is for stimulating

muscles.

Uses

Medical

TENS is a non-invasive, safe nerve stimulation intended to reduce pain, both acute and chronic. While controversy exists as to its effectiveness in the treatment of chronic pain, a number of systematic reviews or meta-analyses have confirmed its effectiveness for postoperative pain, osteoarthritis, and chronic musculoskeletal pain.^[7] Conversely, results from the Bone and Joint Decade 2000-2010 Task Force on Neck Pain, reported in early 2008, showed no clinically significant benefit to TENS for the treatment of neck pain when compared to sham treatment.^[8] A January 2010, systematic literature search published in the journal *Neurology*,^[9] advised against recommending TENS for chronic low back pain since evidence is controversial for that type of pain. However, other reputable neurologists wrote in the same issue of the journal: "Absence of evidence is not evidence of absence," and although the research on TENS may be thin, "there seems to be considerable empirical evidence that, at least in some patients, TENS is useful."^[10] Recent clinical studies and meta-analysis suggest that having an adequate intensity of stimulation is necessary to achieve pain relief with TENS.^{[11] [12]}

Scientific studies show that high and low frequency TENS produce their effects by activation of opioid receptors in the central nervous system. Specifically, high frequency TENS activates delta-opioid receptors both in the spinal cord and supraspinally (in the medulla) while low frequency TENS activates beta-opioid receptors both in the spinal cord and supraspinally. Further high frequency TENS reduces excitation of central neurons that transmit nociceptive information, reduces release of excitatory neurotransmitters (glutamate) and increases the release of inhibitory neurotransmitters (GABA) in the spinal cord, and activates muscarinic receptors centrally to produce analgesia (in effect, temporarily blocking the pain gate). Low frequency TENS also releases serotonin and activates serotonin receptors in the spinal cord, releases GABA, and activates muscarinic receptors to reduce excitability of nociceptive neurons in the spinal cord.

In palliative care and pain medicine, TENS units are used in an attempt to temporarily alleviate neuropathic pain^[13] (pain due to nerve damage). Some patients benefit from this approach, while others do not, depending on individual differences,^[14] and pain threshold.^[15] Use of TENS causes cell death at the site of application and should not be used long term. The number of cells that die is insignificant and most patients heal without complaints. TENS is more effective at relieving chronic pain, whereas when used on new injuries it sometimes aggravates the pain. Further use is documented in the attached references: in obstetric care, particularly in labour;^[16] knee pain,^{[17] [18]}^[19] lithotripsy or bladder-stone removal;^[20] and limb pain.^[21]

A significant number of TENS machine brands have been targeted for use for labour pain, although a 1997 report of a study done by the University of Oxford said that TENS "has been shown not to be effective in postoperative and labour pain."^[22]

Other

TENS units are used as sex toys for erotic play involving electrical stimulation.^[23]

Safety

TENS electrodes should never be placed:

- Over the eyes due to the risk of increasing intraocular pressure^[24]
- Transcerebrally^[25]
- On the front of the neck due to the risk of a acute hypotension (through a vasovagal reflex) or even a laryngospasm^[24] ^[26]
- Through the chest using an anterior and posterior electrode positions,^[24] or other transthoracic applications understood as "across a thoracic diameter"; this does not preclude coplanar applications^[26]
- Internally, except for specific applications of dental, vaginal, and anal stimulation that employ specialized TENS units^[24]
- On broken skin areas or wounds, although it can be placed around wounds.^[24]
- Over a tumour/malignancy (based on in vitro experiments where electricity promotes cell growth)^[24] ^[26]
- Directly over the spinal column

TENS should not be used across an artificial cardiac pacemaker (or other indwelling stimulator, including across its leads) due to risk of interference and failure of the implanted device. Serious accidents have been recorded in cases when this principle was not observed.^[26] A 2009 review in this area suggests that eletrotherapy, including TENS, "are best avoided" in patients with pacemakers or implantable cardioverter-defibrillators (ICDs). They add that "there is no consensus and it may be possible to safely deliver these modalities in a proper setting with device and patient monitoring", and recommend further research. The review found several reports of ICDs administering inappropriate treatment due to interference with TENS devices, but notes that the reports on pacemakers are mixed: some non-programmable pacemakers were inhibited by TENS, but others were unaffected or auto-reprogrammed.^[27]

On areas of numb skin/decreased sensation TENS should be used with caution because it's likely less effective due to nerve damage. It may also cause skin irritation due to the inability to feel currents until they are too high.^[24] There's an unknown level of risk when placing electrodes over an infection (possible spreading due to muscle contractions), but cross contamination with the electrodes themselves is of greater concern.^[28] TENS should also be used with caution in people with epilepsy or pregnant women; do not use over area of the uterus as the effects of electrical stimulation over the developing fetus are not known.^[26] ^[29]

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External links

- BBC article on TENS (<http://www.bbc.co.uk/health/conditions/tens1.shtml>)
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