Percutaneous Electrical Nerve Stimulation – Electroacupuncture by Another Name? A Comparative Review.

Mike Cummings

Summary
Percutaneous electrical nerve stimulation (PENS) is a technique that has been described as a ‘novel analgesic therapy’. A review was performed of the published literature in order to compare PENS with the author’s knowledge and experience of the use of EA, specifically with regard to the stimulation parameters, the selection of points, and the reported efficacy. The conclusion of the review is that PENS is neither different in principle nor in practice from EA, and whilst the term accurately reflects the nature of the treatment, there is no substantial justification for referring to PENS as a novel therapy.

Keywords
Percutaneous electrical nerve stimulation, electroacupuncture, review.

Introduction
During a casual search for recent reviews of TENS (transcutaneous electrical nerve stimulation) in the Cochrane database, the author happened upon the lesser know acronym PENS (percutaneous electrical nerve stimulation) for the first time. At a first glance over several abstracts of RCTs of PENS, there appeared to be a remarkable similarity between this ‘novel technique’ and the more familiar EA (electroacupuncture). The author was concerned that these papers had been missed from his routine literature searches for acupuncture papers, because the abstracts of the PENS papers did not include any text beginning with the stem ‘acup’ – the search term he had regularly employed.

Methods
A computerized text word search of PubMed and the Cochrane database was performed in February 2001 using the search term ‘pens’. No other restrictions were applied to the search. A further text word search of PubMed was performed using the complete term ‘percutaneous electrical nerve stimulation’. Reading the titles and abstracts identified the references of relevance, and these papers were obtained. An analysis of the technique of PENS described in the papers was compared with the author’s knowledge and experience of the use of EA, specifically with regard to the stimulation parameters, both manual and electrical, the selection of points, and the reported efficacy.

Results
The PubMed search using the text word ‘pens’ produced 1268 references. The subsequent search using the complete term ‘percutaneous electrical nerve stimulation’ revealed only 13 references,1-13 and a search of the Cochrane database did not produce any additional ones. Of the 13 references, there were seven relevant RCTs,1-7 and one case series.8 The other references were to letters,9-13 and one reference was to a systematic review of treatments for herpes zoster9 that mentioned one of the PENS trials already identified.5
eight papers included in the review are summarised in table 1.

**Stimulation parameters**

**Manual**

All the PENS trials use ‘acupuncture-like needle probes’ inserted to a depth of between 1cm and 4cm. These probes were obtained from a Japanese company that produces acupuncture needles. The needles used were 32G (0.25mm diameter). This is a very commonly used gauge of needle for EA. Whilst the PENS papers do not mention manipulation of the needles, other than careful insertion, the stimulation is likely to be indistinguishable from that when performing EA.

**Electrical**

**Waveform –** In four of the PENS papers a unipolar square wave of 0.5ms duration is reported to have been used.1,3,4,6 In one paper a biphasic wave is reported to have been used.7 The sciatica trial reportedly used a pulse width of 0.1s (100ms);7 pulse widths of over 0.5ms are avoided in EA because they are excessively painful, so this is likely to be a reporting error. Biphasic waves tend to be the norm in modern EA, and the pulse widths most frequently used are around 0.2ms; however, these differences are unlikely to have a significant effect on nerve depolarisation in comparison with the current utilised and the proximity of the needle electrodes to nerve tissue.

**Frequency –** PENS was applied at either 4Hz, 100Hz or at an alternating frequency of 15 and 30Hz; 4Hz alone was used in two papers,1,2 15/30Hz was used exclusively in three papers,4,6,7 and in two papers all three frequencies were applied.3,8 These frequencies are all within the standard range used in EA. One paper claimed a benefit of 15/30Hz over either 4 or 100Hz;8 however, as there was no control for the alternation of frequency, it cannot be said that these frequencies are superior – any difference

*Table 1  Papers on Percutaneous Electrical Nerve Stimulation (PENS)*

<table>
<thead>
<tr>
<th>Clinical area</th>
<th>Periodical</th>
<th>Year</th>
<th>Type of study</th>
<th>Score</th>
<th>N</th>
<th>Reported result</th>
</tr>
</thead>
<tbody>
<tr>
<td>low back pain (LBP)</td>
<td>JAMA</td>
<td>1999</td>
<td>RCT - crossover 1/52 washout</td>
<td>3</td>
<td>60</td>
<td>PENS &gt; sham PENS (p&lt;0.02)</td>
</tr>
<tr>
<td>Sciatica</td>
<td>Pain</td>
<td>1999</td>
<td>RCT - crossover 1/52 washout</td>
<td>1</td>
<td>64</td>
<td>PENS &gt; sham PENS (p&lt;0.01)</td>
</tr>
<tr>
<td>LBP – comparing frequencies of PENS</td>
<td>Anesth Analg</td>
<td>1999</td>
<td>RCT - crossover 1/52 washout</td>
<td>1</td>
<td>68</td>
<td>15/30Hz &gt; 4 or 100Hz (p&lt;0.05)</td>
</tr>
<tr>
<td>LBP – comparing duration of PENS</td>
<td>Anesthesiology</td>
<td>1999</td>
<td>RCT - crossover 1/52 washout</td>
<td>1</td>
<td>75</td>
<td>30/45mins &gt; 15mins (p&lt;0.05)</td>
</tr>
<tr>
<td>Herpes zoster</td>
<td>Anesth Analg</td>
<td>1998</td>
<td>RCT - parallel PENS vs famciclovir</td>
<td>2</td>
<td>50</td>
<td>PENS &gt; famciclovir (p&lt;0.05)</td>
</tr>
<tr>
<td>Mixed headache</td>
<td>Headache</td>
<td>1999</td>
<td>RCT - crossover 1/52 washout</td>
<td>1</td>
<td>30</td>
<td>PENS &gt; sham PENS (p&lt;0.05)</td>
</tr>
<tr>
<td>Diabetic neuropathic pain</td>
<td>Diabetes Care</td>
<td>2000</td>
<td>RCT - crossover 1/52 washout</td>
<td>1</td>
<td>50</td>
<td>PENS &gt; sham PENS (p&lt;0.05)</td>
</tr>
<tr>
<td>Pain from bony metastases</td>
<td>Clin J Pain</td>
<td>1998</td>
<td>Case series n/a</td>
<td>3</td>
<td></td>
<td>2 of 3 patients achieved good to excellent pain relief with PENS</td>
</tr>
</tbody>
</table>

