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Abnormal microstate resting-state EEG characteristics in Amyotrophic lateral sclerosis

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***Abstract*—We studied the brain microstates as a well-established method for dynamic resting-state analysis of electroencephalogram (EEG), to assess the functional changes in the brain networks in Amyotrophic lateral sclerosis (ALS).**

***Clinical Relevance*— EEG microstates changes can reflect the disrupted functional balance between motor and cognitive networks in ALS and act as a potential neurophysiological marker of the disease subtypes and progression.**

I. INTRODUCTION

Resting-state electroencephalography (EEG) has been demonstrated to be a promising tool in pinpointing connectivity disruption in ALS [1]. A dynamic approach of brain networks could further improve the understanding and detection of networks with disrupted functional balance, as evidenced by findings in other neurodegenerative diseases [2]. Transient, quasi-stable and recurrent brain state episodes, also called microstates, are hypothesized to represent 'building blocks of spontaneous thinking' [3]. This study reports preliminary findings on abnormalities of EEG microstates in ALS patients, as potential prognosis biomarkers of cognitive and motor network function.

II. METHODS

High-density resting-state EEG recordings (3x2 min blocks) from 27 patients and 72 healthy controls (HC) were analysed. The spatial topographies of HC resting-state EEG (bandpassed between 1-30Hz) were obtained at randomly-selected peak times of the global mean field power (1000/subject) to derive four microstates classes (optimal number based on a cross-validation method). For both HC and patients, EEG full recordings were backfitted by associating each topography to their most resembling microstate class [4].

The coverages, durations, occurrences and global explained variances (GEV) of each state were then extracted and statistically compared (Mann-Whitney U test, FDR correction at 0.1) between both groups [2], [4]. For the patient group, the same characteristics were also correlated (Spearman, FDR correction at 0.05) with clinical scores (survival, revised ALS functional rating score, ALSFRS-R,).

III. RESULTS

The optimal number of clusters and the microstate prototypes obtained from the HC (Figure 1. were highly similar to the ones conventionally reported in the literature [5]. Higher occurrence ($p = 0.002$) and coverage ($p = 0.003$) were observed for microstate class B in ALS patients compared to HC. Significantly different durations were also observed for microstate classes A, B and C ($p = 0.009$, $p = 0.04$, $p = 0.09$). The GEV of microstate class B correlated strongly with ALSFRS-R sub-scores progressions, estimated by linear mixed model (upper limbs: $p= 0.002$, $\rho = -0.6$, $1-\beta =0.9$; lower limbs: $p = 0.004$, $\rho = -0.6$, $1-\beta =0.9$).

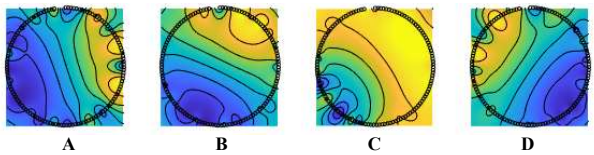

Figure 1. Spatial topographies of the four microstate classes labelled A-D. The polarity is not taken into account.

IV. DISCUSSION & CONCLUSION

The characteristics of resting-state EEG microstates are altered in ALS. Further work on brain sources generating the observed microstates topographies, would allow to further associate the findings with functional network changes in ALS.

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