Voxel-based morphometry of gray and white matter in lateralized temporal lobe epilepsy

A. B. McMillan[1], B. P. Hermann[2], S. C. Johnson[3], M. E. Meyerand[4]

[1]Biomedical Engineering, University of Wisconsin, Madison, WI, United States, [2]Neurology, University of Wisconsin, Madison, WI, United States, [3]VA Medical Center and Department of Medicine, University of Wisconsin, Madison, WI, United States, [4]Medical Physics, University of Wisconsin, Madison, WI, United States

INTRODUCTION

Voxel-based morphometry (VBM) can be used to compare regional differences in brain matter volume between groups from whole brain images, especially differences that might not otherwise be apparent on MR images. VBM has previously been used to characterize abnormalities in gray matter among subjects with temporal lobe epilepsy (TLE)[1]; however, to date, there has been little examination of white matter in TLE subjects using VBM. The purpose of this study is to characterize abnormalities in both gray and white matter morphometry in subjects with lateralized TLE using VBM.

MATERIALS AND METHODS

26 subjects with lateralized TLE were selected on the following criteria: 1) age 14 to 60 years, 2) complex partial seizures of temporal lobe origin demonstrated by ictal EEG recording, 3) absence of MRI abnormalities (e.g. lesions) other than atrophy, 4) no other neurological disorder. Among TLE subjects, 13 had unilateral left and 13 had unilateral right temporal lobe seizure onset. 62 friend or family members with no history of psychiatric disorder were selected as healthy controls. Subjects were scanned with a 3D-SPGR sequence for full cranial volume on a 1.5T GE Signa MRI scanner. Each scan was individually examined to be free of artifacts and centered on the anterior commissure. SPM2 was used to create study specific brain templates including *apriori* gray and white matter templates and to perform VBM[2]. ANCOVA analysis was used with total gray or white matter volume (to control for intensity differences across scans), with age and gender as confounding covariates. Results were corrected for multiple comparisons at FDR < 0.05.

RESULTS AND DISCUSSION

VBM indicated a significant deficit in both gray and white matter distributed throughout the brain. Hippocampal volume reduction was present in the left TLE group (cluster size = 14). At a decreased significance level (FDR < 0.08), hippocampal volume decrease was seen in the right TLE group. Other notable effects at the FDR < 0.05 level included regions of gray matter volume decrease in the ipsilateral thalamus and the cerebellum. The right TLE group further indicated a volume decrease in the ipsilateral temporal pole gray matter with accompanying frontal and parietal differences, predominately on the ipsilateral side. White matter VBM showed a profound and dramatic decrease in white matter volume, again, mostly focused on the ipsilateral side to seizure onset, but evident contralaterally as well. The most marked effect was present in the ipsilateral temporal pole white matter, but the effect extended throughout the prefrontal, frontal, and parietal white matter. The effect continued inward and included discrete white matter tracts including the corpus callosum and fornix.

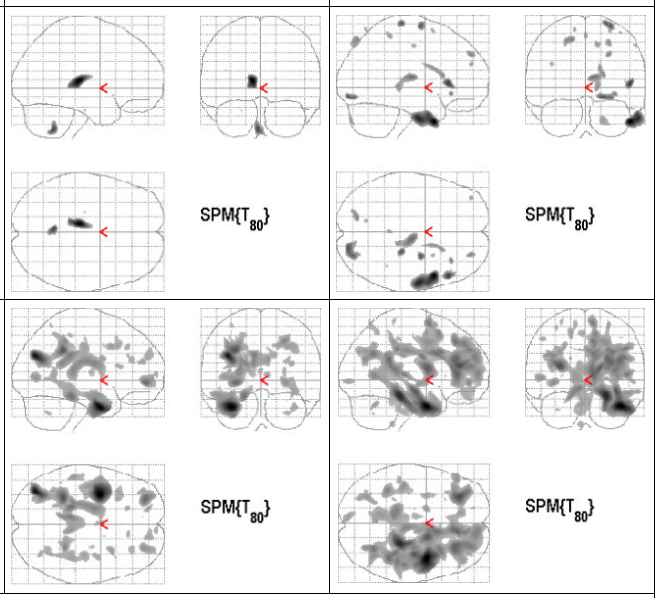

Figure 1. Result of VBM: SPM's where TLE population has less volume than controls, significant at FDR < 0.05

CONCLUSION

The results of the gray matter VBM analysis complement previous studies by identifying extratemporal regions of volume abnormality in patients with TLE[1]. The apparent lack of a large hippocampal effect is not unexpected due to the fact that patients were not selected on the basis of hippocampal sclerosis, excluding the relatively large degree of smoothing (10 mm) with respect to hippocampus size and modest sample size. These findings extend our recent report of significant volume decreases in cerebral white matter across the frontal, parietal, and temporal lobes[3]. The present results provide a finer specification of the regions involved, demonstrate the ipsilateral and contralateral effects in patients with ictally confirmed unilateral TLE, and characterize the considerably greater impact on white compared to gray matter. The large effect in white matter volume raises the question of the cognitive consequences of decreased white matter volume and probable decreased cerebral connectivity in TLE. The neuropsychological consequences of this decreased white matter volume and the etiology underlying the extensive white matter abnormality remain to be clarified and represent important areas for future investigation.

REFERENCES

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