Influence of spinal cord stimulation on evoked potentials by cutaneous electrical stimulation

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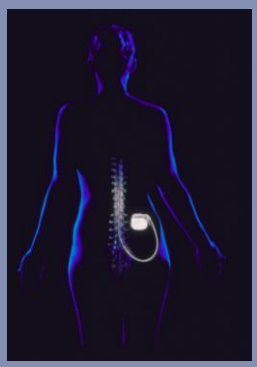
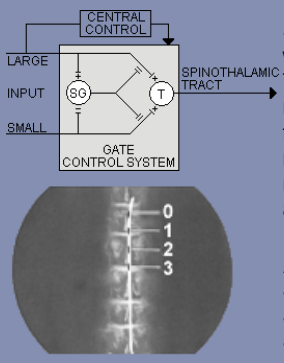




Introduction

Spinal cord stimulation (SCS) is an invasive technique for pain suppression. An electrode with several tips is positioned in the epidural space in order to stimulate the dorsal columns. The exact mechanisms of this pain suppression technique are unknown: the frequently mentioned Gate control theory [1] explains success but not failure. More research is therefore required. Theuvenet [2] demonstrated effect of SCS on MEG responses to median nerve stimulation. However, this stimulation method is not selective for pain specific nerve fibres, as larger fibres are preferentially stimulated. Furthermore, MEG is not clinically available on large scale.

Aims

- To explore the technical feasibility of Evoked Potentials (EPs) in patients receiving SCS
- To evoke brain responses using selective Aδ (pain specific) cutaneous afferents
- To study the effect of SCS on EP morphology

Methods

Subjects

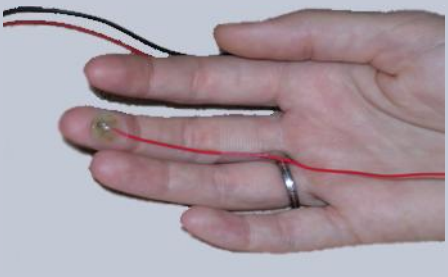
In this study healthy (pain free) subjects as well as chronic pain patients participated. Eight patients with various unilateral chronic pain aetiologies who benefit from SCS have been studied. In all patients (2 male, 6 female), age 21-67 years, the SCS electrodes were positioned in such a way that the paresthesia completely overlapped the painful skin area. The pulse generator was implanted in the left abdominal wall.

Evoked Potential Recording

The EPs have been recorded with 64 electrodes in the extended international 10-20 system (0.16-70Hz bandwidth). Offline EOG rejection was applied, before averaging all sweeps. The Cz-channel was referenced to earlobe A2 and used for analysis.

Protocol

EPs were recorded under SCS and non-SCS conditions from using electrical stimulation on a chronic pain location and its contralateral location (Table). For each location, sensation threshold was determined within a few minutes after the SCS-system had been switched off. Subsequently, a series of 30 identical stimuli just above sensation level were given with a random inter-stimulus interval (12-17 s). The patient was asked to report the intensity of every perceived stimulus, using a numeric rating scale from 0 (no sensation) to 100 (intolerable pain).



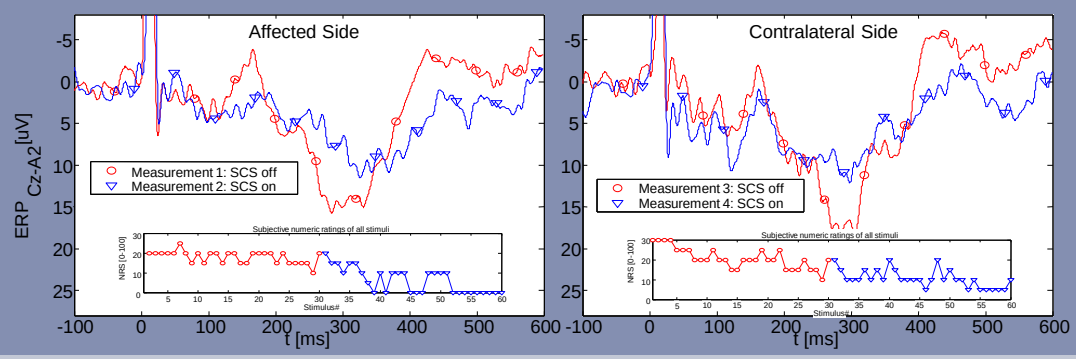
Stimulation

A small (∅ 1 mm) electrode was used that stimulates primarily Aδ fibres [3]. Stimuli consisted of biphasic pulse trains (3 pulses) with a pulse duration of 0.2 ms (cathodic phase) and an inter pulse interval of 5 ms.

Measurement	1	2	3	4
Skin area	affected	affected	contralateral	contralateral
SCS	off	on	off	on

Results

The graphs below show examples of EPs measured with and without SCS. They show decreased amplitude between 200 and 400 ms in the SCS condition compared to the non-SCS condition. It is suggested [4] that the amplitude difference between the small negative component and the subsequent large positive component can be used as a tool for pain measurement. Many patients reported declining grades for the given stimuli during each measurement (Numeric Rating Scale from 0 (no sensation) to 100 extremely painful). In addition patients reported differences in quality of perception: without SCS the stimulus was felt as a short, sharp pinprick, whereas with SCS the stimulus was felt dull and less intense.



Conclusions

- EPs can be obtained from patients receiving SCS for treatment of chronic pain.
- Our EPs suggest that primarily Aδ fibres are stimulated.
- More measurements are needed to differentiate between effects of SCS and habituation.

References

1: Melzack & Wall. Science 1965;150:971-79
2: Theuvenet *et al.*, Brain Topography 1999;11:305-13
3: Inui *et al.* Pain 2002;96:247-52
4: Bromm & Lorenz. Electroenc Clin Neurophysiol 1998;107:227-53