Title: Investigating quantitative and structural differences in short association, U-shaped fibres in temporal lobe epilepsy

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Structured Abstract:

Introduction: The brain can be considered a network, comprising of many regions interacting and communicating via white matter fibres [1]. Abnormalities to the network [1, 2] can lead to network disorders, such as epilepsy which is often associated with seizures. Other groups have studied these pathological changes at both the microscopic scale (histology) and macroscopic scale (structural and functional networks). Despite this, little is known about short association, u-shaped fibres, joining adjacent brain regions (local connectivity) [3] which have exhibited abnormalities in epilepsy [4]. Diffusion MRI (dMRI) is one technique capable of providing data to model and group white matter fibres via tractography and clustering techniques to identify structural pathways (tracts). We hypothesized that identified short association tracts would exhibit quantitative diffusion characteristics (fractional anisotropy and mean diffusivity) that differentiate local pathways in temporal lobe epilepsy patients from healthy individuals.

Methods: We acquired dMRI data from a group of controls (N=20) and patients diagnosed with temporal lobe epilepsy (N=19) on a 3T Siemens Prisma MRI. The data was acquired with a multiband echo-planar sequence (2mm resolution, b-value=0, 1300, and 2600 s/mm2, 140 diffusion-encoding directions, acquired with alternating phase encoding directions). Whole-brain tractography was performed using MRTrix [5] following processing of data to correct for image distortion. A filter was implemented into a tractography evaluation tool to identify candidate U-shaped fibres. Quantitative diffusion measurements and fiber geometry metrics were computed. Comparison of quantitative and geometric measurements between control and patient groups were performed for each identified tract using two-tailed t-tests, corrected for false discovery.

Results: Candidate U-shaped fibres were identified and extracted using the implemented filter. Comparisons of quantitative diffusion measurements in identified pathways did not find significant differences between control and epilepsy patient groups. Similar comparisons performed for geometric measures also failed to identify significant differences.

Discussion: The ability to identify pathways can reaffirm connections of coupled brain regions and help explain activity in functional networks. While no significant differences were found for either quantitative diffusion data or geometric structure of U-shaped fibers in this preliminary investigation of individual tracts, differences may be present at the network level. Future work includes investigating differences in specific classifications of epilepsy (e.g. left vs right temporal lobe epilepsy) and probing local connectivity at a network level.