

PERCUTANEOUS ELECTRICAL NERVE STIMULATION (PENS) THERAPY FOR REFRACTORY PRIMARY HEADACHE DISORDERS

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Percutaneous electrical nerve stimulation (PENS) therapy

In PENS, one or more individual nerves or dermatomes are stimulated using needle probes. A single probe with a grounding pad or pairs of fine-gauge needles are inserted into the subcutaneous plane near the targeted nerves or into the affected dermatomes. The needles are connected to a low-voltage pulse generator and an electrical current is then applied. This may generate a sensation of paraesthesia and muscle contraction (due to alternating low and high frequency stimulation). The duration of treatment varies but each session of stimulation typically lasts between 15-60 minutes.

Randomised controlled trials (RCTs) have shown that PENS may be effective in chronic pain conditions such as sciatica, and diabetic neuropathic pain. Key efficacy outcomes in these trials include reduction in pain (alleviation of localised neuropathic pain, relief of allodynia and hyperpathia, reduction in the frequency of sharp shooting pains, reduction in the burning sensation), and associated functional and emotional improvements.

PENS is generally safe and well tolerated. Reports exist of exacerbation of pain, bruising and bleeding as immediate adverse events. Theoretical adverse events include local vascular or nerve damage; pneumothorax; possible interaction with a cardiac pacemaker if used above the waistline; possible epileptogenic effect if used near the head; and possible adverse effects if used in pregnancy. No published reports exist of any of these theoretical problems actually arising, however.

Neuromodulation for headache disorders

Headache disorders are the most common form of neurological disability on a global basis, and the sixth most common cause of disability worldwide. The cumulative lifetime incidence of migraine approaches 50% in females; the 1 year prevalence for cluster headache, for which there is no cumulative data, is about 0.1% of the population; approximately 2% of the population in developed countries have chronic daily headaches. The medical treatment of patients with primary and secondary headache syndromes can be very challenging as serious side effects frequently complicate the course of medical treatments, and some patients prove refractory to numerous and varied medications.

The last 10-15 years has seen the expansion of a new branch of headache treatment: neuromodulation. This group of techniques comprises non-invasive treatments which, by targeting the central or peripheral nervous system, aim at modifying pain and other mechanisms involved in headache, and more invasive surgical approaches directed towards structures directly involved in the genesis of specific headache syndromes. The fact that these approaches lack the side effects and drug interactions common to medical therapies make them attractive choices for many patients.

The principle of these approaches is to modulate the function of neuronal structures that are directly or indirectly involved in detection or transmission of painful stimuli, or in the processing of this information in the brain. Neuromodulation of headache disorders has been achieved by direct modulation of brain structures involved in the generation of attacks (deep brain stimulation of the hypothalamus in cluster headache, for example), modulation of inhibitory antinociceptive pathways (occipital nerve stimulation), modulation of cortical excitability (transcranial magnetic and direct current stimulation), and direct inhibitory effects at the level of the peripheral neuron or the spinal cord (TENS).

High quality randomised controlled trials are few and far between, however, and further controlled studies to validate, strengthen and disseminate the use of neuromodulation for headache disorders are needed. In addition, new techniques with proven safety and efficacy in other pain disorders, such as PENS therapy, should be trialled in headache disorders.

Methods

Our aim was to demonstrate whether percutaneous electrical nerve stimulation (PENS) therapy has a role to play in the management of refractory headache disorders. A retrospective review of the records of 36 patients who have been treated with supraorbital or occipital PENS therapy at our centre between September 2012 and June 2016 was undertaken. Follow-up data was available for 33 patients. Of these, 26 had a primary headache diagnosis, of whom 14 had **chronic migraine (CM)**, 9 had **chronic cluster headache (CCH)**, 2 had **new daily persistent headache** (with migrainous features), and one had **hemicrania continua**. The secondary headaches comprised occipital neuralgia, cervicogenic headache, and trigeminal neuropathy.

