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A STUDY OF FREQUENCY ANALYSIS OF ELECTROENCEPHALOGRAPHY IN PATIENTS WITH DEMENTIA

Physiology

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ABSTRACT

Background & Objectives- Dementia is one of the most common disorders among the elderly. Despite significant disability, early recognition is not easy. we conducted this study with objective of describing EEG changes associated with Dementia particularly in terms of Frequency analysis.
Methods - 50 patients with Dementia were assessed & rated with "Dementia Severity Rating Scale" (DSRS). 16 channel continuous EEG recording for 30 minutes' duration were performed. Offline frequency analysis was performed using EEG Lab.
Results - Theta Band had highest proportion of relative power (52.5%), followed by Delta (28.94%). correlation between DSRS & Relative Theta power showed a significant positive correlation (P 0.02). Co-Relation between DSRS and Relative Beta Power showed significant negative co relation (P 0.02).
Conclusion - EEG showed a characteristic slowing – prominence of relative theta and delta power. The relative theta and beta band powers also had a significant correlation with dementia severity. Thus this study supports the notion that EEG can serve as an add on diagnostic tool for diagnosis of dementia and also for monitoring disease progression

KEYWORDS

Dementia, Electroencephalography, Frequency Analysis

INTRODUCTION

The electroencephalogram (EEG) is a unique and valuable measure of the brain's electrical function. It is a display in graphical form of the voltage difference from two sites of brain's function recorded over a time period. [1]

Dementia is a syndrome characterised by progressive cognitive impairment (memory loss, language difficulties) and is associated with impairment in functional abilities. Dementia is one of the most common disorders among the elderly population. The prevalence rate of dementia in persons aged 65 years or over has been reported to be about 1.8–10.8% in Asian countries. [2]

Despite significant disability associated with this condition, early recognition is not easy because of the insidious and variable onset of symptoms. The EEG seems an attractive non – invasive modality for diagnosing dementia, shown to be having reasonable diagnostic accuracy in some earlier studies. The EEG abnormalities in AD directly reflect anatomical and functional deficits of the cerebral cortex as part of the disease process. EEG has high temporal resolution, and may therefore contain crucial information about abnormal brain dynamics in Dementia patients. [3]

Still in comparison to western scientific literature there is dearth of studies of EEG changes in Dementia from Indian subcontinent. Thus we conducted this study with objective of describing EEG changes associated with Dementia particularly in terms of Frequency analysis.

MATERIALS & METHODS

It was a prospective observational study. The duration of study was 1 year after ethical clearance from the institutional ethics committee. The study was carried out on a group of 50 patients with Dementia.

The diagnosis of Dementia was established by Consultant Psychiatrist as per the "Diagnostic and Statistical Manual of Mental Disorders (DSM IV-TR)" criteria in Psychiatry OPD and then referred to NSCB department of Physiology. Patients with drug dependence, mental retardation or any other psychiatric comorbidity were excluded. Each subject was then interviewed with help of a semi structured Performa including patient identification data and Socio demographic variables with Clinical details like age of onset, duration of illness, past history etc. Subjects were then rated upon with the "Dementia Severity Rating Scale" (DSRS) is an informant-based, multiple-choice questionnaire that assesses severity from the mildest to the most severe stages in the major functional and cognitive domains. [4,5]

The procedure for a subject included continuous EEG recording for 30 mins duration. The subjects lay in relaxed position with closed eyes during the recording. Electrodes were placed according to the International "10-20" system using linked-ears as a reference. EEG recordings were performed with 16 channel Neurograph machine. The sampling rate was 256 Hz, the amplitude bandwidth between 0.3 and 70 Hz, and impedance levels were ≤5 kΩ. Epochs contaminated by blinks, eye movements, and movement-related artefacts were excluded from analyses by direct visual inspection.

EEG analysis was performed using EEG Lab toolbox software Matlab Inc. With help of "Fast Fourier Transform (FFT)" – EEG Frequency analysis was performed and relative powers were obtained for each frequency band for each electrode site. Combined Relative Power Values for each Frequency Band obtained by summating relative power values at individual electrodes. The statistics were computed using software IBM SPSS Statistics version 23.0. For all the statistical tests level of significance was taken as $p < 0.05$.

RESULTS

The Mean age of the sample was 65.5 (SD 7.7) years with a range of 50 to 81 years. There were 70 % Males and 30 % Females in the sample. Majority 66 % of the sample belonged to Urban background & 34 % belonged to Rural background. All 50 subjects were married ever in their lifetime. Majority were Illiterate (44%), followed by Primary level education (32%), High school (10%) and 4 % were graduates.

The Mean DSRS score was 29.6, SD 7.3 with a range of 16 to 48. Severity wise- majority 76 % were in Moderate category, 18 % in Severe category and 6 % were in Mild category. Association between Gender & DSRS Category was tested by Fisher's Exact Test & P value was 0.07 which was Non-significant. Association between Education & DSRS Category was tested by Fisher's Exact Test, P value was 0.15 which was Non-significant.

