Free water elimination and mapping from diffusion tensor imaging (DTI) in chronic schizophrenia

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I. Introduction & Aim

Diffusion tensor imaging (DTI) acquisitions allows the comparison of diffusion characteristics in vivo and gives a unique insight into tissue structure and pathology. However, a limitation of DTI post-processing is the assumption of a Gaussian distribution of diffusion in neural architecture. Free water modelling aims to address this issue, and we present the second application of FA of tissue and free water mapping.

II. Methods

Diffusion weighted data (64 directions, b=1300 s/mm^2, Siemens 1.5T) was acquired for 19 participants(14M,5F, Mean-Age=37±10) with chronic schizophrenia and 19 controls (14M,5F,Mean-Age=39±11). Tract Based Spatial Statistics (TBSS) using threshold-free cluster enhancement (TFCE) was performed on fraction anisotropy (FA) from standard DTI data and freewater fractional anisotropy in tissue (FA_T). The freewater maps were generated using a bi-tensor model implemented in house using Matlab software (v7.11.0). Median FA and FA_T were extracted from regions of interests (namely the splenium, body and genu of the corpus callosum) and examined their relationship (Pearson's coefficient) to illness severity (GAF, SANS, SAPS), duration and the number of psychotic episodes.

III. Results

The schizophrenia group showed widespread increased cerebral free water compared to healthy controls, overlapping with previously reported areas of decreased FA($P<0.05$).

Focal areas (including the genu and splenium of the corpus callosum) demonstrated decreased FA in the presence of normal free water. Median tissue-FA in the splenium showed a proportional relationship with positive symptoms (SAPS)($r=0.55$, $p=0.037$), unlike standard FA which did not correlate with any clinical assessment tools.

IV. Conclusions

Our findings are broadly in agreement with larger N Number studies demonstrating reductions in FA_T, with significant reductions in the body of the corpus callosum when compared with healthy controls [1]. However, we did not demonstrate significant changes in the posterior thalamic radiation bilaterally, the anterior limb of the internal capsule bilaterally and genu[1]. Free water increases are associated with neuroinflammation, atrophy, low dendritic quantity, low cell density, or a breakdown in the cellular membrane and any combination of these will skew a standard DTI assessment, which may explain the inconsistences in DTI studies in schizophrenia todate[2]. By compartmentalizing freewater we can derive a more precise map of white matter degradation using FA_T. Our correlation with positive symptoms suggests that FA_T may be more specific to active pathophysiological processes generating symptoms in schizophrenia.

References

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethics

Ethical approval was obtained from the National University of Ireland Galway and University College Hospital Galway research ethics committees