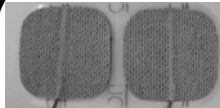




Transcutaneous Electrical Nerve Stimulation (TENS)

ACPOCP May 2007

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University of Hertfordshire



TENS Principles

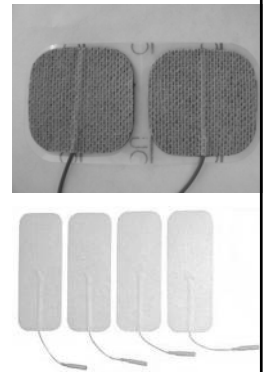
- Aims to activate normal physiological mechanisms of pain management by means of the **PAIN GATE MECHANISM** and/or the **ENDOGENOUS OPIOIDS**
- Primarily works by means of sensory nerve activation
- Symptomatic management rather than cure

TENS Principles II

- More effective with **ACUTE** than with **CHRONIC** pain states
- Non invasive treatment
- Very few side effects compared with drug therapy
- Small percentage experience allergic reaction
- Not to TENS but to electrodes etc

TENS Electrodes

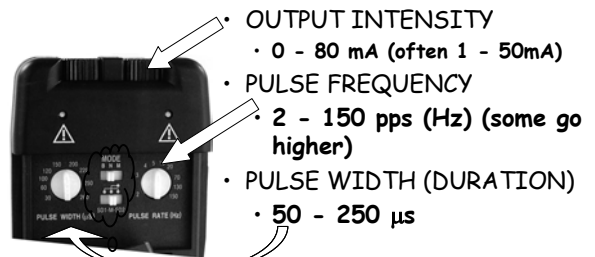
- Most therapists and patients use **pre-gelled, self adhesive electrodes**
- Designed to be **SINGLE PATIENT** but **MULTI USE** electrodes



TENS vs IFT

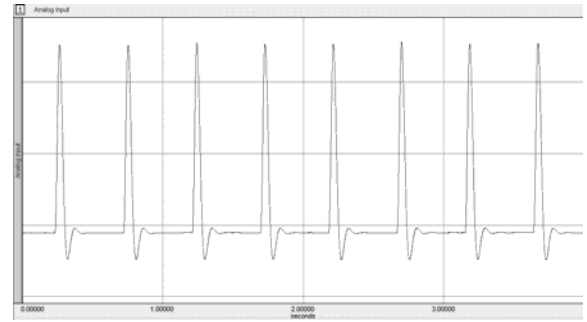
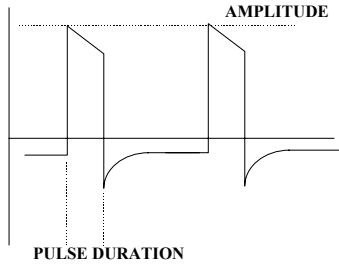
- Recent comparison (Shanahan et al 2006)
- TENS vs IFT both at 100Hz
- Experimental (cold induced) pain model
- Both produced significant increase in **PAIN THRESHOLD**
- TENS more effective than IFT
- Both equally effective in terms of **PAIN UNPLEASANTNESS** and **PAIN INTENSITY**
- Subject preference was for IFT even though TENS was more effective

Variables on modern TENS machines

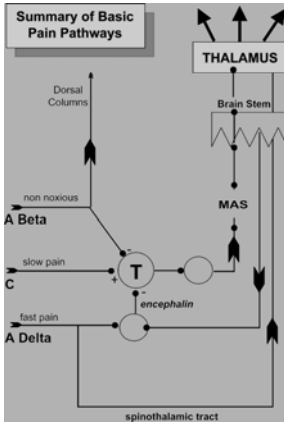


- **OUTPUT INTENSITY**
 - 0 - 80 mA (often 1 - 50mA)
- **PULSE FREQUENCY**
 - 2 - 150 pps (Hz) (some go higher)
- **PULSE WIDTH (DURATION)**
 - 50 - 250 μ s
- Most machines also offer a **BURST** mode
 - Delivers around 2 - 3 bursts per second
- Many machines also now offer a **MODULATED** output

