

Voxel-based morphometry with z-score images for evaluation of fractional anisotropy alterations in major depressive illness

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Background and purpose

It has been reported that diffusion tensor imaging (DTI) can detect the microstructural alterations of cerebral white matter in a variety of neurological diseases¹⁻³. The principal metric derived from DTI is fractional anisotropy (FA). In this study, FA of cerebral white matter of patients with major depressive illness was evaluated, using voxel-based morphometry (VBM) with z-score images.

Materials and methods

All MR examinations were performed using a 1.5T MR imager. Spin-echo echo-planar DTI (TR / TE / NEX / b / number of non-collinear gradient direction = 5100 ms / 139 ms / 2 / 1000 s/mm² / 12) was performed to 16 patients with major depressive illness (6 men and 10 women; Mean age = 45.5 ± 15.9 years). FA maps were generated, and spatially normalized. Pixelwise z-score evaluation of normalized FA of each patient was then performed, with reference to normalized FA of 15 controls of comparable age and sex.

Results and Discussion

VBM with z-score images revealed areas of FA decrease in frontal and temporal white matter of patients with major depressive illness (p<0.05). Compared to early-onset depressive illness, FA decrease was more commonly observed in patients with onset of depression after 50 years of age (Fig 1.).

The finding of FA decrease in frontal and temporal white matter indicates loss of integrity of frontal and temporal white matter fibre tracts; and suggests that neuroanatomical circuit abnormalities are encountered in major depressive illness^{1,2}. More common occurrence of FA decrease in patients with late-onset depression may imply that pathological processes encountering in late-onset depression are different from those of early-onset depression.

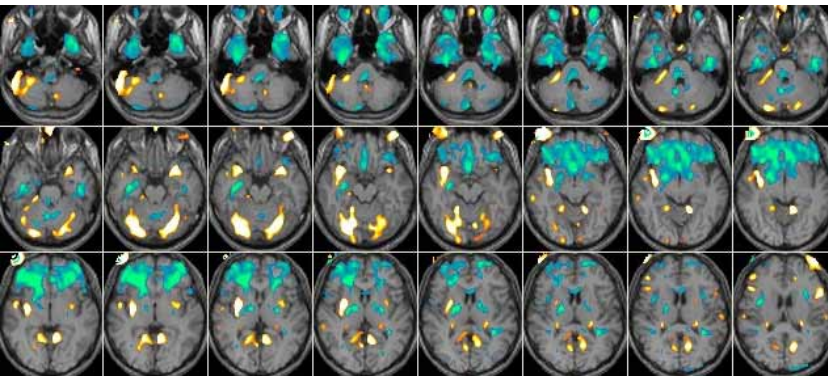


Fig 1 (shown at left). VBM with z-score images of a 52 year-old man who had been suffering from major depressive illness for 17 months. Areas of significant FA alterations ($z \geq 3$ or $z \leq -3$) are shown. Look-up table indicates z-scores. Areas of low z-scores are shown in green~blue, and those of high z-scores are shown in red~yellow. Significant FA decrease is noted in bilateral frontal and temporal white matter, bilateral cerebral white matter and brainstem. Areas shown as FA increase or decrease but located external to brain parenchyma are considered artifactual.

Conclusion

VBM analysis with z-score images can show FA alterations associated with major depressive illness, and can be used as a clinical tool for detection of FA alterations associated with the illness.

References

1. Nobuhara K, Okugawa G, Sugimoto T, et al. Frontal white matter anisotropy and symptom severity of late-life depression: a magnetic resonance diffusion tensor imaging study. *J Neurol Neurosurg Psychiatry* 2006; 77: 120-122.
2. Nobuhara K, Okugawa G, Minami T, et al. Effects of electroconvulsive therapy on frontal white matter in late-life depression: a diffusion tensor imaging study. *Neuropsychobiology* 2004; 50: 48-53.
3. Alexopoulos GS, Kiosses DN, Choi SJ, et al. Frontal white matter microstructure and treatment response of late-life depression: a preliminary study. *Am J Psychiatry* 2002; 159: 1929-1932.