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Does severe acute pain provoke lasting changes in attentional and emotional mechanisms of pain-related processing? A longitudinal study

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ABSTRACT

Pain experiences, learning, and genetic factors have been proposed to shape attentional and emotional processes related to pain. We aimed at investigating whether a singular major pain experience also changes cognitive-emotional processing. The influence of acute postoperative pain after cosmetic surgery of the thorax was tested in 80 preoperatively pain-free male individuals. Acute pain was measured as independent variable during the first week postsurgery by pain intensity ratings and the requested analgesic boluses (Patient-Controlled Epidural Analgesia (PCEA)). Pain catastrophizing (Pain Catastrophizing Scale (PCS)), pain anxiety (Pain Anxiety and Symptom Scale (PASS)), pain hypervigilance (Pain Vigilance and Awareness Questionnaire (PVAQ)), and attentional biases to emotionally loaded stimuli (including pain) in a dot-probe task were assessed 1 week, 3 months, and 6 months postsurgery as dependent variables. Hierarchical regression analyses were performed to test whether the 2 acute pain parameters can predict these cognitive-emotional variables. As a rigorous test, significant prediction was required in addition to the prediction of the dependent variables by themselves with lag-1. Acute pain (mainly the pain ratings) appeared to be a significant predictor for PCS, PASS, and PVAQ 1 week after surgery (deltaR^2 = [8.7% to 11.3%]). In contrast, the attentional biases in the dot-probe task could not be predicted by the pain ratings. The levels of pain catastrophizing and pain hypervigilance increased in the acute phase after surgery when influenced by acute pain and declined, along with pain anxiety, during the next 3 months. In conclusion, a one-time intense pain experience, such as acute postoperative pain, appeared to produce at least short-lived changes in the attentional and emotional processing of pain.

1. Introduction

Attentional and emotional mechanisms related to pain processing, such as pain catastrophizing, fear of pain, hypervigilance, and attention to pain (ie, attentional focusing or avoidance), have turned out to contribute to interindividual variance in pain sensitivity [11,17,20], and to promote the development and maintenance of chronic pain [6,7,10,25,34]. The fear-avoidance model and its variants give a theoretical frame for the understanding of the reciprocal relationship between such cognitive-affective variables and pain experience [41,43].

However, the development of these pain-related psychological variables is still largely unknown. A little more is known about the development of pain perception. Besides genetic factors, previous experiences of pain seem to be relevant factors influencing future pain perception. Effects of previous pain experiences can go two ways. On the one hand, previous pain experiences can lead to adaptation [3,4,8,15,29,31] and thus to a decrease in pain sensitivity. The assumption of such adaptation level effects implies that major pain experiences in the past serve as a frame of reference for subsequent pain experiences [37]. On the other hand, sensitization due to continuous or repeated noxious stimulation can also occur, leading to an increase in pain sensitivity [23,30,38]. Sensitization

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has been reported to have occurred already in children exposed neonatally to severe pain [12,16].

Severe pains in the past seem to alter not only future pain perception, but also pain-related psychological variables, as a study on children with neonatal pain experience recently demonstrated [18]. These children reported increased pain catastrophizing at school age. However, not much more evidence is available on this matter.

For now, we can assume: first, pain can alter future pain perception, and second, these changes may be long-lasting. Third, in accordance with the results of Hohmeister et al. [18], pain experience may affect not only sensory mechanisms, but also cognitive and emotional processing related to pain. Interestingly, the relevance of such experience-based changes in cognitive and emotional processing is a prominent topic in fear research. Even a single-episode trauma may result in altered cognitive-emotional processing for a long while [14]. Is it possible that a one-time severe pain experience can have a similar effect, provoking lasting changes in pain-related cognitive and emotional processing?

The present study aimed at investigating how a singular major pain experience can affect attentional and emotional processing related to pain. Postoperative pain after a cosmetic correction of chest malformations was chosen as a model of major pain. The surgical intervention causes vast lesions in muscle and bone tissues that are sufficient to cause intense postoperative pain. Moreover, the patients are young and until the surgery had no exposure to severe pain. Technically speaking, the predictive power of acute postoperative pain for changes in pain-related cognitive and emotional processing assessed by self-report (eg, pain catastrophizing, pain anxiety, pain hypervigilance) and by a behavioral attention test (attentional biases toward pain, social threat, and positive words assessed in a dot-probe task; nonpain words were added to test for general emotional changes) was determined 1 week, 3 months, and 6 months after surgery.