TENS Pulse



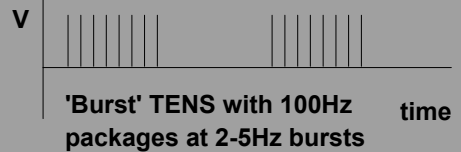
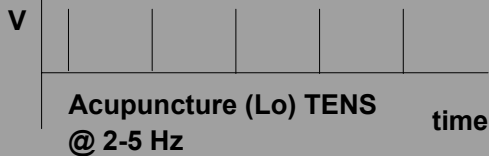
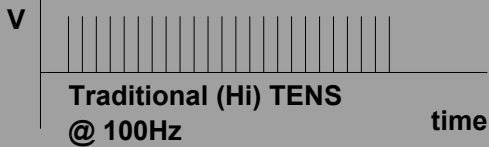
**TENS @ 2Hz to forearm.
200 microsec pulse duration.
TPN 200 Plus Machine**

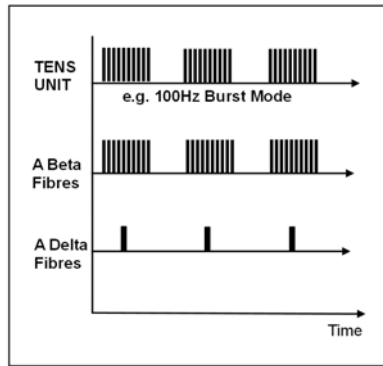


Stimulation Parameters

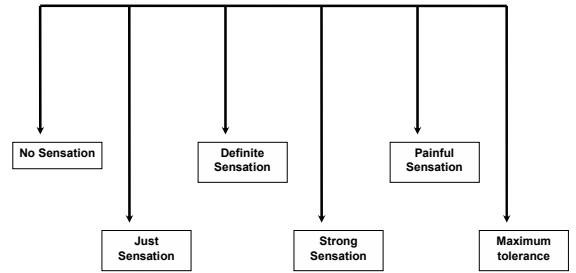
Aβ fibres → Pain Gate activation → 90 - 130 Hz

Aδ fibres → Opioid system activation → 2 - 5 Hz

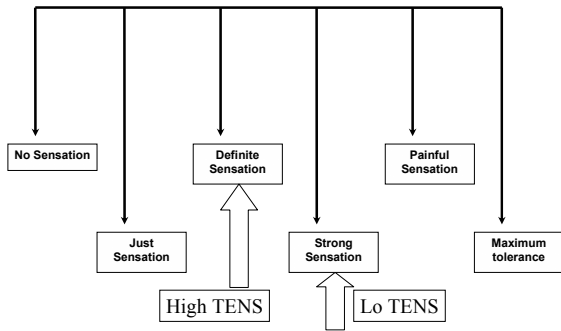




Stimulation Intensity

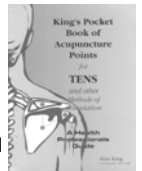
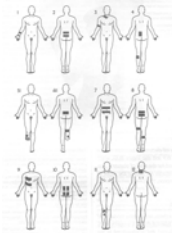


Stimulation Intensity

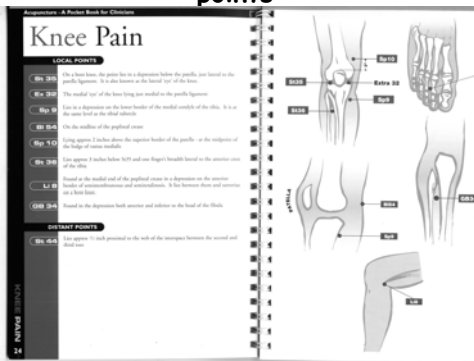


Electrode Placement

- ✓ Target stimulus at appropriate spinal level
- ✓ Either side of lesion
- ✓ Over nerve roots
- ✓ Over peripheral nerve
- ✓ At motor points
- ✓ At trigger/acupuncture points
- ✓ Dermatome, Myotome, Sclerotome
- ✓ If vague or extensive, can try 2 channel



