Journal of Neuroscience Methods 293 (2018) 17–26

Contents lists available at ScienceDirect

Journal of Neuroscience Methods

journal homepage: www.elsevier.com/locate/jneumeth

Research article

Micropatterned surface electrode for massive selective stimulation of intraepidermal nociceptive fibres

Massimo Leandri[a,b,*], Lucio Marinelli[a,b,c], Antonio Siri[d,e], Luca Pellegrino[e]

[a] Department of Neuroscience, Rehabilitation Ophthalmology, Genetics, Maternal and Child Health (DINOGMI), University of Genova, L.go Daneo 3, 16132, Genova, Italy
[b] Interuniversity Centre for Pain Neurophysiology (CIND), University of Genova, Via Dodecaneso 35, 16146, Genova, Italy
[c] Department of Neuroscience, Ospedale Policlinico San Martino, L.go R. Benzi 10, 16132, Genova, Italy
[d] Physics Department, University of Genova, Via Dodecaneso 33, 16146, Genova, Italy
[e] National Research Council, CNR-SPIN, Corso Perrone 24, Genova, 16152, Italy

HIGHLIGHTS

- A new surface electrode for selective stimulation of nociceptive afferents is presented.
- The electrode is characterized by a micropattern with 150 μm gaps covering large areas without loss of selectivity.
- Only late SEP responses can be recorded with our electrode.
- Conversely, with a wider gap electrode, early and medium SEP components can be recorded.
- Lack of early and medium SEP components show selectivity of our electrode, which is an alternative to laser stimulation.

ARTICLE INFO

Article history:
Received 20 June 2017
Received in revised form 20 August 2017
Accepted 26 August 2017
Available online 9 September 2017

Keywords:
Pain
Free nerve endings
Electrode
Micropattern
Evoked potentials
Stimulation

ABSTRACT

Background: No satisfactory neurophysiological test for nociceptive afferents is available to date. Laser stimuli present risks of skin damage, whilst electrical stimulation through specially designed electrodes is not selective enough.
New method: We present a new electrode designed according to critical issues identified in preliminary computer simulations concerning electric field gradient through the skin. To provide selective stimulation the activating electric field must be limited to intraepidermal free nerve endings. To this end, a new interdigitated electrode (IDE) was made of conductive rails arranged in a comb-like micropattern, situated only 150 μm apart from each other (150 IDE) and alternately connected to the opposite poles of the stimulator.
Results: Evoked potentials recorded from the scalp were obtained after stimulation with the 150 IDE and with a similarly designed, but more widely spaced electrode (1000 μm, or 1000 IDE). Small amplitude early and medium latency components were recorded with the 1000 IDE, suggesting activation of Aβ fibres. On the other hand, the 150 IDE only evoked late responses, confirming sufficient selectivity in small fibre activation.
Comparison with existing method(s): The main differences with existing electrodes are: 1) Microspaced interdigitated conductive rails. 2) The potentially unlimited surface of stimulation and high efficiency per surface unit, resulting in large numbers of activated nociceptors.
Conclusions: A new electrode providing selective stimulation of nociceptive nerve free endings is presented. It is non-invasive, and its surface can be enlarged at will. It is expected that it may greatly help in neurophysiological assessment of conditions affecting the nociceptive pathway.

* Corresponding author at: Department of Neuroscience, Rehabilitation, Ophthalmology, Genetics, Maternal and Child Health (DINOGMI), University of Genova, L.go Daneo, 3, Genova, 16132, Italy.
E-mail address: massimo.leandri@unige.it (M. Leandri).

http://dx.doi.org/10.1016/j.jneumeth.2017.08.032
0165-0270/