Health and distress predictors of heart rate variability in fibromyalgia and other forms of chronic pain

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ABSTRACT

Objective: To examine health, psychological, and autonomic impairment differences between individuals with fibromyalgia and those with other chronic benign pain in these conditions. The possible role of the autonomic nervous system in the maintenance of chronic benign pain can be examined using heart rate variability (HRV), which measures the interplay between the excitatory sympathetic and the inhibitory parasympathetic nervous system. Predictors of HRV will also be examined.
Methods: This study examined resting HRV in a sample of 84 patients with chronic benign pain, a subgroup of whom had fibromyalgia. Participants completed a battery of self-report measures and underwent measurements of resting HRV.
Results: Individuals with fibromyalgia experienced higher levels of depression (t (82) = − 2.27, $p<.05$) and significantly greater difficulty with physical functioning (t (75.8) = 2.65, $p<.01$) than did those with other chronic benign pain, there were no significant differences in any of the HRV indices. Across all pain conditions, we found that age, gender, physical health functioning, pain anxiety, and pain sensations were all significant predictors of HRV, suggesting that each are involved in the relationship between chronic benign pain and autonomic function.
Conclusions: These findings emphasize the importance of addressing psychological distress and physical functioning in chronic pain populations and specifically fibromyalgia. Future research can further examine the role of physical health functioning, psychological distress, and pain severity in the relationship between chronic pain and autonomic abnormalities.

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Introduction

Chronic pain, defined as experiencing pain for at least 6 months that does not resolve with treatment, is a major health concern that accounts for 80% of physician visits [1]. A specific chronic pain condition is fibromyalgia, a condition of unexplained widespread pain with fatigue, sleep disturbances, gastrointestinal complaints, and psychological symptoms [2]. Although chronic pain generally has been associated with great morbidity [3], fibromyalgia has been associated with even more substantial health impairments [4,5]. For example, individuals with fibromyalgia exhibit increased emergency department utilization [6] and significantly worse mental health [7] compared to individuals with rheumatoid arthritis, suggesting that

they may experience more severe physical and mental impairments compared to patients with other benign pain conditions.

A growing body of research has begun to examine the possible role of the autonomic nervous system in the development and maintenance of chronic pain in general and fibromyalgia specifically [8]. A well established method of evaluating the state of the autonomic nervous system, that has been frequently used with individuals diagnosed with fibromyalgia [9,10], but less so with those diagnosed with other chronic benign pain is heart rate variability (HRV). HRV is a measure of the interplay between the excitatory sympathetic and the inhibitory parasympathetic nervous system [11]. The many indices of HRV can be used to examine autonomic abnormalities, with lower levels of resting HRV acting as a potential marker for deficits in self-regulation.

Measures of HRV have been associated with different types of pain. For instance, patients with chronic low back pain exhibited reduced parasympathetic and increased sympathetic activity [12]. Likewise,

patients with fibromyalgia exhibited significantly lower HRV [13], and increased sympathetic and decreased parasympathetic nervous system activity compared to a control group [13,14]. However, the emerging research on HRV in chronic pain conditions has several shortcomings. Mainly, the previous studies have not examined potential differences in autonomic function across different pain conditions. In addition, little attention has been paid to other factors that may be related to HRV function in individuals with pain conditions. For example, anxiety, depression, health impairments, and poor sleep were related to reduced HRV while active and acceptance coping were related to increased HRV across a number of studies and conditions [12,15–19]. Given the known association between chronic benign pain and many of these factors, examining the role of these psychosocial factors in autonomic function of individuals with chronic pain warrants further exploration.

To our knowledge, no studies have compared HRV in individuals with fibromyalgia to those with other chronic benign pain conditions, nor have they explored psychosocial predictors of HRV indices in chronic benign pain. This study examines resting HRV in a sample of patients with chronic benign pain, a subgroup of whom had fibromyalgia. Our goals were to: 1) examine health, psychological, and HRV differences between individuals with fibromyalgia and those with other forms of chronic pain; and 2) identify predictors of HRV in individuals with chronic benign pain. We hypothesized that individuals with fibromyalgia had more severe symptoms across all examined domains, and that measures in each domain would be associated with autonomic nervous system functioning.