Example of TENS at Acupuncture points



TENS Contraindications

- Patients who do not comprehend the physiotherapist's instructions or who are unable to co-operate
- Application of the electrodes over the trunk, abdomen or pelvis during pregnancy except if using TENS for labour pain
- Patients with a Pacemaker
- Patients who have an allergic response to the electrodes, gel or tape
- Dermatological conditions e.g. dermatitis, eczema
- Patients with current or recent bleeding / haemorrhage or with compromised circulation
- Application over the anterior aspect of the neck or carotid sinus

PRECAUTIONS

- If there is abnormal skin sensation, the electrodes should be positioned in a site other than this area to ensure effective stimulation
- Electrodes should not be placed over the eyes
- Patients who have epilepsy should be treated at the discretion of the physiotherapist in consultation with the appropriate medical practitioner
- Avoid active epiphyseal regions in children
- The use of abdominal electrodes during labour may interfere with foetal monitoring equipment

Recent Papers concerning Electrical Stimulation and Pain Management

Pearl, M. L. et al. (1999).

"Transcutaneous electrical nerve stimulation as an adjunct for controlling chemotherapy-induced nausea and vomiting in gynecologic oncology patients." *Cancer Nurs* 22(4): 307-11

BACKGROUND: To evaluate the efficacy of a miniaturized portable transcutaneous electrical nerve stimulation (TENS) unit (ReliefBand) as an adjunct to standard antiemetic therapy for controlling nausea and vomiting induced by cisplatin-based chemotherapy in gynecologic oncology patients.

Pearl et al (1999) contd

- **METHODS:** Forty-two patients were enrolled in a randomized, double-blind, placebo-controlled parallel-subjects trial with a follow-up crossover trial. All patients received a standardized antiemetic protocol, then wore the ReliefBand continuously for 7 days.
- **RESULTS:** Thirty-two patients were evaluable for the parallel-subjects component, 16 in each group.

Pearl et al (1999) contd

RESULTS (contd)

The percentage of patients with absent or minimal nausea was 59% overall, which was similar to that for both the active (56%) and placebo (62%) groups.

The incidence and severity of nausea and vomiting was similar for each group.

Eighteen patients completed two consecutive cycles and were evaluable for the crossover component.

Pearl et al (1999) contd

The percentage of cycles with absent or minimal nausea was 47% overall, which was similar to that of the active (50%) and placebo (44%) cycles.

However, the severity of nausea was significantly lower in the active cycles during days 2 to 4. Patients averaged less than one episode of vomiting daily in each cycle.

CONCLUSIONS: The ReliefBand is an effective adjunct to standard antiemetic agents for controlling nausea induced by cisplatin-based chemotherapy in gynecologic oncology patients.

Hamza, M. A. et al. (1999). "Effect of the frequency of transcutaneous electrical nerve stimulation on the postoperative opioid analgesic requirement and recovery profile." *Anesthesiology* 91(5): 1232-8.

BACKGROUND: Transcutaneous electrical nerve stimulation (TENS) at either an acupoint or dermatome corresponding to the surgical incision produces comparable decreases in postoperative opioid requirements and opioid-related side effects.

However, the effect of the frequency of the electrical stimulus on the postoperative analgesic response to TENS therapy has not been studied.

Hamza et al (1999) contd

One hundred women undergoing major gynecological procedures with a standardized general anesthetic technique were enrolled. Patients were randomly assigned to four groups:
Group I : patient-controlled analgesia (PCA) plus sham TENS (no stimulation)
Group II : PCA plus low-frequency (2-Hz) TENS
Group III : PCA plus high-frequency (100-Hz) TENS
Group IV : PCA plus mixed-frequency (2- and 100-Hz) TENS.

