

Case Report

Decreased electroencephalogram alpha band [8-13 Hz] power in amyotrophic lateral sclerosis patients: A study of alpha activity in an awake relaxed state

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An attempt was made to quantitatively analyze the alpha activity in the awake relaxed state of Amyotrophic Lateral Sclerosis (ALS) patients and was compared with normals. ALS patients showed significantly low amplitude with a corresponding alpha band (8-13 Hz) power reduction, in both hemispheres though the change was more prominent in the left hemisphere. A review of the literature revealed no studies done on alpha oscillations in ALS patients; hence the results may have important implications for the interpretation of resting state brain activities.

Key Words: Amyotrophic Lateral Sclerosis (ALS), alpha rhythm amplitude, non-stimulus conditions, intra-cortical processes

Introduction

Various studies on Amyotrophic lateral sclerosis (ALS) patients using neuropathology,^[1] neuropsychology^[2] and neurophysiology^[3-5] have revealed that there is cortical dysfunction beyond the motor cortex. These studies were based on auditory selective attention, verbal fluency, word generation and/or planning ability. No studies on alpha oscillations, which is reported to be a reflector of thalamic activity,^[6] have been performed. Hence in the present study, the alpha rhythms under non-stimulus condition, with eyes closed was studied and compared with controls.

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Twelve ALS patients (9 males, 3 females with mean age 46.75 years ($SD = 14.429$), mean disease duration - 14.33 months ($SD = 11.523$)) diagnosed by a neurologist at a tertiary care center, and their age-matched controls (9 males, 3 females with mean age 47.17

years ($SD = 15.320$)) were investigated, from March 2003 to March 2004. All patients with secondary cause were excluded and it was also made sure that no patient was on medication relevant to the central nervous system functions and none had dementia as per history. Ethical clearance was taken and all subjects gave their written consent to the experiment.

In the experimental paradigm designed for the study, the subject was asked to lie down comfortably in a relaxed position with eyes closed, and a total of 30-minute data was recorded from eight electrodes (C3, C4, P3, P4, F3, F4 and T3, T4). The recorded data from each subject was then divided into 5-second epochs, each extracting two from the start, two from the middle and two towards the end of the entire recording, for the purpose of analysis. Recording was done using Medelec Profile VEEG Machine (Oxford Instruments Medical Ltd.) as per the following settings: High Frequency filter 50 Hz, Low Frequency filter 1.6 Hz, Notch filter 50 Hz, Sensitivity 7 micro Volt/mm and Sampling rate of 256 Hz. From each of the 5-second epochs, for every one-second data, the FFT spectrum of the 8-13 Hz alpha band was extracted for further analyses. All evaluations were done using MATLAB R13 v 6.5 signal processing toolbox and one way within subjects ANOVA (repeated measures) were done for statistical analyses using the Analyse-It software version 1.71.

Discussion

Total band power values obtained for each unipolar electrode pair for central, frontal, temporal and parietal between ALS patients and their age-matched controls are shown in Figure 1 and 2 and Table 1.

Figures show that the maximum and minimum band power values for ALS patients lie between 190 - 7400 μV^2 , whereas the same for Controls are between 280 - 23000 μV^2 . From Table 1, the total alpha band power in the left hemisphere appeared to be about 60% - 70% lower in ALS as compared to that in age-matched controls. The *P-values* show that EEG alpha band power reduction was more significant in the left

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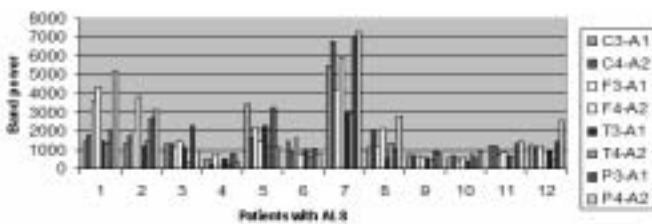


