Statistical analysis of electrical impedance tomography image sets of epicortically recorded evoked neural activity in the anaesthetised rat

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An impedance decrease can be measured during neuronal activity as a result of voltage-gated ion channels opening during depolarisation, using electrical impedance tomography (EIT) this decrease can then be reconstructed into a depth resolved, tomographic image. Recently, the first tomographic images of fast neuronal activity, during evoked responses, were produced with EIT, using a 29 contact planar, epicortical electrode array in the anaesthetised rat. Presented in this study is quantitative analysis of the laminar propagation of this activity in comparison to expectations from the physiological literature. Analysis was with statistical parametric mapping (SPM), using second level analysis and one-sample t-tests, with family-wise-error (FWE) corrected p-values, of images generated with somatosensory forepaw (n=22/N=8, images/rats), hindpaw (n=5/N=2) and vibrissae (n=6/N=3), and photic stimulation (n=5/N=2). Voxel-wise analysis for forepaw indicated that in 14/24 voxels (1x1x0.5 mm) peak changes occurred earlier in deeper voxels, at depths of greater than 1.5 mm, than those more superficial. This deep to superficial propagation corresponds to directly recorded physiological data from the literature, which indicates forepaw activity starts at 5 ms at the layer IV/V and V/VI borders, and spreads superficially to layers III-IV, II-III, and the I/II border at 8, 9 and 12 ms respectively. The other groups did not achieve significance, probably due to an insufficient number of samples. Future work on these first ever reported EIT images of fast neural activity will include further analysis to fully examine these changes, improvement of meshing and inversion techniques, additional data collection and paradigm refinement.