Technical details

PENS was given using Algotec® disposable 21 gauge PENS therapy probes (50mm) to the occipital nerve ipsilateral to the pain (or bilaterally in cases of bilateral pain). In some cases supraorbital PENS was tried on a second or subsequent occasion if the patient had failed to respond to occipital stimulation. Stimulation was delivered at 2 Hz/100 Hz, at 3 cycles/second, between 1.2-2.5 V depending on patient tolerability, for 25-28 minutes. No immediate complications were recorded during stimulation, apart from one patient who experienced pain during stimulation, and in most cases the treating neurosurgeon (DN) recorded good coverage and radiation of effect during stimulation.

Results

Six out of the nine patients with CCH improved significantly (see the table below); these patients had previously failed to respond to between two and eight oral preventive medications, and had at best experienced temporary benefit from nerve blocks with local anaesthetic agents. In all patients with CCH, PENS therapy was well tolerated, with no significant adverse events reported. One patient with CCH reverted to the episodic form of the disorder; this improvement has been maintained for more than two years following the cessation of therapy. Only three of the patients with CM experienced any noticeable benefit with PENS therapy; one patient with CM experienced pain during stimulation, two patients with CM experienced severe neck pain, and three patients with CM experienced an exacerbation of their condition lasting days to weeks. These adverse effects are possibly due to the presence of significant allodynia, not improved by PENS therapy.

Conclusion

PENS therapy shows great potential as a relatively non-invasive, low-risk, and inexpensive component of the treatment options for refractory primary headache disorders, particularly chronic cluster headache. Further trials of the technique in this debilitating condition are warranted.

Acknowledgements

The authors are grateful for the assistance of the nursing staff of Ward 10N, Charing Cross Hospital, in delivering PENS therapy to our patients, and to Coral Winslow-Llewellyn and Susan Daniels of Algotec® for their support.



Response to PENS therapy in chronic cluster headache

PATIENT #	AGE	SEX	YRS CH	YRS CCH	# PENS Rx	PREVIOUS PREVENTIVE TREATMENTS	BEST RESPONSE TO GONB	RESPONSE TO 1 st PENS Rx	SUBSEQUENT COURSE	OUTCOME
1	32	F	13	3	7	VER, TOP, LI, MEL, SVP, MTH, VNS	2-3 wks, itching & localised alopecia	6 wks pain free	Up to 3 mths pain free	Ongoing PENS therapy & GONB
2	39	M	4	3	2	VER, TOP, LI, MTH, PIZ	3-4 days	4 wks pain free	Only 3 days pain free	Referred for ONS
3	45	F	22	3	1	VER, TOP	N/A	Unhelpful	N/A	Ongoing medical treatment
4	49	M	9	9	1	VER, TOP, LI, MEL, DHE, INDO	3-4 days	4 days reduced severity	N/A	Ongoing medical treatment
5	42	F	2	1	8	VER, TOP, LI, MEL, MTH, INDO	Up to 5 wks, but less effective over time	5 days pain free	Up to 2 mths pain free	Reverted to episodic CH
6	63	M	7	5	3	VER, TOP	3-4 days	6 wks pain free	Up to 3 mths pain free	Ongoing PENS therapy
7	33	F	6	6	4	VER, TOP, LI, MEL, MTH, PRG, AMI, INDO, VNS	3-4 days, painful	6 wks pain free	6-8 wks pain free	Ongoing PENS therapy & referred for ONS
8	32	F	1	1	2	VER, TOP, LI, INDO	Unhelpful	6 mths reduced severity	3 mths pain free	Ongoing PENS therapy
9	29	M	12	12	1	VER, TOP, LI	3-4 days	6 mths reduced severity	N/A (declined further PENS Rx)	Ongoing medical treatment

CH: cluster headache; CCH: chronic cluster headache; VER: verapamil; TOP: topiramate; LI: lithium; MEL: melatonin; SVP: sodium valproate; MTH: methysergide (no longer available); VNS: vagal nerve stimulation (non-invasive); PIZ: pizotifen; DHE: dihydroergotamine (IV infusion); PRG: pregabalin; AMI: amitriptyline; INDO: indomethacin; GONB: occipital nerve blockade (with Depo Medrone & lidocaine); ONS: occipital nerve stimulation.