Table 1- shows Co-relation between DSRS Score & Age – tested statistically with Pearson co-relation coefficient – It came out to be statistically significant for a Positive Co-relation with a P value of < 0.05.

Table 2 – shows Combined Relative Power Values for each frequency band. Theta Band had highest proportion of relative power (52.5%),

followed by Delta (28.94%), Alpha (11.89%) and Beta (6.15%).

Table 3 -Shows The Values of Relative Power in Each Frequency Band and Their Comparison Between Right and Left Side. Theta Band had the highest Relative power bilaterally, followed by Delta Band. None of the frequency bands power values differed in statistically significant manner between right and left side.

Table 4 shows Co-Relation Between Severity of Dementia (DSRS scores) & Relative Power Values in different Frequency Bands tested statistically through Pearson Co relation test. correlation between DSRS & Relative Theta power showed a Positive Correlation with a significant P value of 0.02. Co-Relation between DSRS and Relative Delta power showed a Positive Correlation however, was not statistically significant. Correlation between DSRS and Relative Alpha Power showed a Negative Correlation however, was not statistically significant. Co-Relation between DSRS and Relative Beta Power showed Negative co relation with a significant P value of 0.02

Table 1 – DSRS Score – Age correlation

Correlations		DSRS SCORE	AGE (YRS)
DSRS SCORE	Pearson Correlation	1	.404**
	Sig. (2-tailed)		.004 (P)
	N	50	50
AGE (YRS)	Pearson Correlation	.404**	1
	Sig. (2-tailed)	.004 (P)	
	N	50	50

Table 2 – Combined Relative Power Values

Combined Relative Power	N	Min.	Max.	Mean	SD
DELTA	50	1.66	82.00	28.94	23.15
THETA	50	11.03	97.82	52.50	31.44
ALPHA	50	.19	36.52	11.89	9.62
BETA	50	.28	23.94	6.15	5.64

Table 3 – Comparison Between Right & Left Relative Power

Relative Power	Mean	N	Std. Deviation	Std. Error Mean	Sig.
RIGHT-DELTA	28.45	50	23.02	3.25	0.475
LEFT -DELTA	29.44	50	24.29	3.43	
RIGHT-THETA	52.47	50	31.63	4.47	0.934
LEFT-THETA	52.53	50	31.46	4.44	
RIGHT-ALPHA	11.91	50	9.89	1.39	
LEFT-ALPHA	11.89	50	9.80	1.38	0.980
RIGHT-BETA	6.10	50	5.63	.79	
LEFT-BETA	6.26	50	5.79	.81	0.576

Table 4 – Correlation Between Dsrs Score & Relative Power

Correlation Variables	Pearson correlation	Significance
DSRS & Relative Theta Power	0.31	0.02
DSRS & Relative Delta Power	0.25	0.07
DSRS & Relative Alpha Power	-1.51	0.29
DSRS & Relative Beta Power	- 0.31	0.02

DISCUSSION

Socio-demographic variables in index study were found to be in accordance with census data on elderly in India. [6,7] Distribution of DSRS category and its associations were found to be similar to studies of Paliwal et al & Royall et al. [8,9]

In the index study Relative Power of each frequency wave were calculated and also compared between Left and Right hemispheres. Theta band had highest mean relative power (52.5) followed by Delta band (28.9), Alpha band (11.8) and Beta band (6.1). None of the frequency bands relative power values differed in statistically significant manner between right and left side.

As per previous literature the earliest EEG changes in dementia are an increase in theta activity and a decrease in beta activity, which are followed by a decrease in alpha activity and Delta activity increases later during the course of the disease. [10].

The statistical co-relation between Dementia Severity Rating Scale Scores (DSRS) and Relative Theta Band Power showed a Positive Correlation with a significant P value of 0.02 i.e. Theta Power Increased with increased Severity of Dementia.

The co-relation between Dementia Severity Rating Scale Scores (DSRS) and Relative Beta Band Power. Statistically it showed Negative co relation with a significant P value of 0.02 i.e. Beta Power decreased with increased Severity of Dementia. Our findings are in agreement with the previous research in terms of relative power and its correlation with severity of dementia. [11,12,13]

However, our study has certain limitations like smaller sample size, lack of control group and an institution base study. Thus the results cannot be generalised.

CONCLUSION

In index study, EEG in patients with dementia showed a characteristic pattern of slowing – as demonstrated by prominence of relative theta and delta power while reduced alpha and beta band power. The relative theta and beta band powers also had a significant positive and negative correlation respectively with dementia severity score. Thus this study supports the notion that EEG can serve as an add on diagnostic tool for diagnosis of dementia and also for monitoring disease progression. However, further research particularly longitudinal studies with larger sample size and normative control groups are warranted.

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