Voxel based morphometry of 3D FLAIR imaging in cryptogenic intractable focal epilepsy

K. J. Riney[1,2], K. C. Chong[3], J. Cross[2,4], and C. A. Clark[1]

[1]Radiology and Biophysics, University College London Institute of Child Health, London, London, United Kingdom, [2]Department of Neurology, Great Ormond Street Hospital for Children NHS Trust, London, London, United Kingdom, [3]Department of Radiology, Great Ormond Street Hospital for Children NHS Trust, London, London, United Kingdom, [4]Neurosciences Unit, University College London Institute of Child Health, London, London, United Kingdom

Introduction

Magnetic resonance imaging (MRI) has transformed the delineation of structural brain pathology which can underlie intractable focal epilepsy (IFE). However some children with IFE have unrevealing conventional MRI, even though one suspects a structural lesion. There is evidence from neuropathological studies that in such children with 'cryptogenic' IFE, pathology exists that is not detected on MRI. Fluid-attenuated inversion-recovery (FLAIR) sequences combine cerebrospinal fluid (CSF) signal suppression with heavy T2 weighting and have improved detection of subtle focal cortical dysplasia (FCD). Recently methods have been developed to allow the acquisition of 3D FLAIR volumes. Voxel based morphometry (VBM) is an objective method of assessing 3D volumetric imaging of individuals, on a voxel by voxel basis, against a control group to look for statistically significant differences in the individual brain. To date VBM of 3D FLAIR has not yet been reported in the literature. In this study we proposed that (1) a method for performing VBM of 3D FLAIR imaging could be developed, (2) that VBM of 3D FLAIR could reliably detect visible FCD and (3) that VBM of 3D FLAIR could also detect abnormality (likely to represent occult FCD) in a proportion of children with cryptogenic IFE.

Method

Children with IFE due to FCD and children with cryptogenic IFE were recruited from the Epilepsy Unit at Great Ormond Street Hospital, London. A control group of similar age was also recruited. MR imaging was carried out on a 1.5T Avanto scanner (Siemens, Erlangen, Germany). 3D FLAIR (TR 6000ms, TE 353ms, TI 2200ms, FOV 256mm, voxel size 1mm^3) images were acquired in addition to routine epilepsy protocol MRI. Images were reviewed by an experienced Neuroradiologist. VBM was performed using SPM5 (Wellcome Institute of Cognitive Neuroscience, London) running in MATLAB 7.1 (The MathWorks, Natick, Mass., USA).

Results

Eight children with IFE and FCD (M=5, age 7.9-17.3y, median 13.6y), 14 children with cryptogenic IFE (M=8, 7.8-16.8y, median 13y) and 24 controls (M = 13, 7.1-18.7y, median 11.3y) were recruited. VBM detected 7/8 FCD and detected abnormality in 4/14 children with cryptogenic IFE. On review of the VBM abnormalities seen in the cryptogenic IFE group, 2/4 abnormalities were found subsequently to represent subtle FCD not detected on original visual inspection of the MRI.

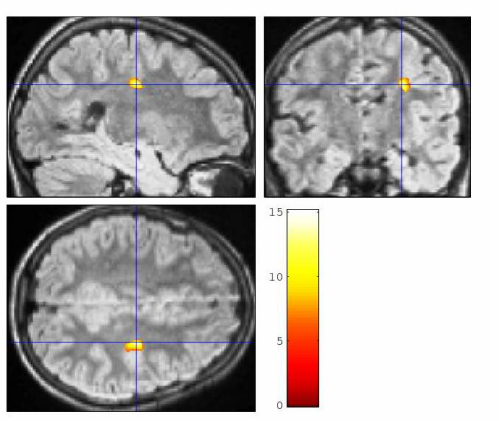

Figure 1. Child with cryptogenic IFE in whom VBM detected an abnormality in the right frontal lobe. Ictal EEG and SPECT localized to the right frontal region. Subsequent review of original MRI has confirmed that the area detected by VBM represents subtle FCD missed on original visual inspection.

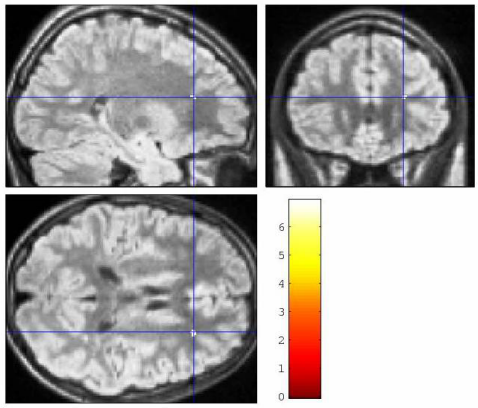

Figure 2. Child with cryptogenic IFE in whom VBM detected an abnormality in the right frontal lobe, concordant with seizure focus as determined by EEG. Subsequent review of original MRI has confirmed that the area detected by VBM represents subtle FCD missed on original visual inspection.

Discussion

VBM of 3D FLAIR is possible and reliably detects visible FCD. All of our children with cryptogenic IFE had high resolution epilepsy protocol imaging, reported by a dedicated experienced neuroradiologist with all the clinical information to hand. Despite this, VBM of 3D FLAIR has led to detection of subtle FCD in 2/14 children, previously thought to have MRI. We therefore propose that VBM FLAIR should be considered in all children with cryptogenic IFE as in a proportion of these children it may reveal subtle FCD, allowing these children to be considered for epilepsy surgery as a treatment option for their intractable focal seizures.

Acknowledgements

This work was funded by SPARKS, UK (Sport Aiding Medical Research for Kids) and was undertaken at Great Ormond Street Hospital for Children NHS Trust / The University College London Institute of Child Health who receive a proportion of their funding from the Department of Health's NIHR Biomedical Research Centre funding scheme.