ABSTRACT
The present study investigated the relationship between resting cortical activity and cognitive performance in women with fibromyalgia (FM). To achieve this goal, data extracted from a randomized clinical trial involving 31 women diagnosed with FM were used. The results demonstrated that better cognitive performance was associated with greater power of alpha 1 and alpha 2 oscillations in the frontal, parietal and occipital regions. These results suggest that chronic pain may affect not only sensory perception but also cognitive ability. Furthermore, the relationship between changes in alpha oscillations and levels of depression highlights the interconnection between emotional state, pain perception and cognition in FM. These findings have implications for the clinical management of FM, emphasizing the importance of considering both cognitive and emotional manifestations, and suggest the potential for neuromodulation to improve both pain and cognitive function, although more research is needed to better understand the mechanisms involved.

Keywords: Fibromyalgia; cortical activity; cognitive performance; chronic pain.

RESUMO
O presente estudo investigou a relação entre a atividade elétrica cortical em repouso e...
Fibromyalgia Beyond Pain: The Possibilities of Cortical Electrical Assessment to Direct Treatment

1. Introduction

Fibromyalgia (FM) is a syndrome characterized by generalized pain, tension, fatigue, sleeping problems, and exacerbated somatic and cognitive complaints (Wolfe et al., 2016). The world prevalence rate is around 2.7%, being more frequent in women over 50 years old (Queiroz, 2013). The pathophysiology of the FM is not well understood. One of the most accepted theories is that centralized pain processes amplifies the sensory stimulation and, consequently, enhances the pain responses (Häuser et al., 2015).

Most common comorbidities are psychiatric disorders (Melo; Madruga;
As regard to the cognitive complaints, difficulties in memory and concentration have been reported, with a negative influence on daily living activities (Gelonch et al., 2017). A possible explanation for the presence of cognitive dysfunction in FM is that pain captures attentional resources from other cognitive processes (Samartin-Veiga; González-Villar; Carrillo-De-La-Peña, 2019).

Few studies explored the relationship between cortical electrical activity and cognitive functioning in FM. In some of them, an association between the alpha frequency band and the states of relaxation and alertness was found (Caro; Winter, 2011). This frequency range seems to be correlated to cognitive performance, and it is altered in some brain pathologies (Başar; Güntekin, 2012). The alpha-band oscillations, divided into alpha 1 (8-10 Hz) and alpha 2 (10-12 Hz), have been associated with alertness and attention processes, reflecting connections between the structures of default mode network (Vanneste et al., 2017). In this sense, greater alpha power would be related to a greater state of relaxation (Caro; Winter, 2011) and, consequently, to a better cognitive performance. Studies have shown changes in parietal, frontal and occipital regions in patients with chronic pain, characterized by the increased of the alpha and theta power at spontaneous EEG data (Pinheiro et al., 2016), so we could expect to find a similar pattern in patients with FM.

In the present study, we analyzed the cortical activity of alpha 1 and alpha 2 at rest in women with FM and their relation with cognitive performance. We hypothesized that a better cognitive performance would be related to a higher alpha spectral power in frontal, parietal and occipital regions.

2. Method

The research is part of a larger randomized controlled trial (Melo et al., 2020) approved by the university's ethics committee, under the registration CAAE: 64247317.6.0000.5188, in accordance with the ethical principles of the Declaration of Helsinki.

The study comprised 31 women diagnosed with FM, with the following inclusion criteria: (1) having diagnosis of FM, according to the criteria of the
American College of Rheumatology; (2) diagnosed at least three months ago; (3) female; (4) age between 25 and 60 years old. The exclusion criteria were: (1) a score below 24 on the MMSE; (2) illiterate; and (3) severe depression, with a score greater than 36 in Beck Depression Inventory (BDI).

Participants were assessed using the instruments: Sociodemographic and Clinical Questionnaire; Cumulative Disease Classification Scale, to check the presence of comorbidities; Visual Analog Scale, to assess pain intensity; Beck Depression Inventory, to assess depressive symptoms; Mini Mental State Exam, to analyze the cognitive state; ActiCHamp 32-channel (Brain Products) electroencephalogram to register cortical activity.

EEG data was collected in individual sessions. Thirty-two electrodes were placed on the scalp through an adjustable cap according to the International System 10-20, with the impedance kept below of 20kΩ. Records were performed using the BrainVision Pycoder software. An amplifier ActiChamp was used, with a sampling rate of 500Hz. The reference electrodes were placed in TP9 and TP10, at the left and right mastoids, respectively. During data collection, participants sat comfortably in a chair and were instructed to avoid excessive facial, body and eye movements to reduce artifacts during data acquisition. Data was collected at rest, 6 minutes with the participant’s eyes opened and 6 minutes with the eyes closed, divided into blocks of two minutes, alternately (Hassan et al., 2015).

