

TENS is a non-pharmacological method of managing pain. How does it work and what is the evidence for its use – and why does its use pose a dilemma to nurses?

Exploring the evidence for using TENS to relieve pain

In this article...

- › How TENS works to relieve pain
- › What the research evidence says about TENS
- › Limitations in the current evidence base

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Transcutaneous electrical nerve stimulation (TENS) has several advantages as it is a non-addictive, non-invasive means of analgesia that is simple to use, portable and can give continuous analgesia for a variety of conditions.

This article outlines how it works and examines the evidence on its efficacy and possible uses in clinical practice.

As far back as 2500BC, stone carvings depict a species of catfish with organs that produce an electrical charge being used to treat pain. The physician to the Roman Emperor Claudius in AD46 was the first to document that standing on an electric fish could relieve some symptoms of pain (Walsh, 1997).

How does TENS work?

Transcutaneous electrical nerve stimulation (TENS) is a simple to use, portable, non-addictive, non-invasive means of analgesia.

Fortunately, technology has moved on since AD46 and now many devices are available on the market, at a range of prices. All these work on the same premise; small electrical pulses are delivered via electrodes that are placed directly onto the skin, usually around or nearby the area of pain.

The body is divided into segments that are innervated by sensory fibres from a single spinal nerve. Brown et al (2007) experimented with alternative electrode placement by comparing TENS administered at the site of experimentally induced ischaemic pain (the segmental site) with TENS administered at a location completely unrelated to the pain (an extra-segmental site). They found no statistically significant difference in pain intensity between TENS used in the different locations and therefore suggested that electrode location did not affect outcome.

However, Chen et al (1988) said that simultaneous stimulation at the dermatomal level corresponding to skin incision as well as acupuncture point stimulation could produce a greater opioid-sparing effect than by stimulating either site alone in postoperative patients. Similarly, Claydon et al (2008) found greatest analgesic effect in study participants where simultaneous high-intensity stimulation was given at both segmental and extra-segmental locations.

The gate-control theory

The use of electroanalgesia increased with the publication of the gate-control theory (Melzack and Wall, 1965). This hypothesised that pain is caused by activity in small-diameter nerve fibres and that, by stimulating the larger-diameter sensory nerve fibres, the perception of pain could be reduced.

Melzack and Wall (1965) proposed that a physiological gating mechanism exists in the dorsal horn of the spinal cord. This

5 key points

1 TENS is a simple to use, portable, non-addictive, non-invasive pain relief method

2 Small electrical pulses are delivered via electrodes placed directly onto the skin, usually around or near the area of pain

3 The use of electroanalgesia increased following the publication of the gate-control theory

4 The research evidence on the use of TENS for pain relief is often conflicting, partly due to problems with trial design

5 Despite the lack of evidence, TENS can still be considered as an additional method of pain management



“What makes me proudest of all is supporting people who wish to die at home”

Candice Pellett > 24



TENS digital pain reliever: patients experience wide variations in pain relief

positions or the electrical settings can reduce this.

Evidence for use Postoperative/acute pain

Three systematic reviews have examined the use of TENS for managing postoperative pain. Carroll et al (1996) identified 17 randomised controlled trials with pain outcomes. Of these, 15 concluded that TENS had no analgesic benefit in the acute postoperative period.

Reeve et al (1996) carried out a further systematic review, which included 20 studies of postoperative pain, and concluded that 12 of these had positive TENS outcomes.

A recent Cochrane review (Walsh et al, 2009) was able to extract data from only six of the 12 RCTs that met their inclusion criteria, and found that only one out of five studies comparing TENS with placebo showed a statistically significant superior effect of active TENS. However, the authors were unable to draw any definitive conclusions about the effectiveness of TENS as a sole treatment for acute pain due to insufficient data. It is important to note that studies that allowed additional analgesics were excluded from this review.

A report by the Royal College of Surgeons of England and the Royal College of Anaesthetists (1990) stated: “TENS is not effective as the sole treatment of moderate or severe pain after surgery.” This seems reasonable as, in isolation, TENS is unlikely to be able to manage severe pain. However, this report and the previously mentioned systematic reviews did not examine nor discuss the use of TENS in conjunction with traditional analgesic methods.

