Abstract ID 59

TENSOR ELECTRICAL IMPEDANCE MYOGRAPHY OF THE TONGUE IN AMYOTROPHIC LATERAL SCLEROSIS IDENTIFIES THE IMPEDANCE SIGNATURE OF DISEASE PROGRESSION

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Keywords: Amyotrophic Lateral Sclerosis, Biomarker, Bioimpedance, Dimensionality Reduction, Electrical Impedance Myography, Linear Mixed Modelling, Non-negative tensor factorisation

Summary: Objectives: Electrical impedance myography (EIM) is a promising biomarker for amyotrophic lateral sclerosis (ALS). A key issue is how best to utilise high dimensional, multi-frequency data to fully characterise the progression of disease. Methods: Muscle volume conducted properties were obtained from EIM recordings across three electrode configurations and 14 frequencies and non-negative tensor factorisation (tensor EIM) was applied. Data were collected over a maximum of 9 months in 28 patients with ALS and 17 controls. Tensor EIM was evaluated against EMG data, the amyotrophic lateral sclerosis functional rating scale (ALSFRS) bulbar sub-score, tongue strength and an overall bulbar disease burden score. Results: EIM spectra with differing spectral shapes were seen in association with EMG findings of acute and chronic denervation. Tensor EIM identified both shapes in longitudinal measurements from patients with ALS, but with an increasing trend towards the spectral pattern associated with chronic denervation. Tensor EIM increased within three months ($p<0.01$) and continued to do so over the 9-month duration ($p<0.001$). In a hypothetical clinical trial scenario tensor EIM required fewer participants ($n=15$), than single frequency EIM measures (n range 28-189) or the ALSFRS bulbar subscore ($n=54$).Conclusions: Tensor EIM captures the effects of denervation/ reinnervation and provides a sensitive measure of disease progression over time. Significance: There is currently a lack of objective biomarkers for the assessment of bulbar disease in ALS. Tensor EIM enhances the biomarker potential of EIM and can improve bulbar symptom monitoring in clinical trials.