**Introduction**

A growing body of evidence suggests that EEG analyses, including both resting state and event-related stimulation protocols, may be useful in early detection of neural signatures of dementia [1-6]. Moreover, EEG-based analysis shows potential for discriminating across dementia sub-types, including Alzheimer’s [AD], MCI (Mild Cognitive Impairment), Vascular Dementias, and the Lewy Body Dementias (LBD) — including Parkinson’s Disease with Dementia (PDD) [1-6]. Although these approaches have been largely confined to university research investigations, if proven accurate, reliable, and scalable, the widespread use of EEG as a neuroimaging modality could provide an inexpensive, easy to implement alternative for early diagnosis and treatment outcome studies of the dementias.

Promising EEG biomarkers include: 1) increased power in the low frequency bands (i.e., theta, delta) with reductions in higher frequency bands (i.e., beta, gamma) [7, 8]; 2) changes in the amplitude and latency of evoked potentials for both cognitive (i.e., attention, memory, learning) and sensory stimuli [i.e., visual, auditory, somatosensory] [9-13]; 3) reduction in the complexity of the EEG dynamics assessed with non-linear analyses (e.g., entropy, Granger causality) [14], and 4) abnormal functional connectivity as assessed by coherence, phase, and source localization (e.g., LORITA analyses). In addition to the potential for developing a sensitive, quantitative early diagnostic index, a variety of EEG-based metrics of variability have been successfully applied to characterize the Cognitive Fluctuations and discriminate across sub-types of dementia associated with LBD and PDD but not present in AD [2, 15-17].

In an analysis of resting state EEG data acquired by Orius Medical (Minneapolis, MN) from a cohort of 31 subjects previously diagnosed with AD and 44 healthy controls, statistically significant differences were seen between groups in frequency bandwidths, frequencies, ratios, and wavelets. The patterns observed support the utility of EEG-based biomarkers of AD.

**Methods**

The dataset analyzed herein was obtained from a study conducted by Orius Medical at Alexian Brothers Neurosciences Institute (Elk Grove Village, IL), entitled “Improved Diagnosis of Alzheimer’s Disease using Magnetoencephalography (MEG) and the Synchronous Neural Algorithms” [15]. The study involved acquisition of MEG and 64-channel resting state EEG data from a total of 75 subjects, 31 documented as having a previous diagnosis of AD and 44 healthy controls, with criteria for inclusion in the healthy cohort indicated by Orius Medical as a mini-mental state examination (MMS) score of ≥ 26. The demographic information is summarized in Table 1, with average values and SEMs. In addition to the MMS, the AD patients were also administered the Alzheimer’s Disease Assessment Scale-cognitive subscale (ADAS-cog), and the Clinical Dementia Rating (CDR).

**Results**

**Frequency Bandwidths**

To highlight the increase in slow wave and the decrease in fast wave activity seen in the AD cohort, the following bandwidth power ratios were computed: delta/beta, theta/beta, and theta/gamma. For each bandwidth ratio, the value was compared against the corresponding average ratio of the healthy controls. Significant regions (by one-way ANOVA) are indicated in Figure 4. The ratios for the majority of AD patients were more than 1 SD above healthy controls over these regions: right parietal, left temporal, posterior temporal, and anterior temporal (Figure 3). This aligns with prior work suggesting excessive slowing occurs primarily in parietal and temporal regions in AD [7, 8].

**Frequency Bandwidth Ratio Analysis**

The preliminary findings summarized herein show great potential for the role of EEG in detecting neural signatures of dementia. ABB plans to build upon this initial work with more advanced feature detection, and by developing classification models using methods such as: linear and quadratic discriminant function analyses, logistic regression, support vector machines, and/or markov models. We also plan to conduct subject-wide LORITA to analyze EEG amplitude asymmetry, coherence, and phase. Additionally, we will be expanding the analysis to include data from an ongoing study of neuroimaging modalities as early biomarkers for AD.

**Conclusion**

EEG-based biomarkers show promise for utility in early detection of Alzheimer’s Disease, notably:

- **Frequency Bandwidths** — significant decreases in parietal/temporal alpha, and global sigma, beta
- **Frequency Bandwidth Ratios** — excessive slowing in parietal and temporal regions
- **Wavelet Analysis** — significant increases in slow wave activity over the sensorimotor region

These findings support potential for EEG as an inexpensive, easily-implementable biomarker for AD.

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