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EEG ALPHA PEAK FREQUENCY ANALYSIS DURING MEMORIZING OF FIGURES IN PATIENTS WITH MILD COGNITIVE IMPAIRMENT

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Abstract – **Objective:** To investigate spectral analysis of electroencephalograms (EEG) for the alpha frequency band during rest and cognitive stimulation in healthy adults and individuals with mild cognitive impairment. **Method:** We analyzed 56 EEGs from 28 patients, 7 men and 21 women, 12 of whom (40%) were controls, 16 patients with mild cognitive impairment (60%). Ages ranged from 61 to 83 years. All individuals were patients in the Psycho-geriatric Out-patients Clinic of LIM-27, of the Psychiatric Institute of the Clinicas Hospital of the Faculty of Medicine of the University of São Paulo, IPq-HCFMUSP, between 2004 and 2007. Each patient underwent two exams with an interval of at least six months between them. During the exam, performed after a period of wakefulness and rest, the patients memorized series of pictures. **Results:** Analysis of spectral potential both at rest and during the memorizing task showed no statistical differences between baseline and final recordings. **Conclusion:** Spectral analysis of EEGs showed coherent results with the clinical stability of the patients evaluated but was unable to distinguish between the control group and patients with MCI. Future studies should include a larger sample and a longer follow up.

KEY WORDS: EEG, qEEG, memorization, mild cognitive impairment.

Análise do pico de frequência alfa do EEG durante a memorização de figuras em pacientes com comprometimento cognitivo leve

Resumo – **Objetivo:** Realizar a análise espectral da banda de frequência alfa do EEG em adultos saudáveis, com comprometimento cognitivo leve (CCL), durante o repouso e a estimulação cognitiva. **Método:** Analisamos 56 EEGs de 28 pacientes, 7 homens e 21 mulheres, 12 dos quais (40%) controles, 16 pacientes com CCL (60%), com idades entre 61 a 83 anos.Todos os pacientes foram atendidos no serviço de psicogeriatria do LIM 27, do Instituto de Psiquiatria da Faculdade de Medicina da USP,entre os anos de 2004 a 2007, sendo que cada paciente realizou 2 exames com intervalo de 6 meses entre eles. Os registros dos EEGs foram realizados em repouso e durante a realização de atividade de memorização de figuras. **Resultados:** A analise espectral durante o repouso e a tarefa de memorização não mostraram diferenças estatísticas entre os EEGs iniciais e finais. **Conclusão:** A análise espectral dos EEGs mostrou-se coerente com a estabilidade clínica dos dois grupos, no entanto não foi capaz de distinguir o grupo controle do grupo CCL. Estudos futuros deverão incluir um maior número de indivíduos por um tempo maior de seguimento.

PALAVRAS-CHAVE: EEG, EEG quantitativo, memorização, comprometimento cognitivo leve.

Over the last few years, different quantification techniques using the EEG have proven useful in the study of cognitive processes[1]. According to the "Recommendations for the recording/interpretation of topographical mapping of the EEG" by the Brazilian Society of Clinical Neurophysiology the EEG has, by and large, long been in routine use and is well established as an aid in the evaluation of dementias and encephalopathies, especially when

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the diagnosis remains unclear after initial clinical evaluation[2]. Corroborating these recommendations, the American Academy of Neurology and the American Society of Clinical Neurophysiology advise the use of a quantitative method in clinical states of dementia in their guidelines for the application of the EEGq. These directives are based on evidence derived from one or more well designed clinical studies with control groups, cohort studies, expert opinions of specialists in the field, and /or case reports[3].

The most common findings are a slowing of baseline cerebral electrical activity, with predominance of delta and theta rhythms and a diminution or absence of the alpha rhythm. Nevertheless, these findings are more common in patients at moderate or advanced stages of the disease[4-6].