Score – this is the Jadad score, a measure of internal validity, with a maximum possible value of 5.

N – number of subjects in the study.

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2. www.medical-acupuncture.co.uk/aimintro.htm

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may have been due to the alternation rather than the specific frequencies.

Amplitude – Where details were given, the PENS papers describe a low output electrical generator that produces a current of less than 25mA. In the application of PENS the authors state that the intensity of the electrical stimulation was adjusted to produce the maximum tolerable sensation without muscle contraction. This is likely to correlate with relatively mild EA stimulation, since muscle contraction is actively sought in the latter, although the intensity perceived by the patient, rather than muscle contraction, generally determines the maximum amplitude applied.

Point Selection
The PENS papers describe point selection based on dermatomes, though this is used to imply segmental principles, since deeper tissues are invariably stimulated. Some of the diagrams in the papers are not consistent with stimulating the intended segments, but these probably represent reporting errors rather than errors in point selection. In the reply to a letter published in Anesthesia and Analgesia, White and Craig (whose names appear on the author list of all the PENS papers) justify calling PENS a novel therapy, different from EA, because the principles of point selection are based on segmental ideas rather than on classical Chinese teachings. Of course, EA is not a classical Chinese technique, as it was invented in the 1950s as an alternative to surgical anaesthesia, and whilst classical points are used, local segmental needling is also commonly applied. Moreover, segmental EA has been formally taught on British Medical Acupuncture Society courses for at least the last 10 years.

Efficacy
The active intervention proved significantly superior to the control in all seven RCTs of PENS. Sham PENS was used as a control in six of these trials. When treated with sham PENS there was no significant change in outcome measures for any group in these trials. Sham PENS involved inserting 0.25mm diameter needles at the same sites, and to the same depths (1cm to 4cm), as used in the PENS procedure, but there was no electrical stimulation of the needles. These are the only reports of a sham procedure involving skin penetration, to the author’s knowledge, in which there was no significant change in any outcome measure following the intervention.

Discussion
In terms of the sensory stimulus applied to the patient, PENS is certainly a form of EA. The name ‘percutaneous electrical nerve stimulation’ may be novel, and is an accurate description of the technique, but this reviewer feels that describing PENS as a ‘novel analgesic therapy’ is not supported by the information in the published literature. Whilst traditional Chinese acupuncture does not use terminology such as dermatomes, myotomes, sclerotomes and viscerotomes, it is likely that the majority of traditional acupuncture treatments involve segmental stimulation, both in the approach to pain and to visceral disease. Therefore, whatever the name given to the treatment, the stimulus to the patient’s nervous system is likely to be indistinguishable.

Two of the authors of the PENS papers formed a company (PENS Inc.) for the purpose of developing an electrical generator for PENS therapy. If such a device gains FDA approval, they expect to receive direct financial benefits. This reviewer was able to mimic the stimulation parameters described in the PENS papers with a commercially available EA device (Cefar Acus II), with the exception of the pulse width – a maximum pulse width of 0.45ms can be produced with the Acus II, rather than the 0.5ms described in the PENS papers. With two needles inserted bilaterally in tibialis anterior, an alternating frequency of 15/30Hz was applied with a bipolar square wave and a pulse width of 0.45ms. Robust muscle contractions were produced without
discomfort at an amplitude of 3.5mA. This reviewer contends that commercially available EA devices are likely to offer a sufficient variety of stimulation characteristics for optimal peripheral nerve stimulation, and there is unlikely to be a need to develop a further device.

The matter of the consistent lack of efficacy of sham PENS, a stimulus that equates to standard segmental dry needling, is puzzling. In blinded trials of acupuncture for chronic low back pain, penetrating controls have been associated with a 50% response rate.19 Sham PENS has not been reported to produce any significant change over time in the published trials to date.

Whilst the reviewed papers have produced consistently positive results for PENS, there is clearly a need for independent research to confirm the findings of this group. It is suggested that future trials address the issue of adequate masking, which appears to have been lacking in the papers to date. The term ‘percutaneous electrical nerve stimulation’ is acceptable for reporting purposes, however, it is suggested that the term ‘acupuncture’ is included in the keywords or abstract of future papers so that they are revealed in the electronic literature searches of relevant systematic reviews.

In conclusion, this review finds that PENS is neither different in principle nor in practice from EA, and whilst the term accurately reflects the nature of the treatment, there is no substantial justification for referring to PENS as a ‘novel analgesic therapy’.

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Reference List
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