Contrasting Non-Linear Dynamic Analyses of EEG in Alert and Sedated States

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Title

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Background

Complex systems, such as the brain, involve non-linear neuronal interactions. These in turn translate into self-organization and emergence of distinct patterns of activity. And although a loss of integrated neuronal activity or increased entropy during anesthesia has been described in the literature, it has not yet been well characterized. These in turn could serve as the basis to better understand pathophysiological states like depression.

Methods

Task free resting 64 channel EEG recording (Neuroscan, Compumedics) was collected before and during anesthesia with Etomidate (0.2 mg/kg) or Propofol (2 mg/kg) from patients scheduled to undergo Electro-Convulsive Therapy (ECT). An 81 second window was chosen for each of the awake and anesthesia states. The Symmetric Sensor Difference Series (SSDS) was generated by subtracting sensor pair outputs (e.g. the left frontal F3 sensor from the right frontal F4 sensor) thus resulting in a difference wave from frontal, central, parietal and temporal leads. The following parameters were extracted: power spectral scaling indices (alpha); topological, metric, and fuzzy entropies and Lyapunov exponents.

Results

To date, we acquired 38 recordings from 19 patients with major depressive disorder (9 females, age 1/4 47 ± 9 years). Frontal power spectral scaling index (alpha) showed significant differences awake and under anesthesia state (1.79 ± 0.7, 1.97 ± 0.9, p<0.001). Frontal Entropy measures and Lyapunov exponent were also significantly different (0.38 ± 0.07, 0.34 ± 0.04 and 0.43 ± 0.1, 0.22 ± 0.1 respectively; p<0.001). These differences were also present at the central, temporal and parietal leads.

Conclusion

Neuronal activities exhibit a decreased in complexity after onset of anesthesia in depressed individuals. The changes in non-linear dynamics appear spatially consistent. Ongoing studies are investigating the potential for complex emergence between depressed and healthy individuals. These could serve as future biomarkers for treatment response.

Keywords

EEG, non-linear, emergence, anesthesia, depression.

Disclosures

Nothing to disclose.