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Topographic analysis of laser evoked potentials in chronic tension-type headache: Correlations with clinical features

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Abstract

In the present study, we examined clinical and laser-evoked potentials (LEP) features in a group of chronic tension-type headache (CTTH) patients, in order to perform a topographic analysis of Laser evoked potentials (LEPs) and a correlation with clinical features. Eighteen patients suffering from CTTH [Headache Classification Subcommittee of the International Headache Society. The International Classification of Headache Disorders 2nd ed. Cephalalgia 2004; 24 Suppl 1, 1–159.] participated in the study. Twelve age- and sex-matched controls were also examined. We performed a basal evaluation of clinical features, Total Tenderness Score (TTS) and a topographic analysis of LEPs obtained by the hand and the pericranial points stimulation in all patients vs healthy subjects. The later LEPs, especially the P2 component, were significantly increased in amplitude in the CTTH group, specially when the pericranial points were stimulated.

The P2 wave amplitude was correlated with TTS levels and anxiety scores.

The results of this study confirm that pericranial tenderness is a phenomenon initiating a self-sustaining circuit, involving central sensitization at the level of the cortical nociceptive areas devoted to attentional and emotional components of pain.

Keywords: Tension-type headache; Laser-evoked potentials; Pericranial tenderness

1. Introduction

Although tension-type headache (TTH) is the most common type of primary headache, its pathophysiology is poorly understood. The best documented abnormality in patients with TTH is increased pericranial myofascial tenderness (Vandenheede and Schoenen, 2002; Jensen, 2003). With manual palpation of head and neck muscles, increased pericranial tenderness was found in patients with both episodic and chronic TTH (CTTH). It was demonstrated that the pericranial tenderness was positively associated with both the intensity and the frequency of tension-type headache (Bendtsen, 2000; Jensen et al., 1993). It is generally accepted that myofascial tenderness probably plays a key role in the pathophysiology of tension-type headache. The search for peripheral mechanisms responsible for sensitization of myofascial nociceptors has however largely been unsuccessful, and muscle contraction appears to be a consequence of myofascial pain rather than a causal factor (Bendtsen, 2000). Recently, a pathophysiological model for tension-type headache was proposed. According to this hypothesis, the main problem is central sensitization at the level of the spinal dorsal horn/trigeminal nucleus, resulting from prolonged nociceptive inputs from pericranial myofascial tissues. This central sensitization is posited to cause supraspinal sensitization and central neuroplastic changes, possibly leading to increased pericranial muscle activity (Bendtsen, 2000). In a recent study we examined features of laser evoked potentials (LEPs) (Bromm and Treede, 1984, 1991), as well as cutaneous heat–pain thresholds to laser stimulation, in relation to the tenderness of pericranial muscles in chronic tension-type

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headache (CTTH), during a pain-free phase (de Tommaso et al., 2003). The amplitude of the N2–P2 complex elicited by stimulation of the pericranial zone was greater in CTTH patients than in controls; the amplitude increase was significantly associated with the Total Tenderness Score (TTS, Langermark and Olesen, 1987). Our findings suggested that pericranial tenderness may be a primary phenomenon that precedes headache, mediated by increased pain awareness at the cortical level. In that study, LEPs were examined by a derivation on the vertex to record the greatest waves. Multichannel recording of LEPs allows the performance of a topographic analysis, and the examination of all the LEP components (Valeriani et al., 2000), the earlier originating from the suprasylvian region (parietal operculum, SII), (Garcia-Larrea et al., 2003) mainly devoted to the discriminative component of pain, (Iannettia et al., 2005) and the later from the anterior cingulate cortex (ACC), (Garcia-Larrea et al., 2003) subtending the attentive and emotive features of pain (Peyron et al., 2000).

The aim of the present study was to extend previous analysis of LEPs in chronic tension-type headache, by performing multichannel topographic analysis in a new headache patients series during the pain-free phase in comparison to a group of normal subjects, and correlating the LEP findings with the Total Tenderness Score, the main clinical features, and the levels of anxiety and depression scored by the Zung (1965, 1976) scales.

