

Shape analysis of the hippocampus and caudate in First Episode Psychosis

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Purpose

Investigations into hippocampal volume in first episode psychosis (FEP) have produced conflicting results, with the vast majority reporting preservation¹. The caudate has been implicated at FEP, however assessing brain structure volume on a global scale may not be sensitive to local regional changes in structural integrity. While the majority of studies to date have assessed gross volumetric changes, shape analysis provides a means of examining regional differences in brain structure independent of volume. The purpose of this study was to 1) determine if subtle structural volume or shape changes are present at first presentation with a psychotic illness and 2) investigate if identified neuroanatomical abnormalities are related to clinical outcome 3 years later.

Methods

1.5 Tesla T1-weighted MR images were acquired for 39 FEP patients and 41 healthy controls (group matched for age and gender). The hippocampus and caudate were manually segmented according to a strict anatomical protocol by trained raters (intra and inter-rater reliabilities ICC > 0.85). After segmentation, left and right hippocampus and caudate shape were modelled using SPHARM-mat². Normalisation to a template was performed to remove the effect of overall volume so shape change can be measured. Non-normalised shape was also analysed to determine regional volume differences. Signed Euclidean distance to an average template was calculated at each surface vertex and displacement maps produced for each subject. Linear regression was carried out to determine the effect of group on 1) overall global volume 2) regional volume and 3) shape change at each surface vertex, co-varying for age. Regional and shape analyses were corrected for multiple comparisons using the false discovery rate method (FDR). Intracranial volume was also added as a covariate in overall global volume and regional volume analysis. 23 patients were clinically assessed 3 years later and changes in Positive and Negative Symptom Scale (Δ PANSS), Global Assessment of Functioning (Δ GAF) and Usual Symptom Severity (USS) assessed. The relationship between these factors at 3 year follow-up and identified structural abnormalities at baseline were recorded in an analysis of covariance (ANCOVA) model correcting for age. Ethical approval was obtained from the University College Hospital Galway (UCHG) Clinical Research Ethics Committee. All subjects provided written informed consent.

Results

There was no global volume change found between groups for left or right hippocampus or caudate. FEP was associated with a regional volume contraction along the entire superior aspect of the left caudate and 2 regions of shape expansion at the anterior inferior head and inferior body of the left caudate, relative to the control group. No regional volume or shape abnormalities were detected in the hippocampus. There was significant effect of symptom severity at follow-up on the left caudate regional volume reduction at baseline ($F=4.9$, $p = 0.02$). Δ PANSS and Δ GAF were not significantly related to the volume or shape changes in the caudate.

Discussion

The present findings reveal areas of regional volume and shape difference in the caudate of first episode psychosis patients which were not detected in a whole structure volume analysis. This supports the use of shape analysis as a more sensitive method of detecting morphological variations in brain structure than overall volume alone. The volume contraction in the superior body of the caudate was related to psychotic symptom severity assessed 3 years following the MRI scan, with worse symptom severity associated with greater volume reduction. This novel finding demonstrates the potential of structural neuroimaging as a bio-marker for predicting outcome in the future.

References

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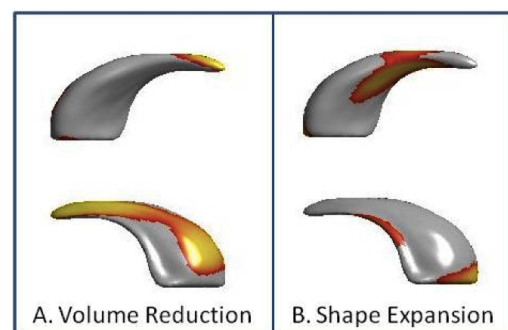


Figure 1 A) Volume reduction and shape expansion in the left caudate of FEP subjects