Does Fixed-Site High-Frequency Transcutaneous Electrical Nerve Stimulation Provide Analgesia Beyond Application Site?

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INTRODUCTION

Transcutaneous electrical nerve stimulation (TENS) is a non-invasive treatment for chronic pain that has no major side effects. Conventional TENS is delivered through surface electrodes at a frequency and intensity that produces a strong, nonpainful sensation. The resulting stimulation of large diameter, deep tissue afferents produces pain relief by decreasing central excitability and increasing central inhibition.

In traditional practice, TENS electrodes are applied to the painful area. Alternative sites are recommended if localized placement is undesirable due to skin irritation or allodynia, or impractical as in the case of phantom limb pain. Stimulation proximal to the pain, distal to the pain, contralateral to the pain, within the same dermatomes as the pain and extra-segmentally have all been shown to be effective.

The widespread analgesic effects of TENS form the mechanistic basis for fixed-site high-frequency TENS (FS-TENS). In this approach, the stimulator is designed for a predetermined location rather than for co-localization with the patient's pain. A single target site enables discreet devices that are suitable for frequent use and are compatible with activity and sleep. FS-TENS has been shown to be effective in chronic lower extremity and low back pain.

In this study, we evaluated whether FS-TENS has widespread effects by comparing outcomes in subjects with and without pain in the area of electrical stimulation.

METHODS

Data previously collected from 130 subjects with chronic pain using an FS-TENS placed on the upper calf was analyzed (Gozani 2016). Inclusion criteria were age≥40 years and low back pain (LBP) or lower extremity pain (LEP) involving the feet or legs for ≥3 months.

Subjects completed a baseline demographic, medical history and pain (Brief Pain Inventory, BPI-SF) questionnaire. At 60 days, self-rated change in chronic pain (5-point PGIC), self-reported change in analgesic consumption (5-point scale) and endpoint BPI-SF were assessed. All subjects signed electronic informed consent at enrollment.

Table 1 Comparison of baseline demographics and pain characteristics between subjects with and without lower extremity pain

Characteristic	No Lower Extremity Pain (N=25)	Lower Extremity Pain (N=63)	p-value
Female: N (%)	9 (36.0)	31 (49.2)	0.26[b]
Age: N (%)			
<50 years	6 (24.0)	17 (27.0)	0.91[c]
50 – 65 years	14 (56.0)	32 (50.8)	
>65 years	5 (20.0)	14 (22.2)	
Duration of pain >4 years: N (%)	17 (68.0)	39 (61.9)	0.59[b]
Number of pain sites: mean (SD)	1.9 (1.0)	4.0 (2.1)	<0.01[b]
Distribution of pain: N (%)[a]			
Low back	25 (100)	50 (79.4)	0.01[d]
Upper extremity	11 (44.0)	44 (69.8)	0.02[d]
Number of painful health conditions: mean (SD)	1.6 (0.82)	2.3 (1.3)	0.02[d]
Brief Pain Inventory: mean (SD)			
Average pain	5.7 (1.5)	6.0 (1.5)	0.23[d]
Worst pain	6.9 (1.7)	7.2 (1.4)	0.55[d]
Sleep interference	5.6 (2.5)	7.1 (2.4)	0.01[d]
Walking ability interference	5.2 (2.9)	6.6 (2.5)	0.04[d]
General activity interference	5.8 (2.3)	6.7 (2.7)	0.06[d]
Mood interference	5.6 (2.6)	6.3 (2.5)	0.25[d]
Pain relief	41 (21)	45 (23)	0.44[d]

Notes: [a]More than one category per participant may apply. [b]two sample z-test. [c]Pearson chi-squared test. [d]Mann-Whitney U test.
Abbreviations: SD, standard deviation.

Table 2 Change in pain measures from baseline to 60-day follow-up

Characteristic	No Lower Extremity Pain (N=25)	Lower Extremity Pain (N=63)	p-value
Brief Pain Inventory: mean (SD)			
Average pain	-0.76 (1.6)	-0.19 (1.6)	0.27
Worst pain	-0.76 (2.2)	-0.81 (1.7)	0.87
Sleep interference	-0.44 (2.4)	-1.4 (2.7)	0.16
Walking ability interference	-0.76 (3.9)	-1.4 (2.3)	0.34
General activity interference	-0.48 (2.7)	-1.3 (2.3)	0.23
Mood interference	-1.0 (3.3)	-0.56 (2.7)	0.45
Pain relief	16 (25)	16 (27)	0.86

Notes: Brief pain inventory p-values determined by Mann-Whitney U test.
Abbreviations: SD, standard deviation.

RESULTS

Follow-up data was available for 88 subjects; 25 -LEP and 63 +LEP.

At baseline (Table 1), the groups differed in pain sites (-LEP 1.9±1.0 vs. +LEP 4.0±2.1, p<0.01), painful conditions (1.6±0.82 vs. 2.3±1.3,p=0.02), LBP (100% vs. 79.4%, p=0.01), upper extremity pain (44.0% vs. 69.8%, p=0.02), and interference with walking (5.2±2.9 vs. 6.6±2.5, p=0.04) and sleep (5.6±2.5 vs. 7.1±2.4, p=0.01).

At 60-days, there were no statistically significant differences in PGIC ("improved/much improved", 84.0% vs. 79.4%, p=0.62), reduction in analgesic use ("decreased a-lot/decreased a-little", 60.0% vs. 69.8%, p=0.38), and baseline to endpoint changes in pain intensity or interference (Table 2).

CONCLUSIONS

FS-TENS does not require pain at the site of stimulation to be effective. This result suggests that the analgesic effects of FS-TENS are related to segmental and extra-segmental circuits, likely involving descending pain inhibition.

References

Gozani SN. Fixed-site high-frequency transcutaneous electrical nerve stimulation for treatment of chronic low back and lower extremity pain. *Journal of Pain Research*. 2016;9:469-479.

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