Electroencephalographic evoked pain response is suppressed by spinal cord stimulation in complex regional pain syndrome: a case report

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Introduction

Spinal cord stimulation (SCS) is considered as an option for the management of complex regional pain syndrome (CRPS). Hyperalgesia, an increased pain response to a mechanical or thermal stimulus at normal or increased threshold is a common feature of CRPS. Animal studies have demonstrated that SCS significantly reduces mechanical hyperalgesia. These studies suggest that SCS mechanisms may involve reduction of glial activation at spinal cord level and/or activation of μ-opioid and δ-opioid receptors. However, in humans it has been observed that SCS had no effect on experimental pain thresholds and did not produce decreased sensitivity for pressure, warmth, and cold induced pain in CRPS patients. The majority of currently available studies on the effectiveness of SCS, including those using quantitative sensory testing (QST) rely on patient reported outcomes such as visual analogue or numerical rating scales. The current case report investigates the effectiveness of SCS based on electroencephalogram (EEG) analysis of contact heat evoked potentials following experimental induction of thermal stimuli.

Case report

The patient developed neuropathic pain in both hands in 1999, when she was 57 years of age. Investigations included magnetic resonance imaging (MRI) of the brain and cervical spinal cord which found only insignificant minor ischaemic areas of brain and spondylitic changes of cervical spine without nerve compression. The patient was considered for SCS on 11/04/2005 and following a successful SCS trial period (≥ 50% pain relief during one week trial) had a permanent system with an octopolar lead placed at C4 and dual quadrupolar leads at T10 implanted on 06/11/2006.

Following ethical approval and informed consent the patient switched off the implantable pulse generator (IPG) the night prior to the test session. We induced thermal stimuli using a quantitative sensory testing system on the right hand of the patient with the spinal cord stimulator switched off and with the spinal cord stimulator switched on. The patient reported a clinically significant reduction in thermal induced pain using the numerical rating scale (71.4% reduction) with spinal cord stimulator switched on.

Analysis of electroencephalogram recordings indicated the occurrence of contact heat evoked potentials (N2-P2) with spinal cord stimulator off, but not with spinal cord stimulator on (Figure 1).

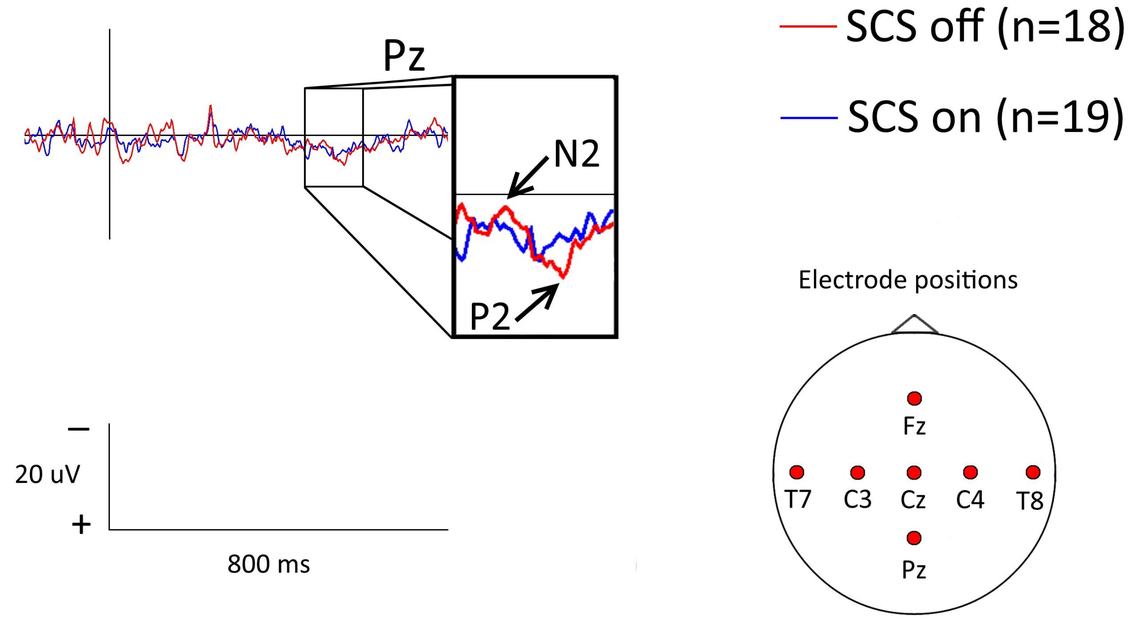

Figure 1. Scalp distribution of the effect of spinal cord stimulation on contact heat evoked potentials

Discussion

A deflection in the waveform which resembles the N2-P2 complex that is characteristic of a contact heat evoked potential 7 was observed when the patient had the SCS switched off. There was no observable evoked potential when the patient had the SCS switched on. It should be noted that due to the small number of stimuli used, the EP is greatly affected by noise. In order to confirm and extend this limited observation, future work would benefit from an increase in the number of stimuli. Here, 25 stimuli were used in each condition, which were further reduced to 18/19 after removal of eyeblink artefacts. By increasing the number of stimuli to >40 the average waveform would benefit from an improved signal to noise ratio, making the presence or absence of an EP more obvious. It is possible that EPs were occurring during the SCS on condition, but were obscured by the presence of random noise, and an increase in the number of stimuli would reveal any EP present in the data. We note that it is important to minimise participant discomfort, especially when the study involves inflicting pain on a person already suffering chronic pain. However, the present case study demonstrates the need for more stimuli, if we are to gather higher quality data in the future.

Conclusion

This case report suggests that SCS for the management of CRPS may contribute to a decrease in both the subjective perception of thermal pain and the neuronal activity evoked by pain stimuli. Further research is warranted to corroborate these results.

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