Aberrant Inter-hemispheric Functional Connectivity in dementia: a resting state fMRI VMHC approach

Eva Yi Wah CHEUNG[1], Patrick Ka Chun CHIU[2], Yat Fung SHEA[2], Joseph SK KWAN[2], Henry Ka Fung MAK[1]*

[1]Department of Diagnostic Radiology, LKS Faculty of Medicine, The University of Hong Kong, Hong Kong
[2]Division of Geriatric Medicine, Department of Medicine, Queen Mary Hospital Queen Mary Hospital, Hong Kong
[3]Department of Medicine, Li Ka Shing Faculty of Medicine, The University of Hong Kong, Hong Kong

RADIOLOGY HONG KONG 2020
28th Annual Scientific Meeting of Hong Kong College of Radiologists
14th - 15th November 2020 (Saturday & Sunday)

Poster 20

Introduction

Previous studies have demonstrated that functional connectivity (FC) of different brain regions in resting state functional MRI were abnormal in patients suffering from Mild Cognitive Impairment (MCI) and Alzheimer's disease (AD) when comparing to healthy controls (HC) using seed based, ICA or small world network techniques. A new technique called VMHC was used in current study to evaluate FC.

Method

51 participants were recruited from the university hospital memory clinic. A multidisciplinary panel formed by a neuroradiologist and two geriatricians classified each of them into Alzheimer's Dementia (AD), Mixed Dementia (MD), Vascular Dementia (VD) and Subjective Cognitive Declined (SCD) based on clinical history, neuropsychological score (HK-MoCA), structural MRI, MR perfusion, and 18-F Flutametamol (amyloid) PET-CT findings of individual subject. A sub-group of 25 healthy control (HC) was also recruited for comparison with SCD and dementia patients.

MRI images were acquired using a Phillips Achieva 3T. A T1W MPRAGE (repetition time [TR]=6.8ms, echo time [TE]=3.2ms, inversion time [TI]=844ms, flip angle = 8°, 256 slices; field of view = 256mm, voxel size = 1 x 1 x 1.2mm) and one 8-min resting state scan (multi-echo echo planar imaging (EPI) sequence; 180 time points; TR=2000ms Flip angle = 90°, 36 slices, voxel size = 1.6 x 1.6 x 4mm).

All participants were asked to remain quiet and relax during the scan, with their eyes closed but not to fall asleep. The fMRI images were pre-processed by SPM12 with Mathlab 2018a. It included elimination of the first 10 time points, slice timing correction, normalization and head motion correction.

For VMHC, we adopted the method of calculation used by Kelly et al 2011 [1] and Zuo et al 2010 [2]. VMHC map was obtained. VMHC values in Default Mode Network (DMN), Salient Network (SN) and Executive Control Network (ECN) was obtained for different types of dementia. Two sample T-test was performed to compare each group with HC. Two-tailed Gaussian Random Field theory with voxel level of $p<0.01$ and cluster level of $p<0.05$ was used in VMHC map analysis.

Demographic of cohort

	HC	AD	Mixed	SCD	VD
No of participants	25	21	6	6	18
Age	68.84 ± 6.27	75.24 ± 7.24	82.33 ± 3.93	72.00 ± 6.45	78.24 ± 6.92
Gender (M/F)	9/16	8/13	5/1	1/5	9/8
HK-MoCA	28.56 ±1.23	16.65* ±7.21	15.67* ± 6.37	27.50 ±2.07	20.88* ± 4.54

*Bonferroni post hoc test $p<0.001$. One AD participant was unable to perform HK-MoCa

Result

AD vs HC: Significant reduction in VMHC value in DMN (precuneus, lingual gyrus, cuneus, fusiform gyrus and calcarine) and SN (postcentral gyrus, inferior parietal lobe, parietal lobe and occipital lobe) (Fig. 1).

MD vs HC: Significant increased in VMHC value in SN (thalamus, putamen, superior motor area, superior frontal gyrus, medial frontal gyrus, pallidum) and significant reduction in VMHC value in lateral occipital cortex, angular gyrus, middle temporal gyrus and post supramarginal gyrus (Fig. 2).

VD vs HC: Significant reduction of VMHC value in DMN (precuneus, lingual gyrus, cuneus, fusiform gyrus and calcarine) and significant increase in ECN (putamen, insula, precentral gyrus, cingulate gyrus and superior frontal gyrus) (Fig. 3).

SCD vs HC: Significant increased of VMHC value in DMN (precuneus, lingual gyrus, cuneus, fusiform gyrus and calcarine) and SN (postcentral gyrus, inferior parietal lobe, parietal lobe and occipital lobe) (Fig. 4).