2. Methods

2.1. Subjects

Eighteen outpatients attending the Headache Centre of the Neurology Clinic of Bari University, who fulfilled the criteria of CTTH associated with a pericranial muscles tenderness, according to International Headache Society (code 2.3.1) (International Headache Society Headache Classification Committee, 2004), participated in the study. All patients had been attending the practice for at least 6 months, during which they had been requested to register all headache episodes in a diary. All patients underwent an interview, which was standardized in our Centre to describe all headache features, as well as a clinical neurological and psychiatric examination. Twelve gender- and age-matched controls were selected, each without any history of headache or other cranio-facial pain according to IHS criteria. The clinical features are summarized in Table 1. Subjects with general medical, neurological, psychiatric (according to American Psychiatric Association, 1994) diseases, and patients who were taking psychoactive drugs, prophylactic treatments for headache, or had displayed over-use of analgesic drugs in the last 2 months, were excluded. All patients who participated were instructed to come to the recording session free from pain and free of medication intake for at least the previous 12 h; longer intervals were not possible, since most of the patients experienced daily headache (Table 1).

All patients and controls gave their informed consent to the study, which was ethically approved by our Department (Neurological and Psychiatric Science Department of Bari University). The clinical examination and recording session were carried out between 12 and 55 h after the end of the last headache (mean 23 ± 12.2 h), in the basal condition. The TTS was performed by manual palpation by one neurologist with experience in headache, who was experimentally blinded to the patients and the controls. The right frontalis, masseter, temporalis, pterygoid, sternocleidomastoid, and trapezius muscles, and the sternocleidomastoid and neck muscle insertions were examined using the TTS system. This method uses a combination of behavioural and verbal items, each of which is scored on a four-point Likert scale, defined as: 0 denial of tenderness, no visible reaction; 1 verbal report of discomfort or mild pain, no visible reaction; 2 verbal report of moderate pain, with or without visible reaction; 3 verbal report of marked pain and visible expression of discomfort, according to Langermark and Olesen (1987). The LEP recording was performed at least 1 h after the TTS examination.

Table 1
Clinical features of chronic tension-type headache patients and controls

Patients	Age	Sex	Age of illness (years)	Frequency of headache (days with headache/month)	Total tenderness score	Self-evaluating anxiety scale (Zung)	Self-evaluating depression scale (Zung)
Patients							
M	39.1	10 F	4.8	22.8	5.2	36.2	34.4
SD	11.5	8 M	5	6.8	2.8	7.5	4.9
Controls							
M	33.6	6 F			0.2	27.5	25.5
SD	12.8	6 M			3.5	9.8	6.5

2.2. CO_2 laser stimulation and LEP recording

Each subject was seated in a comfortable chair positioned in a quiet room with an ambient temperature of 21–23 °C, in an awake and relaxed state, with eyes closed. Subjects and experimenters wore protective goggles during data acquisition. The pain stimulus was a laser pulse (wavelength 10.6 μm) generated by a CO_2 laser (Neurolas, Electronic Engineering, Florence, Italy; www.elengroup.com). The beam diameter was 2.5 mm and the duration of the stimulus pulse was 20 ms. EEG was recorded through 19 disk electrodes, according to the 10–20 International System (impedance below 5000 ohms), referring to the nasion with the ground at Fpz. Another electrode was placed above the right eye to record the electrooculogram (EOG). Signals were amplified, filtered (0.5–80 Hz), and stored on a biopotential analyser (Micromed System Plus; Micromed, Mogliano Veneto, Italy; www.micromed-it.com). Time analysis was for 1 s, at a sampling rate of 512 Hz. Trials contaminated by ocular or muscle artefacts were excluded from the analysis. An automatic artefact rejection system excluded from the average all runs containing transient signals exceeding 65 mV on any recording channel, including the EOG.