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Differential nociceptive deficits in patients with borderline personality disorder and self-injurious behavior: laser-evoked potentials, spatial discrimination of noxious stimuli, and pain ratings

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Abstract

Approximately 70–80% of women meeting criteria for borderline personality disorder (BPD) report attenuated pain perception or analgesia during non-suicidal, intentional self-mutilation. The aim of this study was to use laser-evoked potentials (LEPs) and psychophysical methods to differentiate the factors that may underlie this analgesic state. Ten unmedicated female patients with BPD (according to DSM-IV) and 14 healthy female control subjects were investigated using brief radiant heat pulses generated by a thulium laser and five-channel LEP recording. Heat pulses were applied as part of a spatial discrimination task (two levels of difficulty) and during a mental arithmetic task. BPD patients had significantly higher heat pain thresholds (23%) and lower pain ratings (67%) than control subjects. Nevertheless, LEP amplitudes were either normal (N1, P2, P3) or moderately enhanced in BPD patients (N2). LEP latencies and task performance did not differ between patients and control subjects. The P3 amplitudes, the vertex potential (N2–P2), and the N1, which is generated near the secondary somatosensory cortex, were significantly reduced during distraction by mental arithmetic in both groups. In addition, P3 amplitudes reflected task difficulty. This study confirms previous findings of attenuated pain perception in BPD. Normal nociceptive discrimination task performance, normal LEPs, and normal P3 potentials indicate that this attenuation is neither related to a general impairment of the sensory-discriminative component of pain, nor to hyperactive descending inhibition, nor to attention deficits. These findings suggest that hypoalgesia in BPD may primarily be due to altered intracortical processing similar to certain meditative states.

Keywords: Borderline personality disorder; Analgesia; Heat pain; Self-injurious behaviour; Attention

1. Introduction

Borderline Personality Disorder (BPD) is estimated to have a prevalence of 1.3% (Torgersen et al., 2001). Non-suicidal, intentional self-injurious behavior (SIB) is one of the diagnostic criteria and occurs in 70–80% of all BPD patients (Clarkin et al., 1983). Self-injury is frequently carried out with the intention to terminate states of negative affect or highly aversive inner tension (Coid, 1993; Favazza, 1989; Herpertz et al., 1995; Russ et al., 1992). Approximately two-thirds of the patients with SIB report analgesic phenomena in association with self-injury (Leibenluft et al., 1987).

Under experimental conditions, pain perception in patients with BPD was first evaluated by Russ et al. (1992) using the cold pressor test. These authors compared BPD patients who reported pain during SIB, BPD patients without pain during SIB, and healthy control subjects. They found a significantly attenuated pain perception and an improvement of dysphoric mood in the group of BPD patients without pain during SIB compared with the other two groups. Bohus et al. (2000) studied the effect of subjective distress ('aversive tension') on pain perception in

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BPD patients with subjective analgesia during SIB and reported a significantly reduced pain perception in BPD patients under non-stress conditions, and even greater reductions were found under stress.

So far, investigations of pain perception in BPD patients have only made use of pain rating data, which necessarily are subjective. Laser-evoked brain potentials (LEPs) are an objective method that has proven to be sensitive to document reduced pain sensitivity due to lesions of the peripheral or central nervous system as well as in the context of descending inhibition and nerve blocks (Treede et al., 2003). The first LEP component N1 is a small negative potential in temporal leads which is probably generated in the vicinity of the secondary somatosensory cortex (Frot and Mauguière, 2003; Lenz et al., 2000; Tarkka and Treede, 1993; Valeriani et al., 1996). N1 is followed by the late vertex potential components, N2 and P2, which are at least partly generated in the anterior cingulate cortex (ACC) (Lenz et al., 1998; Tarkka and Treede, 1993; Valeriani et al., 1996). In appropriate tasks, the LEP vertex potential is followed by an endogenous P3 potential, which reflects selective attention to task-relevant stimuli. The P3 potential of the LEP has a peak latency of about 600 ms due to the slow conduction velocity of the afferents involved (Kanda et al., 1996; Siedenberg and Treede, 1996).

