VOXEL-BASED RELAXOMETRY IN PARKINSON VARIANT OF MULTIPLE SYSTEM ATROPHY: A PILOT R2* STUDY ON 3T AND COMPARISON WITH VOXEL-BASED MORPHOMETRY

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Introduction:

Tissue transverse relaxation rate can be a sensitive parameter for identifying abnormalities prior to other MRI changes. As such, measuring T2 relation rate may help differentiating Parkinson variant of multiple system atrophy (MSA-P) from idiopathic Parkinson's disease or other atypical Parkinsonian disorders in early stage. However, published studies on T2 relaxation rate of MSA-P were conducted at 1.5T with using a spin echo (SE) sequence. It is well known that the tissue relaxation rate is magnetic field dependent. In addition, although spin echo sequences are most suitable for T2 measurements, the underlying changes in T2* relaxation may provide a more sensitive means for the differential diagnosis between MSA-P and Parkinson disease.

Methods:

According to the consensus criteria[1], Twenty-two patients with probable MSA-P (10men and 12women; age: 53.1±5.3 years; disease duration: 2.0±1.1 years) and 24 healthy controls (7men and 17women; age: 53.4±4.8years) were included in this study. All the subjects were right-handed.

MRI examination was performed on a 3.0 Tesla scanner (GE Signa VHi Excite) with an 8-channel phase array head coil. An axial T1-weighted 3-dimensional fast spoiled gradient echo sequence (TR=6.9ms, TE=3.3ms, flip angle=15º, matrix=256×256, FOV=24×18cm, slice thickness=1.6mm, slice gap=-0.8mm) and a 16-echo gradient echo sequence (TR=170ms, TE range from 3.5ms to 59.6ms, echo spacing=3.8ms, flip angle=20º, matrix=160×160, FOV=24×19cm, slice thickness=2mm, slice gap=0.5mm) were applied. R2* maps were generated using the software package (Functool 2) provided on GE workstation.

Using SPM8, a customized R2* template was produced for each subject. The T2*-weighted images of the 2nd echo (TE=7.3ms) were chosen to co-register with the corresponding 3D T1 images, and then normalized, with the warping parameters applied to the R2*maps. The normalized R2*maps were smoothed with an 8-mm FWHM isotropic Gaussian kernel, and a mean image (R2* template) was created. Subsequently, all R2*maps in native space were transformed onto the stereotactic MNI space by a second normalization with the R2* template. Each image was checked to prevent the possible warping errors which would interfere the statistical results. Two-sample t-tests were carried out respectively for the VBM and Voxel-based relaxometry (VBR) to compare the differences between MSA-P and controls. Significant levels P were set at 0.005, without correction for multiple comparisons. For the VBM and VBR, each comparison between two groups was implemented with 2 different contrasts to explore the increase and decrease of GM, WM and the relaxation rate.

Results:

By VBR analysis (Fig.1), large areas of relaxation rate decreased in the MSA-P group can be spotted bilaterally in basis pons, cerebellar hemisphere (particular the anterior lobe), vermis, and the supratentorial structures such as insular lobe, caudate nuclei, internal capsule and the splenium of corpus callosum. In terms of VBM (Fig.2), significant grey matter loss (red clusters) in the MSA-P group was demonstrated at the area of anterior lobe of cerebellum, vermis, ventral pons, putamen, caudate nuclei, and some cortical areas in frontal, parietal and insular lobe. White matter atrophy (yellow clusters) was bilaterally detected in medulla oblongata, pons, middle cerebellar peduncle, cerebellar hemisphere, anterior limb of internal capsule and subcortical insular lobe. Comparisons with inverted contrast did not reveal any regions of increase of volume in GM, WM or relaxation rate in MSA-P group.

Discussion and Conclusions:

In general, our VBR results was consistent with the VBM results in most involved areas except central pons, bilateral putamen, corpus callosum and some cortical areas in frontal and parietal lobe. Among these inconsistent areas, corpus callosum showed decreased relaxation rate, without volume loss. However, previous VBM[2, 3] and pathological studies of MSA-P patients with relatively longer disease duration revealed atrophy of the corpus callosum. Thus, the VBR changes without atrophy of the corpus callosum in this study suggest the advantage of the relaxation rate on detecting early degeneration prior to morphological changes. As for central pons, a probable reason for the spared pons in VBR may be due to the severe susceptible artifact from the cranial base (Fig.3 b, c). Thus, the disagreement on putamen can also be owing to the artifact from the iron-rich basal ganglia (Fig.3 a). No significant VBR changes were observed in frontal and parietal lobes, which did not consistent with of the results of VBM, further study is needed. Compared with previous VBR studies[4, 5], our results showed large areas of reduced relaxation rate, indicating with higher magnetic field strength and the sensitive pulse sequence, more difference could be detected.

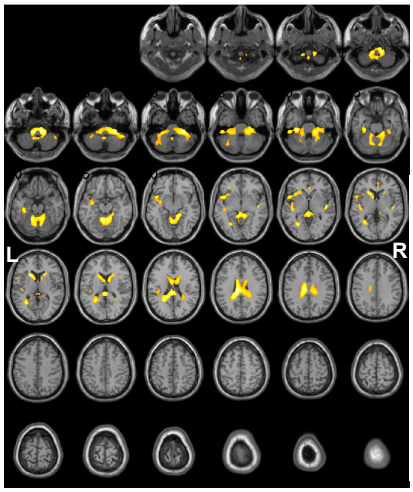
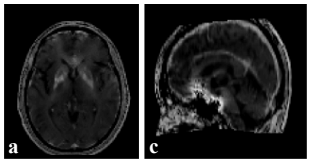


Fig.1 Results of VBR analysis of MSA-P versus control. The yellow clusters indicated the decrease of R2* relaxation rate of the MSA-P group. *P*=0.005, uncorrected, cluster threshold=10 voxels.



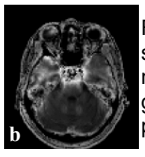


Fig.3 an example showed the artifact next to basal ganglion(a) and pons(b,c).

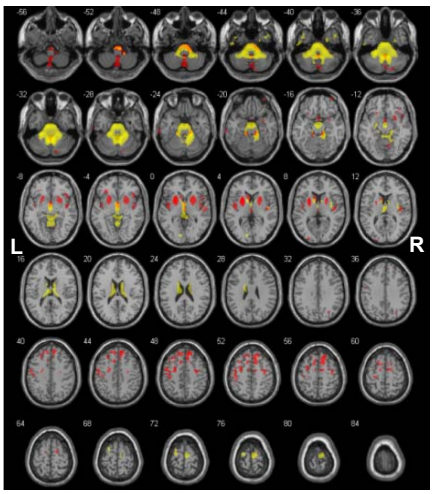


Fig.2 Results of VBM analysis of MSA-P versus control. The red clusters reveal grey matter atrophy of the MSA-P group and the yellow clusters indicate the white matter loss of the MSA-P group. *P*=0.005, uncorrected, cluster threshold=10 voxels.

References: [1] Gilman S et al. *Neurology* 2008; 71: 670-6. [2] Brenneis C et al. *Mov Disord* 2003; 10: 1132-8. [3] Minnerop M et al. *Mov Disord* 2010; 15: 2613-20. [4] Tzarouchi LC et al. *J Neuroimaging* 2010; 3: 260-6. [5] Minnerop M et al. *Neuroimage* 2007; 4: 1086-95.