In contrast, a meta-analysis by Bjordal et al (2003) identified 21 RCTs that examined postoperative analgesic use in patients who had undergone a variety of surgical procedures, comparing the effects of concurrent TENS with placebo controls. They concluded that “there is credible evidence that TENS reduces postoperative pain over and above placebo through less analgesic demand during the first three days after surgery”.

Obstetrics

A significant number of TENS machine brands have been promoted for use in labour pain, despite TENS “having been shown not to be effective in postoperative and labour pain” (McQuay and Moore, 1998). However, these authors suggested that TENS is of possible value in labour pain because it may spare other analgesic

“gate” can be opened or closed to allow or inhibit the transmission of painful information through it, and up to the brain where it is processed.

By selectively exciting A-beta nerve fibres in the skin with TENS, the amount of painful stimulation being transmitted by smaller diameter A-delta and C-fibres can be reduced, causing segmental inhibition. This occurs when TENS is set to high pulse rates, known as “high frequency” or “conventional” TENS (90-130Hz), which triggers the pain gate to close.

As well as having this inhibitory effect on neurons, TENS can affect extra-segmental, descending pain pathways. Stimulating small A-delta fibres found in muscles reduces the release of excitatory neurotransmitters such as aspartate and glutamate and increases the release of inhibitory neurotransmitters such as GABA (gamma-aminobutyric acid) and serotonin (Sluka and Walsh, 2003), and endogenous opioids such as endorphins and enkephalins. When the machine is set on a low pulse rate, also known as “low frequency” or “acupuncture” TENS (2-5Hz), it stimulates the body to produce these endorphins.

It is possible to stimulate both nerve types at the same time by using a “burst” mode where conventional TENS is regularly interrupted by 2-3 “bursts” of lower frequency TENS. Different programmes can be used interchangeably throughout the day and according to personal preference.

Length of pain relief

Conventional TENS tends to have a quick onset of analgesia but loses its effect quite rapidly when the stimulation is turned off. The analgesic effect of low-frequency TENS takes longer to achieve but the pain relief produced by the endogenous opioids can last for some time. The post-stimulation analgesic effects of TENS can therefore last anywhere from five minutes to 18 hours (Woolf, 1991). Some patients’ pain levels do not return to pre-stimulation levels even after 24 hours (Cheing et al, 2003).

People vary widely in how much post-TENS pain-relieving effect they report after treatment and the reason for this is not clear. It has been suggested that the accumulation or depletion of endogenous opioids might influence the strength and duration of post-stimulation analgesia (Cheing et al, 2003).

Because of this as yet unexplained, individual variation, there are no definite recommendations on how long TENS should be used for, with advice varying from 20 minutes to several hours.

Cheing et al (2003) also found a cumulative effect in pain reduction after repeated applications of TENS and proposed that the mechanisms underlying this may be related to possible changes in the neuronal pathway. However, with long-term use, the nervous system can become accustomed to TENS (habituation), which can lead to poorer pain control. Breaks between sessions and/or changing electrode

interventions that carry increased morbidity for mother and baby, and recommended that a large randomised trial should be carried out to test this.

Wound healing

Several studies have shown an improvement in the rate of wound healing when electrodes have been applied locally around sacral and leg ulcers (Asbjornsen et al, 1990; Kaada and Emru, 1988; Kaada, 1983). It has been hypothesised that this could be due to TENS inducing vasodilation or a possible inhibition of sympathetic impulses by the release of brain endorphins.

Chronic pain

A systematic review evaluating the effectiveness of TENS in chronic pain found that in 13 of 22 inactive control (placebo) studies, there was a positive analgesic outcome in favour of active TENS treatments (Nnoaham and Kumbang, 2008). However, for multiple-dose treatment comparison studies, only eight out of 15 were in favour of active TENS treatments.

Low back pain: the National Institute for Health and Clinical Excellence (2009) recommended that TENS should not be offered for the early management of persistent non-specific low back pain that has lasted for less than a year. In addition, a systematic review concluded there was level-A evidence that TENS should not be recommended for chronic lower back pain (Dubinsky and Miyasaki, 2010), according to levels of evidence from the NHS R&D Centre for Evidence-Based Medicine (2002).

A Cochrane review could identify only four RCTs that the authors considered methodologically suitable for review, and concluded that the evidence did not support the use of TENS in the routine management of chronic lower back pain (Khadilkar et al, 2010).