2. Materials and methods

2.1. Subjects

Eighty male patients with funnel chest (mean age 19.2 ± 4.6 years, range 14 to 33 years) participated in the study. The patients underwent the surgical correction of a congenital malformation of the thorax at the Department of Pediatric Surgery of the University of Erlangen. The surgical center is well known in Germany as a specialist center in the correction of thorax malformations. The sample was selected amongst consecutively admitted inpatients according to the following inclusion criteria: 1) male patients (because of the high rates of male patients undergoing the surgical correction), 2) age between 14 and 35 years, and 3) no medical risk indication for applying the surgical procedure. Exclusion criteria were as follows: 1) concurrent acute or chronic pain conditions, 2) previous severe pain experiences, 3) previous major surgical interventions (minor surgical interventions such as tonsillectomies or dental procedures were allowed), 4) strong levels of discomfort due to functional limitations because of the chest malformation, 5) current or previous psychological disorders, and 6) analgesic treatment different from the patient-controlled epidural analgesia (PCEA), because of conditions (eg, skin acne or inflammation at or near the location for the insertion of the PCEA catheter, or intake of blood-thinning drugs during the previous 7 days) that would not allow for the epidural catheter needed for the PCEA to be inserted into the interspinous space.

The study protocol was approved by the ethics committee of the medical faculty of the University of Erlangen. All participants gave written informed consent. In the case of participants not having reached the age of maturity, written informed consent was obtained from their parents and written assent from the subject. All subjects received financial compensation for their participation.

2.2. Surgical intervention and analgesic treatment

The surgical manipulation, the so-called Erlangen technique of funnel chest correction, consists first in the freeing of the lower part of the sternum through an interior incision. Afterward, the sternum is mobilized by the freeing of the xiphisternum. A spring balance is attached to the sternum with a hook, and the sternum is moved in the required position. Finally, the chest wall is stabilized with a lightweight transsternal metal implant (for detailed description of the technique see [45]). The metal implant is usually removed 1 year after surgery. Patients are discharged from the hospital within 7 to 10 days postsurgery.

All participating patients were treated with standardized analgesia during and after surgery, and received the most commonly applied and recommended thoracic Patient-Controlled Epidural Analgesia (PCEA). Before the induction of general anesthesia for surgery, an epidural catheter was inserted through the interspinous space at Th6/Th7 or Th7/Th8. Postoperative PCEA was provided using a standard PCA pump. The pump was set to deliver 0.2% ropivacaine plus 1.0 μg/ml sufentanil at a basal rate of 6 to 8 ml/hour. The patient could additionally request a bolus dose of 3 ml every 30 minutes by pressing a trigger button. Repeated pressing of the trigger button did not provide more than 1 bolus per 30 minutes. Additionally, nonopioids were available as rescue analgesia on demand. The patient's requests for analgesic treatment were recorded for further analysis. After 2 to 3 days postsurgery, the catheter was removed.

2.3. Procedure

The present study was a prospective longitudinal study to assess the influence of acute postoperative pain as a one-time major pain experience on pain-related emotions and attention in the future. Four testing sessions were run at different points in time: 1 day before surgery (T0), 1 week after surgery (T1), and again approximately 3 months (T2) and 6 months (T3) after surgery. The testing sessions took place in a pain laboratory of the Department of Anesthesiology (University of Erlangen), mostly in the afternoon.

Postoperative acute pain was assessed by the use of 1) self-rated pain intensity (pain ratings) and 2) use of PCEA, which were the so-called independent or predictor variables. Data about the frequency of the demand for analgesics by using the PCEA system were collected for 1 to 3 days after surgery. Patients rated the intensity of acute postoperative pain 1 week after surgery (T1). Both measures of acute pain were defined as independent predictors as they represent different aspects of acute pain. The pain ratings measure the subjective perceived intensity of acute postoperative pain; the PCEA use provides an additional behavioral measure of the reaction to pain (drive for analgesia).

In each testing session (T0 to T3), self-report measures of pain catastrophizing, pain-related anxiety, and pain hypervigilance were obtained, and a dot-probe task was run to assess attentional biases to pain-related and other emotionally loaded stimuli. These were the so-called dependent or criterion variables. The T0 session was scheduled to control for preoperative levels of the criterion variables, whereas the remaining sessions (T1 to T3) were supposed to track the effects of acute postoperative pain.