

# The power spectral density of slow fluctuation BOLD signal analysis during resting-state functional magnetic resonance image in fibromyalgia

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## Introduction

Fibromyalgia (FM) is considered to be the central chronic pain syndrome and is associated with widespread pain spontaneously [1]. Fibromyalgia syndrome is not restricted to pain and often leads to other symptoms including debilitating fatigue, sleep disturbance, and depression and anxiety. Currently no investigation is available for identifying the power spectral density(PSD) of low frequency BOLD fluctuations during resting state functional magnetic resonance imaging (rs-fMRI) while recent study evaluated low frequency fluctuation during resting-state.[1] The objective of this study was therefore to (1) demonstrated the medial and lateral pain networks (MPN and LPN) divided by function of pain processing and (2) investigate the differences in the power spectral density of low frequency BOLD fluctuations within pain-related networks between FM patients and healthy controls.

## Subjects and methods

The data from 39 right handed subjects, 19 patients with FM (all female subjects; mean age 40.89  $\pm$  6.72) and 20 age-matched female healthy controls (mean age 38.10  $\pm$  8.16) were included in this study. Slow fluctuation components between 0.01 Hz and 0.1 Hz in individual subjects were analyzed using seed based analysis. [2] All participants gave their written informed consent. Rs-fMRI was employed to assess functional connectivity and neural dynamic activity during the rest. [3] Resting state BOLD signals during the scan were acquired using a 3.0T GE HD scanner (EPI, TR=2000ms, TE =30ms, flip angle =90°, matrix=64x64, FOV=220mm, slice thickness = 4 mm, no gap). Anatomical images were acquired using 3D-FSPGR sequence (TR=8.1ms, TE=3ms, flip angle = 20°, matrix=256x256, FOV=220mm, slice thickness = 1.3 mm, no gap). Image processing and statistical analyses were carried out using MATLAB v. R2010b and SPM5. In rs-fMRI analysis, the medial and lateral pain networks (MPN and LPN) were showed using Functional Connectivity toolbox (FDR p <0.05, <http://web.mit.edu/swg/software.htm>). The crucial seed points of MPN and LPN is anterior and posterior insula, respectively. Based on the functional connectivity maps, we demonstrated pain- related seed points using MarsBar (<http://marsbar.sourceforge.net/>). The PSD was calculated in the pain networks employing Welch's method (using the signal processing toolbox in MATLAB) at low frequencies (<0.08Hz). To show the differences in the PSD between FM patients and healthy controls in pain related brain regions at low frequencies (<0.05Hz) were assessed using a two-sample t-test using the Statistical Package for the Social Sciences (p<0.05, SPSS, Version 18; SPSS, Inc.).

## Results and Discussion

Analyses of intrinsic brain connectivity in low frequency BOLD fluctuations with rs-fMRI (0-0.08Hz) were performed, the MPN(Fig1, FDR p < 0.05) and LPN(Fig2, FDR p < 0.05) were identified by anterior insula and posterior insula, respectively. [2] The pain networks are suitable for display of different pain processing and show pain-related brain regions. Using this intrinsic brain connectivity maps, we defined the pain-related ROIs and compared the average PSD of FM patients with those of healthy controls within pain related brain regions. Low frequency power was strongest at frequencies below 0.05Hz. [3] Therefore, two sample t test performed between groups at the frequency level 0-0.05Hz. The LPN is specific to receiving pain location and encoding pain intensity. The key structures of LPN are posterior insula and somatosensory cortex. The PSD of patients with FM in middle cingulate cortex and primary somatosensory cortex was increased as result of comparison within entire individual ROIs at frequency band: 0-0.05 Hz (Fig3 a, p <0.05). These brain regions associated with emotion and sensory function. It suggested that FM patients have strong neural activities in encoding pain intensity and localization. The MPN is known as getting involved in cognitive and psychological modulation of pain. The key structures of MPN are anterior insula, amygdala, cingulate cortex and prefrontal cortex. The mean PSD in patients with FM showed significant increases in inter-hemispheric dorsolateral prefrontal cortex and amygdala at 0-0.05Hz. (Fig3 b, p <0.05). These brain regions are associated with emotional and affective responses. In resting state fMRI, even FM patients were not exposed to pain, FM patients have strong neural activities within pain-related brain regions. It supposed that neural activities of fibromyalgia patients were strongly activated within pain related brain regions in resting state. The brain regions which showed greater PSD in FM patients are associated with sensory-discrimination, cognitive pain modulation, and affective pain responses. Even FM patients stay alert without any irritation, they have strong neural activities within pain-related brain regions. We concluded that pain perception threshold of FM patients had been much lower than healthy controls. We could demonstrate that causes of greater pain perception and a low pain threshold using the PSD. FM patients feel pain strongly because of neural activity in pain related brain regions, so FM patients feel pain even a light stimulation

## References

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