Conclusion

Using VMHC, resting state fMRI showed different patterns in interhemispheric functional connectivity for AD, MD, VD and SCD when compare to HC, affecting the DMN, SN and ECN. AD showed decreased IFC in all three networks. While for VD and MD, coexistence of decreased and increased IFC was found within three networks. The findings might suggest that recruitment of other brain regions as adaptations to compensate for the reduced IFC.

Results

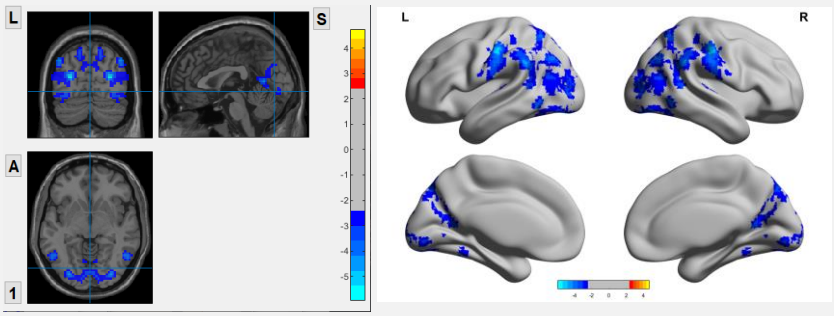

Fig. 1 VMHC value: AD vs HC

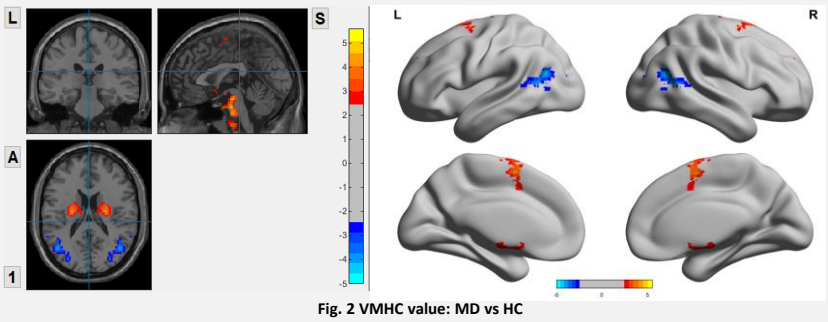

Fig. 2 VMHC value: MD vs HC

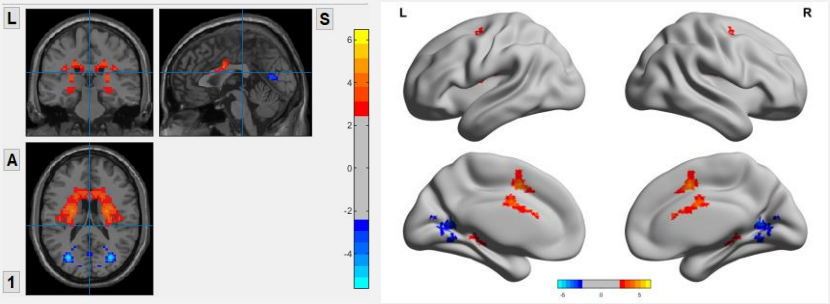

Fig. 3 VMHC value: VD vs HC

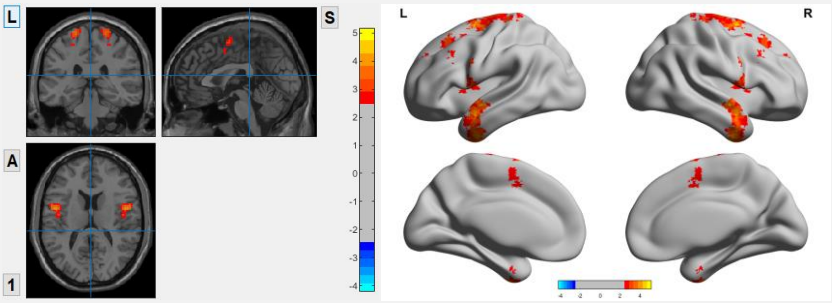

Fig. 4 VMHC value: SCD vs HC

References:

[1]C. Kelly *et al.*, "Reduced interhemispheric resting state functional connectivity in cocaine addiction," *Biological Psychiatry*, vol. 69, no. 7, pp. 684–692, Apr. 2011.

[2]X.-N. Zuo *et al.*, "Growing Together and Growing Apart: Regional and Sex Differences in the Lifespan Developmental Trajectories of Functional Homotopy," *Journal of Neuroscience*, vol. 30, no. 45, pp. 15034–15043, Nov. 2010.

Acknowledgement:

This study was supported by the State Key Laboratory of Brain and Cognitive Science, the University of Hong Kong.