Conclusion: Lack of activation in the right-sided homologue of Broca's area may be explained by suppression or displacement of activity by the epileptic network. Interaction between epileptic and cognitive networks provides insight into the atypical organization of language in patients with epilepsy.

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LANGUAGE LATERALISATION BEFORE AND AFTER EPILEPSY SURGERY IN CHILDREN: RELATIONSHIP TO COGNITIVE FUNCTION

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Purpose: Surgical intervention for intractable epilepsy often involves resection of tissue in close proximity to eloquent cortex. The long-term effects on cognition, in particular language, are not well-documented in paediatric populations. In addition, many children with left hemisphere focal epilepsy show atypical language localisation and lateralisation. The current study evaluates changes in language lateralisation after resective surgery and whether this correlates with changes in verbal abilities.

Method: This preliminary report investigated 20 children who underwent investigations for surgical treatment of medication-resistant epilepsy, including functional MRI (fMRI) during a covert verb-generation task to determine hemispheric language lateralisation. Fifteen subsequently underwent surgery, whilst 5 did not. Seizure localisation varied between patients; 10 temporal, 5 extra-temporal and 5 multi-lobar, but was predominantly left-sided (70% of cases vs. 30% right-sided). Seven healthy sibling controls were also recruited. Patients were reassessed 6 years after presurgical baseline assessment. All subjects underwent the same language fMRI protocol as used at baseline. Lateralisation indices were calculated for Broca's region and the temporal lobes. All subjects underwent neuropsychological testing of verbal and non-verbal intelligence (Wechsler Intelligence Scale-IV).

Results: Verbal IQ scores increased in the surgical group from pre-operative baseline to follow-up ($p = 0.042$), and decreased in the non-surgical group ($p = 0.014$). Baseline and follow-up lateralisation indices showed significant positive correlations (Broca's area: $r = 0.813$, $p < 0.001$, temporal lobes: $r = 0.697$, $p < 0.001$) indicating relative stability over time. Pre-operative lateralisation was not related to post-operative verbal function, but at follow-up greater left-sided temporal lobe lateralisation was correlated with better verbal scores ($r = 0.39$, $p = 0.045$).

Conclusion: Our findings suggest that surgical intervention for epilepsy does not cause large changes in language lateralisation. Overall better verbal intelligence is associated with a more typical language lateralisation. Our preliminary results suggest improved verbal function in surgical compared to non-surgical patients, which is not driven by major changes in language lateralisation.

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BRAIN METALS IN EPILEPSY: FIRST INSIGHTS FROM ATOMIC NEUROSCIENCE IN POST-SURGICAL TISSUE

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Purpose: Metals are intrinsic to the architecture and function of the brain. Disruptions and changes to the levels of biometals have also been linked to epilepsy. However, little is known about the role of metals across scales, types of epilepsy, brain locations, and co-localization. Here we report on ongoing studies from the first application of synchrotron imaging to post-surgical human epilepsy tissue.

Methods: Cortical (n = 17) and hippocampal (n = 7) tissue samples resected during epilepsy surgery were examined using synchrotron x-ray fluorescence imaging (SXRF) at the Stanford Synchrotron Radiation Lightsource. Using two beamlines with resolutions down to the micron, we were able to visualize metal distributions and examine colocalization of elements (e.g., iron, copper, zinc) at scales ranging from layers to vessels and cells.

Results: Cortical layers were distinguishable in both focal cortical tissue and cortical tissue distal to a hippocampal focus (removed via a minimally invasive procedure in order to attain access to the hippocampus). Layers and tracks were also highly visible in multiple metal windows in the hippocampus. The most striking metal distributions were seen at lesion sites, with iron concentrations being a particularly pronounced marker of sclerotic areas. Most interestingly, cortical tissue in a subset of patients showed elevated levels of copper.

Conclusions: This study illustrates the vast information regarding metal distribution and co-localization that is now accessible with post-surgical SXRF imaging. Specifically, mapping the atomic composition of brain tissue in epilepsy opens new avenues for non-invasive patient-specific tests. In particular, identifying changes in metals could offer new ways of understanding symptomology, biomarkers, and mechanisms that could in turn suggest novel metal-based therapies (e.g., dietary, chelation) aimed at addressing metal imbalance, deficiency or overload.

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DIFFUSION TENSOR IMAGING AND TRACTOGRAPHY IDENTIFY STRUCTURAL CHANGES IN CRYPTOGENIC FOCAL EPILEPSY

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Purpose: To investigate the contribution of Diffusion Tensor Imaging (DTI) and Diffusion Tensor Tractography (DTT) in identifying abnormalities in MRI negative patients with cryptogenic extramesiotemporal focal epilepsies.

Method: 14 patients with cryptogenic extramesiotemporal focal epilepsy were investigated. DTI data was acquired on a GE Signa HDx 3T Scanner, using an acquisition scheme with 64 diffusion weighted directions, a b-value of 1,000 m/s^2, 2.4 mm slice thickness and 2 mm in-plane resolution. Fractional anisotropy (FA) maps were investigated for focal changes and asymmetries. Streamline DTT of the whole brain was used and the number of reconstructed streamlines in homolog anatomical areas were compared. Asymmetries of more than 10% for FA maps and more than 20% for the streamline count were rated as significant.

Results: Asymmetries in the number of reconstructed streamlines were found in nine of the 14 patients (64%). In eight of them, these changes were consistent with the clinically suspected seizure onset zone, based on video-EEG-monitoring and nuclear medicine data, however, in two patients DTT indicated more widespread, hemispheric changes, beyond the seizure onset zone. FA maps showed asymmetries beyond 10% in only one patient. In two patients, the seizure onset zone was confirmed in the area of DTT abnormalities by intracranial electrodes, the other patients are still awaiting invasive evaluation, including the one with discrepant DTI findings.