Hamza et al (1999) contd

The PCA device was programmed to deliver 2-3 mg intravenous boluses of morphine with a lockout interval of 10 min.

The TENS device was used every 2 h during the day.

Standard 100-mm visual analog scales were used to assess pain, sedation, fatigue, and nausea at specific intervals after surgery.

Hamza et al (1999) contd

RESULTS:

Mixed frequency (2 and 100 Hz) of stimulation decreased morphine requirements by 53% compared with the sham group;

Low (2-Hz) and high (100-Hz) frequencies produced 32% and 35% decreases, respectively.

All three "active" TENS groups reduced the duration of PCA therapy, as well as the incidence of nausea, dizziness, and itching.

Hamza et al (1999) contd

CONCLUSIONS:

TENS decreased postoperative opioid analgesic requirements and opioid-related side effects when utilized as an adjunct to PCA after lower abdominal surgery.

Use of TENS at mixed (2- and 100-Hz) frequencies of stimulation produced a slightly greater opioid-sparing effect than either low (2-Hz) or high (100 Hz) frequencies alone.

Ezzo, J. M. et al. (2006). "Acupuncture-point stimulation for chemotherapy-induced nausea or vomiting." *Cochrane Database Syst Rev*(2): CD002285.

BACKGROUND:

There have been recent advances in chemotherapy-induced nausea and vomiting using 5-HT₃ inhibitors and dexamethasone. However, many still experience these symptoms, and expert panels encourage additional methods to reduce these symptoms.

Ezzo et al (2006)

OBJECTIVES: The objective was to assess the effectiveness of acupuncture-point stimulation on acute and delayed chemotherapy-induced nausea and vomiting in cancer patients.

SELECTION CRITERIA: Randomized trials of acupuncture-point stimulation by any method (needles, electrical stimulation, magnets, or acupressure) and assessing chemotherapy-induced nausea or vomiting, or both.

Ezzo et al (2006) Main Results

- Eleven trials (N = 1247) were pooled.
- Overall, acupuncture-point stimulation of all methods combined reduced the incidence of acute vomiting (P=0.04), but not acute or delayed nausea severity compared to control.
- By modality, stimulation with needles reduced proportion of acute vomiting (P=0.01), but not acute nausea severity.
- Electroacupuncture reduced the proportion of acute vomiting (P=0.02), but manual acupuncture did not

Ezzo et al (2006) Results contd

- Acupressure reduced mean acute nausea severity (P = 0.04) but not acute vomiting or delayed symptoms.
- Noninvasive electrostimulation showed no benefit for any outcome.
- All trials used concomitant pharmacologic antiemetics, and all, except electroacupuncture trials, used state-of-the-art antiemetics.

Ezzo et al (2006) Conclusions

This review complements data on post-operative nausea and vomiting suggesting a biologic effect of acupuncture-point stimulation. Electroacupuncture has demonstrated benefit for chemotherapy-induced acute vomiting. Self-administered acupressure appears to have a protective effect for acute nausea and can readily be taught to patients though studies did not involve placebo control. Noninvasive electrostimulation appears unlikely to have a clinically relevant impact when patients are given state-of-the-art pharmacologic antiemetic therapy.

Roscoe, J. A. et al. (2002).

"Acustimulation wristbands for the relief of chemotherapy-induced nausea." *Altern Ther Health Med* 8(4): 56-7, 59-63.

- **CONTEXT:** Substantial evidence suggests that acupuncture-point stimulation may be effective in controlling side effects of chemotherapy.
- **OBJECTIVE:** To examine the efficacy of an acustimulation wristband for the relief of chemotherapy-induced nausea.
- **DESIGN:** Randomized clinical trial using a 3-level crossover design.
- **SETTING:** Three outpatient oncology clinics in the northeastern United States.