Studies have shown that spectral analysis is a very sensitive method for detecting alterations in basal cerebral electrical activity, being particularly sensitive in cases with clinically suspected Alzheimer's disease (AD)[7,8]. Among studies that have used this technique/ type of analysis, sensitivity ranges between 71 and 81%. When results of spectral analysis are compared with neuropsychological tests; there is a strong correlation between the two[9,10].

The objective of this study was to analyze alpha frequency band spectral peak during memorization tasks, and to verify if there were differences between healthy controls and individuals with mild cognitive impairment (MCI).

METHOD

This study was conducted within the High Resolution EEG Sector of the Neurosciences Laboratory, LIM-27, of the Psychiatry Department of the Faculty of Medicine of the University of São Paulo.

A total of 30 individuals took part in the study, 7 of whom were men and 21 women: 12 controls (40%) and 16 patients with mild cognitive impairment (60%). Ages ranged from 61 to 83 years. All subjects underwent two recordings.

Patients or their legal representatives signed the terms of consent.

This study was approved by the Ethics Committee of the Clinicas Hospital of the University of São Paulo.

Quantitative recordings were performed with digital equipment) (32 channels, a 12 bit processor and a sampling frequency of 200 points per second), capable of performing quantitative recordings using Fast Fourier Transformation (FFT).

The placement of the scalp electrodes followed the statements of the Brazilian Clinical Neurophysiologic Society (system 10–20 with an ear reference for EEG recordings)[11].

The electrical impedance of the electrodes was kept below 3 kOhms.

Stimuli and tasks

Both groups, after a 15-minute recording of the EEG in resting state, the individual was asked to open their eyes and to pay attention to 10 figures which were presented on a computer screen for 30 seconds. Following this, the individual was asked to close their eyes, and for the next 30 seconds, mentally review the figures which had just been displayed. (These periods of memorization were later analyzed). At the end of the 30 seconds we asked the person to state the figures they were able to recall. This task was repeated three consecutive times to serve as a learning period on the part of the individual tested. At the end of this first task, another 10 minutes of recording under conditions of rest was carried out and then the second task given[12]. This consisted of presentation of 15 figures from the CERAD[11], one by one with an exposure time of 5 seconds per figure. Akin to the first test, after display of the 15 figures, a brief period of 30 seconds was allowed to memorize at rest before tallying the figures recalled. This part of the task was repeated 3 times.

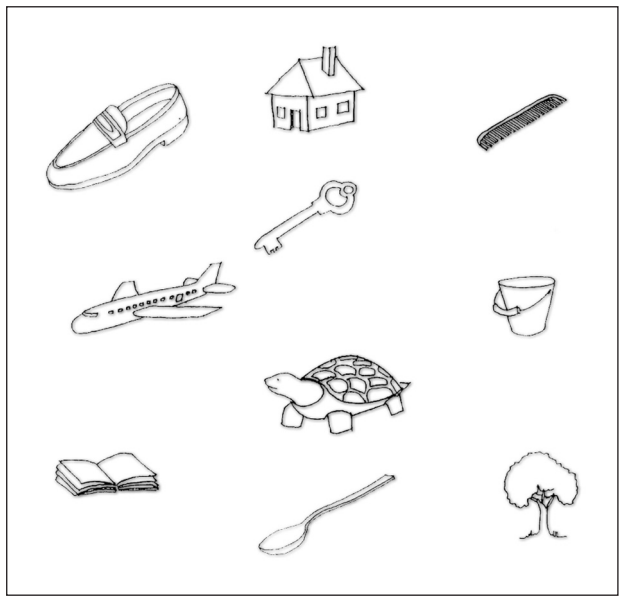

Fig. 1. Table containing 10 figures.

