

A Dynamic Causal Modeling study in empathy for pain stimuli with fibromyalgia

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Introduction

Fibromyalgia(FM) is disorder of unknown etiology [1], characterized by chronic widespread pain and are often accompanied by functional disturbance (dizziness, palpitations) in different organ systems and symptoms of sleep disturbance, anxiety, memory problems, fatigue, and exhaustion. Previous functional imaging studies of FM mainly focused on pain by physical stimuli or functional connectivity. However, there is no emotional and cognitive effective connectivity study with FM. Therefore, the aim of this study investigates the effective connectivity using dynamic causal modeling and difference of pain network between FM patient and healthy controls in the empathy for pain stimuli.

Subject and Methods

Subjects: Twenty-four right-handed, healthy female participants were recruited from the general population and twenty-three right-handed, fibromyalgia female participants were recruited from the fibromyalgia population in this study. The mean ages of fibromyalgia group were 39.4 years and the healthy group were 37.9 years. After detailed explanation of the study design and potential risks, all subjects gave written informed consent. All study protocols were approved by the local Internal Review Board (IRB).

Functional MRI: The fMRI task paradigm was used emotional pain task with block design. Functional magnetic resonance images were acquired using a 3.0T GE HD scanner(EPI, TR=4000ms, TE=40ms, matrix=64x64, Thickness=3.0mm, FOV=192mm, no gap). Anatomical images were acquired using 3D-FSPGR sequence(TR=7.8ms, TE=3ms, matrix=256x256, no gap).

Empathy for pain paradigm: The empathy for pain stimuli had been previously developed and were used with their permission. The picture stimuli consisted of a series of color pictures that showed right hands and right feet in painful and non-painful situations (Fig 1.(a)). The 96 painful pictures used in this paradigm and the session consisted of 26 blocks. The participants were asked to watch and evaluate the pictures describing right hands or feet in painful situations as a task condition(12 blocks). The baseline trials showed a 2 fixed cross blocks at the middle and end of the session. Each task or control block consisted of eight 4-s trials of the same condition. Each picture was shown for 2s, followed for 2s by a faces pain rating scale.

Data Analysis: Statistical parametric map software (SPM5, Wellcome Department of Cognitive Neurology, London, UK) was used to generate activation map. One-sample analysis was performed for selection VOIs with 5mm radius sphere in the DLPFC, insula and ACC, and VOI extracted from individual temporal data. DCM analysis were performed with DCM V.10 in SPM8 with 6 model (Fig 1.(b)) and Bayesian Model Selection(BMS) and Bayesian Model Averaging(BMA) were performed for model comparison and evaluating the connection strengths.

Result and Discussion

The results of BMS processing with all models of both hemispheres were shown in Fig.2 and this process was performed to evaluate which model probability is dominant and different between control and FM group. The BMS of all models in control group selected the model_3 of right hemisphere and the probability of model_3 was 36.54%. However, the BMS of all models in FM group chose the model_3 of left hemisphere with probability of 25.49%. The connection strengths from DLPFC to insula were showed more strong than the strength from insula to ACC or similar in control group. However, the strengths from DLPFC to insula were showed more weak than the strength from insula to ACC in FM group. Relatively, the strengths from insula to ACC were presented very strong than healthy controls. Our results from DCM analysis suggest that the DLPFC delivers controlled pain information and intensity to insula. Then, insula assesses the information and perceives the pain intensity with ACC. In this study, in patients with FM, the effective connectivity between DLPFC and insula was decreased, but effective connectivity between insula and ACC was increased. This finding is possible to postulate that the DLPFC in FM does not execute the role of pain control by cognitive dysfunction, thus the pain perception processing between insula and ACC is overloaded and patients with FM perceive the more pain intensity than healthy controls. Therefore, the role of DLPFC in emotional pain processing is associated with control of pain intensity and inhibitory system. If the DLPFC has a deficit or a dysfunction, patients under chronic pain perceive the more pain intensity than normal.

References

[1] Merskey H, Bogduk N. Classification of chronic pain: descriptions of chronic pain syndromes and definitions of pain terms. Monograph for the Task Force of taxonomy. 2nd edn. Seattle, WA: International Association for the Study of Pain; 1994: 45–7.

Result data



Fig 1. (a)Sample pictures of hands and feet in painful and non-painful conditions and faces pain rating scale. (b)Created DCM model family with 3 regions(DLPFC, insula, and ACC)

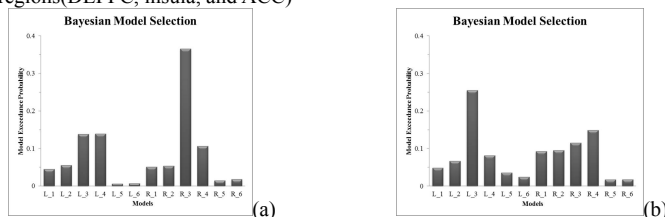


Fig 2. The BMS selected model in left and right hemisphere. The BMS selected the model_3 of right hemisphere in control group (a). However, the model_3 of left hemisphere was selected in FM group (b) and showed a lower probability relatively.

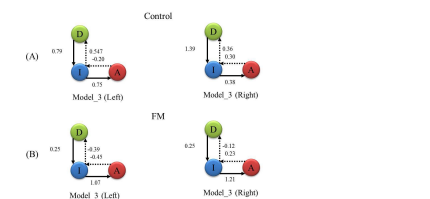


Fig 3. The connection strengths of model_3 in the control and FM patients group.