Analysis of Galvanic Skin Response: Potential Relationships to Stimulus Responsivity and Brain Dopamine Signal

Evgeny Chumin, Daniel Albrecht, and Karmen Yoder

Indiana University School of Medicine
Indiana University-Purdue University Indianapolis

Abstract

Fibromyalgia is a chronic pain disorder that presents itself with no apparent medical explanation for the pain. Functional alterations of neurotransmitters such as dopamine (DA) have been implicated in fibromyalgia neuropathology. It is not known how central dopamine function in pain is associated with objective peripheral measurements that are thought to be associated with the presence of pain and stress. Galvanic skin response (GSR), a physiological measure of nerve system activation, could potentially give insight to novel aspects of DA function. In this study, GSR was recorded from fibromyalgia patients (FM) and healthy controls (HC) while they underwent scanning with [18F]-fallypride (FAL) Positron Emission Tomography (PET). FAL is a D2/D3 DA receptor antagonist that is sensitive to changes in DA levels in the brain. The involvement of DA in cognitive processes, FAL PET can be used to examine baseline DA activity as well as changes from baseline during cognitive load tasks. Relationships between GSR and working memory load, acute pain, and DA function were studied and compared between FM and HC.

Introduction

The prevalence of fibromyalgia has been estimated to be 1-4%. It is higher in women versus men and in older versus younger adults. This disorder is commonly treated with selective serotonin reuptake inhibitors and triyclic antidepressants to some success; however, the neurological mechanisms behind fibromyalgia are not well understood. Altered metabolism of DA and changes in DA receptor function have been reported in FM. DA is well known for its role in reward and was recently suggested to have pain moderating effects. However, it is not currently known whether peripheral measures of physiological responsivity, such as skin conductance, are related to central DA neurotransmission.

GSR is a physiological measure of skin conductance that can be used to quantify peripheral nervous system activation. It also has the advantage of being an objective measure of physiological activation. It is simple, non-invasive, and can be acquired concurrently with other testing methods. PET is a neuroimaging technique that allows for observations in vivo without disturbing the system of study. Small amounts of a radioactively labeled compound can be used to measure blood flow, tissue metabolism, and receptor occupancy and density.

In this study, FAL PET was used to estimate DA function in FM concurrently with GSR recording in order to determine if skin conductance is related to DA changes in response to a working memory task. Relationships between GSR and subjective measures of pain were also examined.

Methods

The study analyzed GSR data obtained from an NIH-funded PET study, which investigated dopaminergic activity in FM versus HC participants. GSR data was collected during algometry testing, which provided measures of pain sensitivity and tolerance, and during two FAL PET scans. FAL is a radiotracer with a half-life of 109.8 minutes that is used as an index of dopamine D2/D3 receptor activity. Two PET scans (baseline and challenge) were counterbalanced and done on separate days due to the relatively long half-life of the 18F isotope. Differences in DA signal between the BL task (Figure 1, p < 0.01) and bilateral in the uncus during the WM task (Figure 2, p < 0.01) were observed. When the groups were analyzed separately, the effect was retained in FM subjects (n =7, p < 0.01).

Results

• Significant correlations were found between ∆GSR and FAL binding potentials in all subjects (n = 12) in the right uncus during WM task (Figure 2, p < 0.01) and bilaterally in the uncus during the BL task (Figure 1, p < 0.01). When the groups were analyzed separately, the effect was retained in FM subjects (n =7, p < 0.01).

• There were no significant differences between ∆GSR during WM task (F (1, 10) = 0.124, p > 0.1) or an interaction of group task (F (1, 10) = 0.279, p > 0.1). A significant positive correlation was found between the BL ∆GSR and WM ∆GSR (R = 0.827, p < 0.01).

• There were no significant differences between ∆GSR during either of the n-back tasks and ∆GSR during subjective pain ratings.

Figure 1. Correlation of D2/D3 receptor availability in the bilateral uncus with ∆GSR during a baseline task

Figure 2. D2/D3 receptor availability in the right uncus is associated with ∆GSR during a cognitive load task

Figure 3. Higher maximum pain tolerance values were correlated with larger changes in GSR

Figure 4. Ratings for average “unbearable” pain level was correlated with larger changes in GSR

References