Hypotheses to be tested in this study were: (1) pain ratings during laser stimulation are lower in BPD patients compared to healthy control subjects; (2) amplitudes of LEPs in BPD patients are smaller than those of control subjects; (3) these differences can be explained by differences in sensory-discriminative capabilities and/or differences in attention. To test the influence of attentional factors, BPD patients and healthy control subjects underwent LEP recordings in two paradigms: a spatial discrimination paradigm for laser-evoked pain (focused attention; Schlereth et al., 2001) and a distraction paradigm using a mental arithmetic task (divided attention).

2. Methods and materials

2.1. Subjects

All patients participated in a dialectical behaviour therapy (DBT) program for the treatment of BPD (Linehan et al., 1991). Patients were eligible if they were female, between 18 and 50 years of age and met DSM-IV criteria for BPD according to the appropriate segment of the Structured Clinical Interview for DSM-IV Personality Disorders (SCID-II; First et al., 1996) and the Diagnostic Interview for Borderlines—Revised Version (DIB-R; Zanarini et al., 1989). Axis-I comorbidity was assessed using the Structured Clinical Interview for axis I DSM-IV disorders-patient edition (SCID-I/P; First et al., 1995). Exclusion criteria were lifetime diagnosis of schizophrenia, bipolar type I disorder, current substance abuse, major depression or severe anorexia. All diagnostic data were assessed by clinically experienced interviewers with an inter-rater reliability of 0.82 for SCID-I, 0.85 for SCID-II and 0.92 for DIB-R.

Within a time-frame of 18 months, 39 patients with current self-injurious behaviour participated in the DBT program, 14 of whom were free of any medication for at least 4 weeks. Ten of those 14 patients reported complete or near complete analgesia during at least 70% of acts of SIB. These 10 patients were recruited into the current study. Ages ranged between 18 and 46 years (mean age ± SD 29 ± 9). Median frequency of self-injurious behaviours (cutting, burning, head-banging, etc.) was eight acts (range between 1 and 75 acts) within the preceding 4 weeks. Patients had no history of neurological disease. Eight patients fulfilled the DSM-IV lifetime-criteria for major depressive disorder or dysthymic disorder, five patients for anxiety disorders, four patients for eating disorders, and four patients reported lifetime substance related disorders.

A group of 14 female healthy volunteers (age 22–38, mean ± SD, 26 ± 4 years) served as control subjects. No healthy volunteer had a history of neurological or psychiatric disease. All subjects and patients gave written informed consent. The protocol was approved by the local ethics committee. Measurements were performed in a light- and noise-reduced, electromagnetically shielded chamber. The chamber temperature was kept at 24 °C. The participants were awake and relaxed with eyes open in a reclining chair.

2.2. Laser radiant heat stimuli

Painful heat stimuli were generated by an infrared thulium-YAG laser (wavelength 2.01 μm, duration 3 ms) outside the chamber (Spiegel et al., 2000). The participants and experimenters wore protective goggles. The output energy was 510 mJ (26 mJ/mm^2). The laser beam was transmitted via a glass fibre to a handpiece inside the chamber. Within the handpiece, a three lens telescope expanded the beam diameter to 5 mm, and a mirror, moveable in two planes, reflected the beam rectangularly onto the subject's skin. To avoid sensitization or receptor fatigue, the beam was moved after each stimulus by small adjustments of the mirror. A pilot laser indicated the area to be stimulated on the back of the hand. At the intensities used, this type of near infrared laser does not cause any burn injuries (Spiegel et al., 2000) and is a well-tolerated procedure for the assessment of nociceptive pathways (Bromm and Lorenz, 1998; Bromm and Treede, 1991).

2.3. Quantitative sensory testing

Prior to LEP recording, the integrity of neural pathways was assessed by quantitative sensory testing within the hairy skin of the back of the hand. Twelve tests were condensed into three scores: (1) nociception score (pin-pricks, pulling