Roscoe et al (2002)

- **PARTICIPANTS:** Twenty-five women and 2 men who experienced moderate or more severe nausea following their first chemotherapy treatment.
- **INTERVENTION:** We compared active acustimulation of the Pericardium 6 (PC-6) point on the ventral surface of the wrist with sham acustimulation (a corresponding point on the posterior surface of the wrist). A control group received no acustimulation.
- **OUTCOME MEASURES:** Severity of nausea and quantity of antiemetic medication used.

Roscoe et al (2002)

- **RESULTS:** No statistically significant differences in average severity of nausea were observed between the 3 interventions.
- However, the data showed a difference close to statistical significance in the severity of delayed nausea reported during active acustimulation compared to no acustimulation ($P < .06$).
- In addition, patients took fewer anti-nausea pills during the active-acustimulation cycle of this experiment compared to the no-acustimulation phase ($P < .05$).
- **CONCLUSION:** Findings on the efficacy of an acustimulation band for the control of chemotherapy-induced nausea are positive but not conclusive.

Roscoe, J. A. et al. (2005).

"Acustimulation wrist bands are not effective for the control of chemotherapy-induced nausea in women with breast cancer." *J Pain Symptom Manage* 29(4): 376-84

- This experiment examined the efficacy of an acustimulation wrist band for the relief of chemotherapy-induced nausea using a randomized three-arm clinical trial (active acustimulation, sham acustimulation, and no acustimulation) in 96 women with breast cancer who experienced nausea at their first chemotherapy treatment.

Roscoe et al (2005)

- Five outcomes related to wrist band efficacy (acute nausea, delayed nausea, vomiting, QOL, and total amount of antiemetic medication used) were examined.
- There were no significant differences in any of these study measures among the three treatment conditions ($P > 0.1$ for all).
- Study results do not support the hypothesis that acustimulation bands are efficacious as an adjunct to pharmacological antiemetics for control of chemotherapy-related nausea in female breast cancer patients.

Brosseau et al (2004)

Efficacy of Transcutaneous Electrical Nerve Stimulation for osteoarthritis of the lower extremities: A Meta-Analysis
Physical Therapy Reviews 9:213-233

- Evaluated the effectiveness of TENS in treating OA pain
- Sig results favouring conventional and low TENS for pain relief and stiffness
- More effective for knee than hip pain
- Burst mode effective for knee pain and stiffness

Chen, L., J. Tang, et al. (1998). "The effect of location of transcutaneous electrical nerve stimulation on postoperative opioid analgesic requirement: acupoint versus nonacupoint stimulation." *Anesth Analg* 87(5): 1129-34.

- Sham controlled study
- Different TENS Rx parameters on post operative (total abdominal hysterectomy or myomectomy) pain
- 100 subjects ; 4 groups
- (1) Sham TENS @ ST36`Zusanli // (2) non acupoint TENS @ shoulder // (3) dermatome TENS @ level of incision // (4) acupoint TENS ST36 Zusanli

Chen et al (1998) contd

- TENS @ 2 and 100Hz
- VAS, sedation and fatigue assessed plus PCA usage
- TENS groups (3&4) required sig less opioid than sham & non-acu point groups
- 37-39% less drug needed than sham
- 35-38% less than non acu point group
- Not only used less opioid, but used PCA for shorter duration

Chen et al (1998) contd

- Peri-incisional and acupuncture point TENS both effective at managing post op pain compared with sham TENS and TENS to non acupuncture point
- Electrode position is important as the TENS applied to non acu point (shoulder) was not effective



Pain 99 (2002) 253-262

PAIN
www.elsevier.com/locate/pain

Sensory stimulation (TENS): effects of parameter manipulation on mechanical pain thresholds in healthy human subjects