Data analysis was performed using EEGLAB, a MATLAB toolbox. Based in a previous study (Hargrove et al., 2010), we processed only data of eyes closed blocks for the frontal (F3, F4), parietal (P3, P4) and occipital (O1 and O2) regions. The software IBM SPSS version 24 was used in statistical analysis. Considering that data were not normally distributed, we used non-parametric tests (Spearman’s test) to analyze the relationship between cognitive performance and brain activity, with a significance level of 5% (p <0.05).

3. Results

Most participants were married 58.1% (n = 18), with a mean age of 44.81
(SD = 8.8) years; and have a mean pain level of 6.66 (SD = 1.70). Mean time of diagnosis of FM was 79.77 months (SD = 64.64). Among them, 29.1% (n = 9) received the diagnosis between 96 to 120 months ago, and 25.8% (n = 8) between 3 to 23 months ago. Mean score in MMSE was 28.39 (SD = 1.61). According to the CIRS scale, the participants did not report serious comorbidities associated with FM.

The Spearman test indicated a positive association between cognitive performance (MMSE) and the spectral power of the alpha frequency range in the three cortical regions analyzed. In the frontal region, there was an association between the cognitive assessment and the spectral power of alpha 1 [ρ = 0.493; p = 0.005] and alpha 2 [ρ = 0.545; p = 0.002]. In the parietal region, there was an association between the cognitive assessment and the spectral power of alpha 1 [ρ = 0.422; p = 0.018] and alpha 2 [ρ = 0.384; p = 0.033]. Similarly, in the occipital region, there was an association between the cognitive assessment and the spectral power of alpha 1 [ρ = 0.428; p = 0.016] and alpha 2 [ρ = 0.484; p = 0.006].

4. Discussion

In the present study, we analyzed the association between the cortical activity at rest and the cognitive performance in women with FM. In agreement with our previous hypothesis, we found that the better the cognitive performance, the higher the spectral power of alpha 1 and alpha 2 in the frontal, parietal and occipital regions in women with fibromyalgia.

Studies have shown that the alpha frequency range is related to relaxation, and that changes in alpha amplitude are associated to behavioral changes (Caro; Winter, 2011). In general, studies have shown altered alpha wave amplitudes at rest in frontal, occipital and parietal regions in chronic pain (González-Roldán et al., 2016), similar to the present findings. Moreover, changes in alpha amplitudes are related to alterations in the depression levels, which impact the quality of life of patients with FM (Vanneste et al., 2017).

Alpha changes are reported as a potential neurophysiological marker of the cognitive functioning (Grandy et al., 2013). According to Navarro Lopez et al. (2015), a lower level of alpha activity indicates a worse sensorimotor integration,
requiring an extra effort to mitigate the sensation of chronic pain. Therefore, the present results support the hypothesis that pain processing recruits neural resources used in other cognitive tasks and promotes an attentional overload that affects cognitive processing (Samartin-Veiga; González-Villar; Carrillo-De-La-Peña, 2019).

Those findings contribute to understand the relationships between the cognition and the patterns of cortical activity in patients with FM. Furthermore, they can help to define neuromodulation protocols for the treatment of patients with FM, which can be set to decrease pain and promote cognition through the use of techniques as transcranial direct current stimulation (tDCS) and transcranial magnetic stimulation (TMS). Future studies may evaluate if the same relationship between the cognition and the alpha oscillations occurs in healthy individuals.

5. Conclusion

The results of this study provide information about the association between resting cortical activity and cognitive performance in women with fibromyalgia. It was observed that the better the cognitive performance, the greater the spectral power of alpha 1 and alpha 2 oscillations in the frontal, parietal and occipital regions. These findings are consistent with existing literature on the relationship between alpha frequency and cognitive processes, suggesting that chronic pain may not only affect sensory perception, but also cognitive capacity, possibly through attentional overload.

Previous studies have already shown changes in alpha wave amplitudes in patients with chronic pain, which is in line with our findings. Furthermore, the relationship between changes in alpha oscillations and levels of depression suggests an interconnection between emotional state, pain perception and cognition in patients with fibromyalgia. These results highlight the importance of considering not only physical pain, but also the cognitive and emotional manifestations of fibromyalgia in the clinical management of this condition.

Furthermore, the findings of this study have implications for the
development of therapeutic interventions. Neuromodulation by transcranial direct current stimulation (tDCS) and transcranial magnetic stimulation (TMS) are techniques that can be explored to modulate cortical activity and potentially improve both pain and cognitive function in patients with fibromyalgia. However, more research is needed to elucidate the mechanisms involved.

REFERENCES