Figure 1: Total alpha band power values in microvolt² from each electrode pair in 12 ALS patients calculated from a one-second EEG data

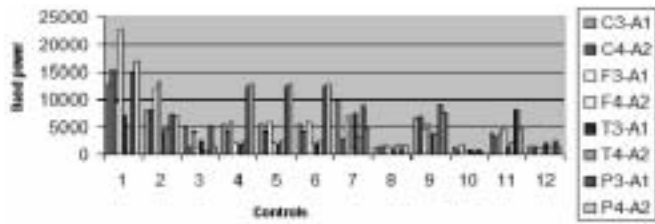


Figure 2: Total alpha band power values in microvolt² from each electrode pair in 12 age-matched controls calculated from a one-second EEG data

Table 1: Alpha band power values

Electrode Site	ALS Patients	Controls	DF	P-values	95% CI of Mean	
	Mean (S.D.)	Mean (S.D.)			ALS	Controls
C3-A1	1660.83 (1406.98)	5540.50 (3531.94)	1	0.0015	766.88-2554.79	3296.41-7784.59
F3-A1	1652.75 (1204.09)	5272.08 (3233.09)	1	<0.001	887.70-2417.80	3217.88-7326.29
T3-A1	1160.33 (772.64)	2978.17 (2296.54)	1	0.0067	669.42-1651.25	1519.02-4437.32
P3-A1	2050.33 (1740.93)	7853.92 (4728.62)	1	0.0013	944.20-3156.47	4849.50-10858.34
C4-A2	1685.58 (1693.91)	4513.08 (4088.24)	1	0.0509	609.32-2761.85	1915.54-7110.62
F4-A2	1936.50 (1796.92)	4836.59 (6627.17)	1	0.1208	794.79-3078.21	625.88-9047.29
T4-A2	1009.67 (773.56)	2518.917 (1482.29)	1	0.0030	518.17-1501.17	1577.11-3460.72
P4-A2	2285.50 (2101.14)	7047.00 (5544.67)	1	0.0171	950.50-3620.50	3524.09-10569.91

Comparison of total alpha band power values in μV^2 from each electrode pair calculated cumulatively for 12 ALS and their age-matched controls, from a one-second recorded data per individual; *CI – Confidence Interval, † DF- Degrees of Freedom

hemisphere (*P* values ranged from 0.0007 - 0.067), compared with the right hemisphere (*P* values ranged from 0.0030 - 0.1208), though the changes appeared bilateral. It was also observed that the total alpha band power, compared between the left and right hemisphere within ALS patients, showed no significant changes.

Numerous studies have stated that the alpha activity is an indicator of memory and cognition,^[7,8] with thalamo-cortical and cortico-cortical networks playing an important role in the generation of alpha rhythmicity. It was reported that there are important cortical mechanisms responsible for spreading alpha activity over the cortex.^[6] Experiments done in patients with Alzheimer's, Dementia, and Aging^[9-11] had already reported significantly lower alpha power in resting EEG and observed alpha band abnormality in non-stimulus conditions. Since a review of the literature showed no such attempts made in ALS patients, the present experiment is a first step towards finding the alpha rhythm variations in resting conditions in ALS patients. The authors would like to mention that no occipital electrodes were used to quantify the occipital alpha rhythm, which is a limitation of the present study. The power reduction of alpha activity extracted from the central, frontal, parietal and temporal electrodes during non-stimulus conditions, when the subject is awake with eyes closed could be used as a marker for cortical involvement in extra motor manifestations of ALS patients. The findings in general agree with the earlier reported studies of reduction in alpha activity at rest in other neurological disorders, hence may have important implications for the interpretation of resting state cortical activity in ALS patients. The preliminary results show a possible disruption of intrinsic cortical neural connections in

ALS patients, and further studies are recommended in a much larger sample.

The authors would like to extend their approach to study the change or shift in total power in different spectral frequencies and to have more observations towards overall organization/disorganization or any loss of cortical rhythms in ALS patients.

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