Linda S. Chesterton^a, Panos Barlas^{a,*}, Nadine E. Foster^a, Thomas Lundberg^b,
Christine C. Wright^c, G. David Baxter^d

Chesterton et al 2002

- Varied TENS frequency (4 or 110 Hz)
- Varied TENS intensity (strong but comfortable or to tolerance)
- Varied electrode site (nerve or acupuncture point)
- Pulse duration fixed at 200 μ s
- 30 min Rx plus 30 min follow up

- High intensity, low frequency acu point stim produced rapid onset relief, built up over Rx period and was maintained for the follow up.
- Lower intensity, higher frequency stim at nerve produced comparable pain relief during stim but was not maintained during follow up

Lone et al (2003) Analgesic efficacy of TENS compared with Diclofenac Sodium in OA knee. *Physiotherapy* 89(8):478-485

- Single blind trial with n=35 patients
- numerous validated outcome measures
- Withdraw all drugs for 1 week
- Three expt phases (2 weeks each)
- 1 week washout between phases
- a) placebo drug and placebo TENS
- b) placebo TENS with real drug
- c) active TENS and placebo drug

Lone et al (2003) contd

- TENS was applied for 20 min 2x daily
- Stim parameters related to individual preference
- Placebo Rx were effective in achieving some pain relief
- Active drug was significantly better than placebo
- Did phase analysis

Lone et al (2003) contd

- **The phase comparison showed that the TENS Rx produced significant pain relief and improved walking in patients with mild to moderate pain and movement restriction.**
- **Significant improvement occurred after phase 2**
- **TENS was not very effective in pts with severe OA**

Han, J. S. et al (1991)

Effect of low- and high-frequency TENS on Met-enkephalin-Arg-Phe and dynorphin A immunoreactivity in human lumbar CSF
Pain 47(3);295-298

- TNS to 37 patients in 4 groups for 30 minutes
- 2 groups low frequency (2Hz) (one to hand, one to leg)
- 2 groups high frequency (100Hz) (one to hand, one to leg)
- Lumbar puncture before & immediately after stimulation

Han et al (1991) contd

- Analysis for opioid peptides
- Met-enkephalin-Arg-Phe (MEAP)
- dynorphin A (Dyn A)
- Low frequency stimulation to HAND and also to LEG resulted in marked increase (367%) of MEAP but not ir-Dyn A
- High-frequency TENS produced a 49% increase in ir-Dyn A (P less than 0.01) but not ir-MEAP.

Han et al (1991) contd

- First report in humans that 2 Hz and 100 Hz peripheral stimulation induces differential release of peptides.
- *(MEAP is opioid peptide related to CNS pain receptor sites whilst Dyn A it is now suggested, is found more in the cord and is considered to act as a moderator of the pain gate mechanisms rather than as an agent which blocks pain transmission directly)*

Ellis, B (1996): A retrospective study of long-term users of TNS

Br J Therapy & Rehab 3(2);88-93

- Literature suggests that long term TNS reduced effectiveness with time - ?? placebo effect diminishing
- Retrospective study 73 patients who had been loaned TNS device (8 weeks) during 1993-5 and who indicated that they intended to purchase machine.
- 74% had spine related problems
- All had chronic pain (1 - 40 years duration)
- >50% had less than 5 years pain
- 86% had received other physiotherapy treatment

- 66 patients available for follow up
- 44 had purchased machine
- All machines offered dual channel facility
- 73% only used 1 channel
- 70% used high frequency continuous
- 18% used low frequency
- 11% varied the frequency regularly
- 82% placed electrodes close to pain site

- Most patients used TNS 5 days a week (6.2 hrs/day)
- Few patients used TNS at night
- Mean pain relief 60% (range 20-100%)
- 70% reported improved function
- 57% of those who had purchased machines reported no change in pain relief
- 23% reported increased effectiveness
- 9% reported purchase of no value
- No patients who purchased reported increased pain