Frequency-Dependent Neural Activity in Patients with Unilateral Vascular Pulsatile Tinnitus

Han Lv[1], Zhenchang Wang[1], Zhaohui Liu[2], Fei Yan[2], Pengfei Zhao[1], and Ting Li[2]
[1]*Beijing Friendship Hospital, Beijing, Beijing, China,* [2]*Beijing Tongren Hospital, Beijing, China*

Target audience Researchers studied on changed neural activities in patients with pulsatile tinnitus.

Purpose Previous resting-state functional magnetic resonance imaging (RS-fMRI) studies have shown that neurological changes are important findings in vascular pulsatile tinnitus (PT) patients[1]. Here we utilized R-fMRI to measure the amplitude of low-frequency fluctuations (ALFF) in two different frequency bands (slow-4, 0.027-0.073 Hz; slow-5, 0.010–0.027 Hz) in patients with unilateral PT [2-3].

Methods PT patients (n=40) and age-, gender-, education-matched normal control subjects (n=40) were enrolled in this study. Two different frequency bands were analyzed to examine the intrinsic brain activity in details. Brain volume changes were also evaluated. For the clusters showing significant main effects and an interaction between group and frequency band, we performed the *post-hoc* two-sample *t*-tests.

Results Widespread ALFF differences between the two bands were observed, predominantly including the aMPFC (anterior medial prefrontal cortex)/ACC (anterior cingulate cortex), PCu (precuneus), part of the lateral regions of bilateral superior temporal gyrus, right fusiform gyrus, right postcentral gyrus, and basal ganglia, bilateral superior temporal gyrus (Figure 1). Compared to controls, PT patients had increased ALFF values mainly in the PCu, bilateral IPL (inferior parietal lobule), left IFG (inferior frontal gyrus), right IFG/anterior insula, bilateral superior temporal gyrus, left fusiform gyrus, and decreased ALFF values in the multiple occipital areas including bilateral middle-inferior occipital lobe, cuneus, vermis and part of bilateral cerebellum posterior lobe (Figure 2). Intriguingly, the ALFF abnormalities in aMPFC/ACC, PCu, right IPL and some regions of occipital and parietal cortices and cerebellar were greater in the slow-5 band compared to the slow-4 band (Figure 3, A and B). Additionally, the THI score of PT patients was positively correlated with changes in slow-5 (r=0.368, p=0.019) and slow-4 (r=0.342, p=0.031) band in PCu (Figure 4). PT patients enrolled in this study did not show any gray matter volume changes.

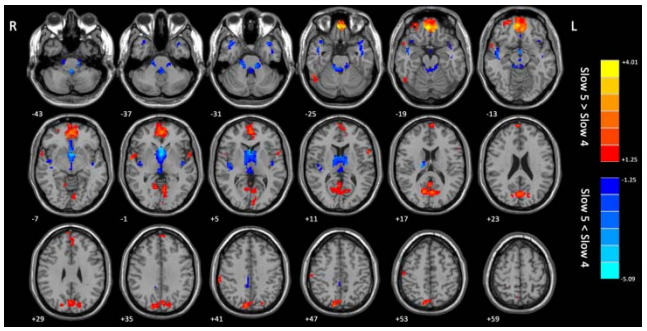


Fig. 1 The main effect for frequency band on ALFF. The hot color represents a higher ALFF in the slow-5 band than in the slow-4 band, whereas the cool color represents a lower ALFF.

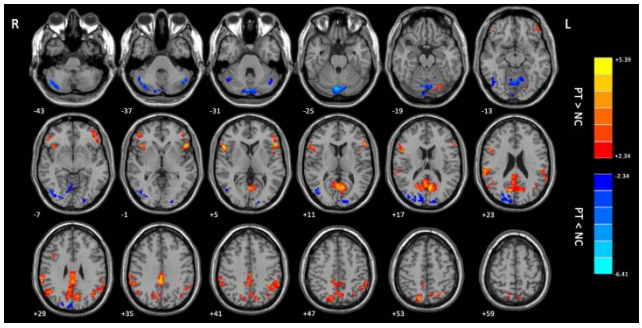
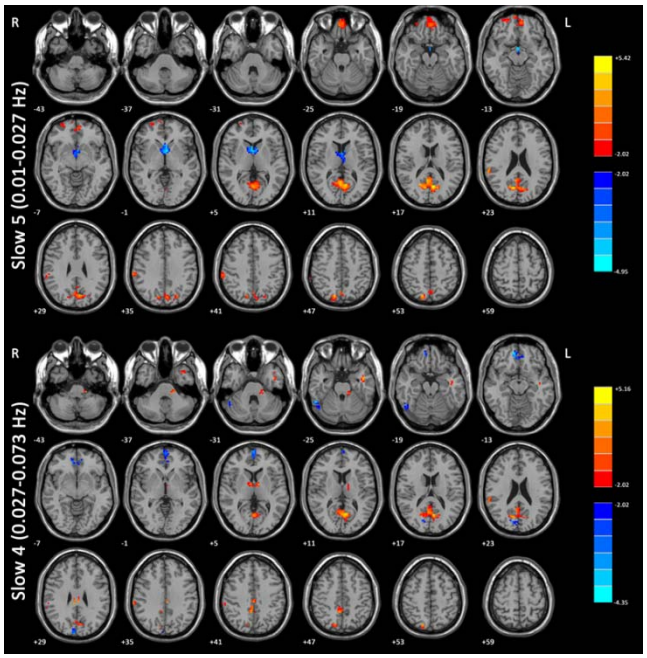


Fig. 2 The main effect for group on ALFF. The hot color represents a higher ALFF in pulsatile tinnitus (PT) patients than in the healthy controls.



Discussion and Conclusion In this study, we demonstrated widespread ALFF abnormalities of neural activity in PT patients. The brain function abnormalities in PT patients exhibited different spatial patterns in different frequency bands. The slow-5 band might be more prominent in detecting PT-related neural changes. The increased activity in the left IFG and right IFG/anterior insula suggested a relationship with the tinnitus awareness. The increased ALFF in PT patients in the anterior insula might also play a role in ongoing neural circuit adaptations to tinnitus-related distress, representing neural modulation and plasticity in PT patients. The decreased ALFF in the vermis may present a down-regulation adjustment of its function to avoid misinterpreting the sounds around. Additional studies are need to further study the neural reorganization in the cerebellum. Additionally, the changed ALFF in PCu in both slow-5 and slow-4 bands were significantly correlated with THI score in patients group. The pathophysiological mechanism of these results should be carefully determined to be helpful in the neurological studies of PT patients.

References 1. Han L, Zhaohui L, Fei Yet al. Abnormal baseline brain activity in patients with pulsatile tinnitus: a resting-state FMRI study. Neural Plast 2014;2014:549162. 2. Xue SW, Li D, Weng XC, Northoff G, Li DW. Different neural manifestations of two slow frequency bands in resting fMRI: A systemic survey at regional, inter-regional, and network levels. Brain Connect 2014. 3. Liu X, Wang S, Zhang X, Wang Z, Tian X, He Y. Abnormal Amplitude of Low-Frequency Fluctuations of Intrinsic Brain Activity in Alzheimer's Disease. J Alzheimers Dis 2014.

Fig. 3 The interaction between frequency band and group on ALFF. Greater group differences in the aMPFC/ACC, PCu, right IPL and some regions of occipital and parietal cortices and cerebellar showed greater group differences in slow-5 band compared to the slow-4 band.