Methods

Participants and procedures

Participants were recruited between 2006 and 2009 for a psychosocial treatment study of chronic pain from clinics at the Veteran Affairs San Diego Healthcare System and through advertisements. Participants were over 18 years of age, proficient in English, and able to provide written informed consent. A diagnosis of chronic benign pain associated with a primary impairment due to a traumatic injury or congenital or acquired disorder was verified by a study physician. In order to take part in the study, participants had to report average pain severity and interference greater than 4 on a 0–10 scale and pain duration of at least 6 months. Exclusion criteria included participation in psychotherapy for pain in the previous 6 months, cognitive impairment determined by a score of less than 25 on the Mini Mental State Examination [20], serious, unstable medical illness in which inpatient hospitalization would be likely, and psychiatric diagnoses of schizophrenia, other psychotic disorder, bipolar I disorder, organic mental disorder, borderline or antisocial personality disorder, and alcohol or substance abuse or dependence. In addition, individuals who had recently started, stopped, or changed pain or mood treatment were not eligible to enroll until two months had elapsed.

A diagnosis of fibromyalgia was determined based on a study physical examination for the presence of chronic widespread pain for more than 3 months and the presence of at least 11 of 18 possible tender points across body sites [2]. All patients also were seen by a study physician who reviewed their medical records to determine pain diagnosis and etiology.

Prior to starting treatment, participants completed a battery of self-report measures and underwent several evaluations including the assessment of resting HRV. Analyses presented here are based on data collected at this baseline assessment. The study was approved by the Institutional Review Board of the University of California, San Diego and the Research and Development Committee of the Veteran Affairs San Diego Healthcare system.

Questionnaires

Demographics

Demographic information included age, gender, race and ethnicity, marital status, and education. Participants also reported on classes of medications they were currently taking.

General health functioning

General health functioning was determined by examining mental and physical health-related quality of life with the Medical Outcomes Study 12-item Short Form Health Survey [21]. This survey has been widely used with medical populations, with both the Physical and Mental component scores found to be highly correlated with the Short Form Health Survey-36, the longer form of the measure ($r = .91$ and .92) [21]. It exhibits acceptable relative validity and test-retest reliability [21]. Good internal consistency was also established with Cronbach's alpha ranging from .70-.87 in this sample.

Psychological distress

The Beck Depression Inventory [22] and Pain Anxiety Symptoms Scale-Short Form [23] were administered to assess for psychological distress. The Beck Depression Inventory is a 21-item measure widely used to assess for self reported depressive symptoms that has been shown to be reliable and well-validated [24]. The Pain Anxiety Symptoms Scale-Short Form is a 20-item measure designed to capture pain-related anxiety, specifically, a patient's fear of pain symptoms by associating pain with harm. This measure also exhibits high internal consistency and validity [23]. Good internal consistency was established for both the Beck Depression Inventory (Cronbach's alpha = .94) and the Pain Anxiety Symptoms Scale-Short Form (Cronbach's alpha = .94) in this sample.

Coping

The Catastrophization subscale of the Coping Strategies Questionnaire-Revised [25] and the Chronic Pain Acceptance Questionnaire-Revised [26] were used to measure coping strategies. The Catastrophization subscale of the Coping Strategies Questionnaire-Revised is a 6-item scale used to measure pain coping styles [25]. The Coping Strategies Questionnaire-Revised is a 20-item scale that measures the degree to which patients have adjusted to pain as part of their identity and lifestyle that exhibits good internal consistency [26]. Good internal consistency was established for both the Coping Strategies Questionnaire-Revised (Cronbach's alpha = .93) and the Chronic Pain Acceptance Questionnaire-Revised (Cronbach's alpha = .91) in this sample.

Pain severity and sensation

The Brief Pain Inventory-Short Form was used to assess for severity and interference of pain [27]. The McGill Pain Questionnaire-Short Form was used to assess for specific pain sensations related to sensory and affective components of pain to determine a total pain score [28]. Both measures are widely used and exhibit good internal consistency [27,28]. Good internal consistency was established for both the Brief Pain Inventory-Short Form severity (Cronbach's alpha = .90) and interference (Cronbach's alpha = .92) scales as well as the McGill Pain Questionnaire-Short Form (Cronbach's alpha = .85) in this sample.

Heart rate variability

There are various HRV indices that can be computed to measure overall HRV or HRV at different frequencies, the most common being time domain and frequency domain measures. The time domain measures are calculated by a period of recording intervals between R-wave spikes generally referred to as "normal to normal" (NN) intervals, which is the waveform associated with the contraction of the heart's ventricles [11]. The frequency domain measures differentiate between sympathetic and parasympathetic components of HRV