Hyperalgesia or hypervigilance?
An evoked potential approach to the study of fibromyalgia syndrome

Summary
Past research on the phenomenon of enhanced pain sensitivity in fibromyalgia syndrome (FS) revealed evidence for both a higher pain magnitude in response to nociceptive stimuli (hyperalgesia) and a general perceptual amplification of sensations (hypervigilance). In order to distinguish between these two aspects of disturbed sensory processing in FS, cerebral evoked potentials after brief painful laser and auditory stimuli were measured in 10 FS patients. Results were compared with those from age-matched painfree controls. Amplitudes of middle-latency (N1) and long-latency (P2) laser evoked potentials (LEPs) were significantly higher in FS than in controls. Furthermore, laser intensity at pain but not at sensation threshold was lower in FS than in controls. However, auditory evoked potentials (AEPs) did not differ between groups. Enhanced N1 and P2 amplitudes of LEPs suggest stronger sensory and attentional processing of nociceptive information in FS, respectively. The concept of hypervigilance is challenged by the failure to find differences in auditory perception among FS and control patients. Yet, the importance of unpleasant intensities of auditory stimulation, not applied in this study, to reveal abnormal non-nociceptive perceptual amplification in FS is discussed.

Zusammenfassung

Key words

Schlüsselwörter
Fibromyalgie Syndrom – Laser evozierte Potentiale – akustisch evozierte Potentiale – Hyperalgesie – Hypervigilanz – Aufmerksamkeit
Introduction

The fibromyalgia syndrome (FS) is a chronic disease of unknown etiology characterized primarily by pain and mechanical tenderness of muscles especially at the muscle-tendon junctions (17). Low pain threshold and augmented cerebral evoked potential amplitudes in response to laser-emitted heat pulses indicate also thermal hyperalgesia in FS (6). On the other hand, there is evidence that abnormal perceptual amplification is not restricted to nociception, but concerns other sensory modalities as well which led to the concept of a generalized hypervigilance in FS (10).

This study investigated laser evoked potentials (LEPs) in FS patients and differentiated middle- (N1) and long-latency (N2, P2) components. The rationale was that these different components reflect activity from different brain generators (15, 16) and different sensitivity towards manipulation of attention (11, 5, for review see 2). Furthermore, auditory stimuli were regularly presented within the laser paradigm, prompting patients to rate each laser stimulus, and used to trigger auditory evoked potentials (AEPs) for control of arousal and vigilance towards non-nociceptive stimuli. Results were compared with age-matched painfree patients. A first communication of the results has been published earlier (7).

Methods

Ten female FS patients and 10 female age-matched and painfree control patients were investigated. Sensation and pain thresholds as well as laser evoked potentials (LEPs) were determined using brief CO$_2$ laser pulses applied to the dorsum of the left hand. Three seconds after each laser stimulus an auditory stimulus occurred, which triggered an auditory evoked potential (AEP). Electroencephalogram (EEG) was recorded from 5 different scalp positions referenced against linked earlobes. T-tests were used for comparisons between FS and control patients.

Results

FS patients had a significantly lower pain threshold than controls, whereas sensation threshold did not differ between groups (Fig. 1). LEPs yielded significantly higher N1 and P2 amplitudes (see arrows) in FS patients than controls (Fig. 2). However, amplitudes of N1 and P2 potentials of AEPs elicited by tones 3 s after each laser stimulus were not different among groups (Fig. 3).
Discussion

The present study of laser evoked potentials (LEPs) in patients with fibromyalgia syndrome (FS) revealed thermal hyperalgesia consistent with an earlier report by Gibson et al. (6). Both middle-latency N1 and long-latency P2 components of LEPs had significantly higher amplitudes in FS patients. Dipole source analysis from multi-lead EEG suggested N1 and P2 to be generated in the secondary somatosensory cortex (SII) and cingulate gyrus (CG), respectively (15, 16). Furthermore, greater dependency of P2 than N1 upon attention (11, 5) substantiated distinct diagnostic validities of these two LEP components as pain correlates. Therefore, the present study suggests both enhanced sensory and attentional processing of nociceptive heat stimuli in FS patients. The cause for this effect can generally be in the periphery or in the central projection of the nociceptive system and may be related to nociceptive sensitization or decreased endogenous inhibitory modulation.

Hypervigilance in FS concerns a general attentional amplification of aversive sensory experience (10) and may at least partly account for the observed augmentation of P2 amplitudes of LEPs. For, as mentioned above, P2 enhancement might not be specific for nociception as it relates to limbic activation subserving any sensory modality in signalling alarm, danger, and threat. The term hypervigilance, however, is not very lucky. Whereas some authors use it, like in FS, to describe perceptual changes in similar pathologies, e.g., the irritable bowel syndrom (12) or chronic pain (3), others refer to it as an intrinsic psychopathologic disturbance of attentional control irrespective of intensity or aversive categories of stimulation, e.g., in schizophrenia (9). The failure in this study to find group differences in auditory evoked potentials (AEPs) with moderate stimulus intensities and neutral emotional meanings speaks against this latter understanding of hypervigilance as adequate for FS. Instead, the disturbed interaction of perception with stimulus intensity seems to be important.

The experience in our laboratory is that the present changes of LEPs are not specific for FS, but can also be observed in chronic pain due to osteoporosis (8) or due to Crohn’s disease (unpublished). It seems that the degree of chronicity of pain is important. Irrespective of the indisputable ‘psychological’ features of FS the question remains whether some distinct ‘organic’ processes are crucial as initial events. It is interesting that both auditory and nociceptive afferent systems exhibit efferent descending pathways serving as ‘gain setters’ through inhibitory modulation. The serotonergic raphe nuclei of the brainstem project both to the trapezoid body of the superior olivary complex inhibiting auditory transmission (1) and to the dorsal horn exerting antinociceptive actions (5). A deficit in serotonergic actions, either by low concentrations (16) or presence of serotonin antibodies (15), have been implicated in the pathophysiology of FS and may be important for the phenomenon of perceptual amplification within auditory and somatosensory modalities.

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References