Osteoarthritis: Rutjes et al (2009) reviewed 18 trials of TENS use for knee pain and concluded there was a lack of adequate evidence to support the use of any type of transcutaneous electrostimulation in patients with knee OA.

Neuropathic pain: the European Federation of Neurological Societies published guidelines following a review of the available literature by Cruccu et al (2007), which concluded that “standard high-frequency TENS is possibly better than placebo (level C evidence) although probably worse than acupuncture-like or any other kind of electrical stimulation (level-B evidence)”.

A systematic review by Dubinsky and Miyasaki (2010) concluded there was level-B evidence that TENS should be considered specifically to treat painful diabetic neuropathy.

Quality of evidence

The majority of authors reviewing TENS trials, for all types of pain, concluded there were great limitations to their review findings in terms of methodological issues.

Bennett et al (2011) looked at the methodological quality of RCTs using TENS and argued that several aspects of study design throughout the literature could lead to bias towards a result of “no effect” including:

- » Small sample size – often fewer than 50 patients;
- » Inadequate randomisation;
- » Lack of blinding of patients, therapists and outcome assessors;
- » Inadequate TENS intervention – incorrect electrode placement, and inadequate intensity and treatment duration;
- » Inadequate assessment of compliance with treatment in home trials;
- » Poorly defined outcome measures – the effect of TENS was often not measured while it was in use;
- » Inconsistency around permissible concurrent analgesics;
- » A variety of disease states and conditions are often looked at within a category, such as neuropathic or low back pain, which are difficult to compare;
- » Lack of instruction to patients about self-administration and expectation of sensation – active TENS produces electrical paraesthesia whereas placebo TENS does not and it is obviously difficult to blind study participants to this. To overcome this, Bennett et al (2011) suggested informing patients that some TENS machines do not produce sensation during stimulation.

Conclusion

The literature available on the use of TENS for pain relief often provides conflicting evidence, perhaps due in part to the inherent problems with trial design.

This gives rise to a dilemma: in a climate where evidence-based medicine prevails, should the decision to use TENS be based solely on research findings or, instead, should clinical experience, expertise and anecdotal patient report be trusted? As Binder and Baron (2010) argued, an “absence of evidence is not [always] evidence of absence” and went on

to say that “there seems to be considerable empirical evidence that, at least in some patients, TENS is useful”. Box 1 gives details on contraindications and cautions.

Despite the lack of robust evidence from RCTs on the efficacy of TENS, it is still useful to consider trying it as an additional method of pain management, as it has no side-effects and therefore a “favourable benefit-risk ratio” (Binder and Baron, 2010). **NT**

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BOX 1. CONTRAINDICATIONS AND CAUTIONS

TENS is not suitable for use

On the front of the neck Risk of acute hypotension through a vasovagal response (Watson, 2008);

On broken skin areas or wounds

Although it can be placed around wounds (Watson, 2008);

Over a tumour or malignancy In vitro experiments have shown that electricity can promote cell growth (Watson, 2008);

Over a pregnant uterus The effects of electrical stimulation over the developing foetus are not known (Watson, 2008). A risk-benefit analysis should be made by a health professional if TENS is to be considered for use during pregnancy generally, even if electrodes are not placed near the uterus. While no adverse effects as a consequence of using TENS during pregnancy have been reported (Association of Chartered Physiotherapists in Women's Health, 2007), often clinicians will try to avoid its use before 36 weeks' gestation in case of hypothesised induction of contractions.

Over a cardiac pacemaker A literature review suggested that TENS is best avoided in patients with cardiac pacemakers (Digby et al, 2009). If it is considered for those with a pacemaker,

this should be discussed with their cardiologist and, if agreed, the TENS device tested during a pacemaker check;

Through the chest using an anterior and posterior electrode position (Watson, 2008);

Internally Except for specific applications of dental, vaginal and anal stimulation that use specialised TENS units (Watson, 2008).

When driving or operating machinery

TENS should be used with caution

On areas of numb skin/decreased sensation It is likely to be less effective due to nerve damage and may also cause skin irritation due to the inability to feel currents until they are too high (Watson, 2008);

Over an area of infection There is an unknown risk of the infection possibly spreading due to muscle contractions, plus cross-contamination from the electrodes can occur;

In people with epilepsy TENS may affect seizure threshold; the safety implications of what would happen if patients had a seizure when on their own, with TENS in situ, need to be considered before use.

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