HUMAN MODELS OF CENTRAL SENSITIZATION USING HIGH-FREQUENCY CONDITIONING ELECTRICAL STIMULATION: PSYCHOPHYSICAL AND ELECTROPHYSIOLOGICAL ASSESSMENT USING REFLEX RECEPTIVE FIELDS


Contact: oka@hst.aau.dk

Introduction

- Central sensitization (CS) denotes an increased responsiveness of nociceptive neurons in the central nervous system to normal or sub-threshold afferent input.
- CS can be experimentally induced by conditioning electrical stimulations (CES). Quantification of CS can be performed by subjective psychophysical and objective electrophysiological parameters such as nociceptive withdrawal reflex (NWR) [1,2].
- Reflex Receptive Field (RRF) features, derived from NWR, can provide additional information about the state of the nociceptive system [2].
- In this study, high frequency CES is applied on healthy volunteers in order to induce long lasting CS.

Methods

- Nine volunteers (5 males and 4 females, mean age 23.6 years, range 22-26 years) participated in the study.
- Each subject participated in two sessions (control and a conditioning), each session consisting of 6 CES recordings (2 baselines and 4 tests).
- CES consisted of 5 trains of 100 pulses (2 ms pulse width) delivered at 100 Hz and repeated at 10 s intervals, with a stimulation intensity equal to 5 times detection threshold for a single electrical stimulus [1].
- Eight surface stimulation electrodes were mounted on the sole of the foot in order to assess the RRF.
- Each NWR stimulation consisted of a train of 5 pulses (1 ms pulse width) delivered at 200 Hz. Each train was repeated 5 times at 3 Hz in order to elicit temporal summation.
- Primary and secondary hyperalgesia were assessed on the conditioned foot using single electrical stimulation and calibrated punctuate probes. The non-conditioned foot was also tested by applying single electrical stimulation.
- Pain ratings were quantified using a Visual Analogue Scale (VAS).
- A two-way-ANOVA (session x time) was used to analyze the psychophysical data. A three-way-ANOVA (session x time x stimulation number) was used to analyze the reflex data.

Experimental protocol

- Time course of the experiment (conditioning session displayed). In the figure, s is assessment of pain threshold. * is test of primary hyperalgesia, □ is test of secondary hyperalgesia, X is the RRF recordings.

Results

Electrical stimulation

- High-frequency CES evoked significant increase in pain ratings to single electrical stimulation on both conditioned (P<0.05) and non-conditioned foot (P<0.05) compared to control.

Mechanical stimuli

- High-frequency CES evoked significant increase in pain ratings to calibrated punctuate probes (P<0.05).

RFF recording methodology: (a) Experimental setup, (b) NWR recording and correlation to electrode placement, (c) RRF map

- RRF sensitivity areas were calculated as the fraction of the sole of the foot delimited by a threshold set by the peak RMS amplitude minus two times the standard deviation of the remaining RMS amplitudes.
- RRF probability areas were calculated as the fraction of the sole of the foot from which a NWR can be elicited by at least 60% of the stimulations.
- RRF volumes were obtained by integrating RMS or probabilities over the RRF areas.

Discussion

- A model for CS was established using high-frequency CES.
- Psychophysical measures showed primary and secondary hyperalgesia in line with previous studies [3].
- Hyperalgesia was also observed on the non-conditioned foot after CES.
- A change of the RRF was observed after CES, in line with results from experimental CS models and chronic pain patients.

References