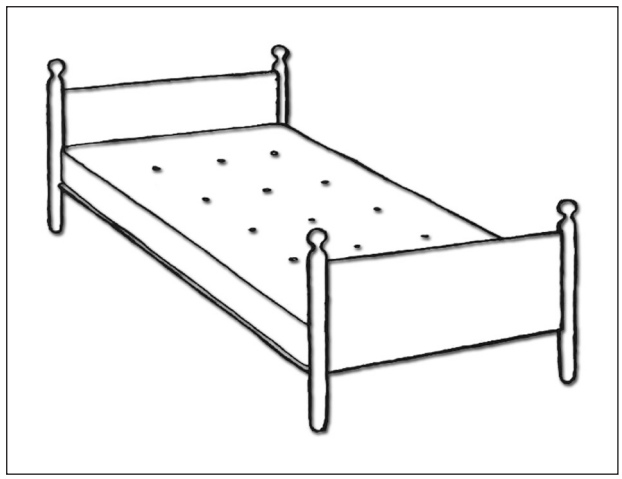

Fig 2. Example of one of the 15 CERAD figures presented individually.

Statistical analysis

The t test was performed to test the equality of the medians of the two groups of numbers (initial and final clinical evaluation)

The higher the value of "t" above zero, the greater the difference between the groups, whereas the lower the "p" value, the greater its significance.

We used a confidence interval of 95%. Across all analyses, the values of the differences between the medians was very close to 0, indicating that there was little or no difference between the groups. We used software EMSA XP Version 2.5.1 to run the t test.

RESULTS

During the study period, the diagnoses of 3 women changed from being control to MCI.

Distribution of the study group at primary diagnosis are showed in Table 1.

Distribution of the study group after the second diagnosis are showed in Table 2.

Differences between two recordings peak of spectral analysis.

First recording: peak of spectral frequency (in Hz) at rest we can see in Table 3.

Final recordings: frequency peaks of the spectra at rest we can see in Table 4.

The t test showed: t=0.0416, df 3.999, p value 0.9688 (not significant), confidence interval of 95% (from −2.538643 to −2.615864).

The analysis of the peak spectra potential showed no differences between controls and patients with MCI, at either the first or final recording during memorizing of the figures.

Initial recordings: frequency peaks of the spectra during memorization task are showed in Table 5.

Second recordings: frequency spectral peaks during memorization task are showed in Table 6.

The t test showed: t=0.0416, df=3.999, p value=0.9688 (not significant), confidence interval of 95% (from −2.538643 to −2.615864).

DISCUSSION

The results obtained on the spectral potential, at rest and during memory task showed no statistical difference between the control group and those with MCI. Similarly, no differences were found between EEG initial and final recordings.

No statistical differences were observed between the EEG initial and final recordings in the two groups analyzed, as the subjects in the study were clinically stable. Three women were exceptions as they were classified as controls at initial diagnosis and then as having MCI at the final evaluation, were excluded at data analysis.

However, as the method used to analyze the quantifi-

Table 1. Distribution of the study group at primary diagnosis.

	Men	Women	Total
Controls	2	10	12
MCI	4	12	16
Dementia	1	1	2
	7	23	30

Table 2. Distribution of the study group after the second diagnosis.

	Men	Women	Total
Controls	2	7	9
MCI	4	15	19
Dementia	1	1	2
	7	23	30

Table 3. First recording: peak of spectral frequency (in Hz) at rest.

Peak	Control	MCI	Total
8.2	9	9	18
9.7	1	3	4
10.2	1	4	5
10.7	1	0	1
11.2	0	0	0
Total	12	16	28

MCI: mild cognitive impairment.

Table 4. Final recordings: frequency peaks of the spectra at rest.

Peak	Control	MCI	Total
8.2	7	10	17
9.2	0	2	2
9.7	1	3	4
10.2	1	3	4
10.7	0	1	1
11.2	0	0	0
	9	19	28

MCI: mild cognitive impairment.

Table 5. Initial recordings: frequency peaks (in Hz) of the spectra during memorization task.

Peak	Control	MCI	Total
8.2	6	8	14
9.7	2	0	2
10.2	1	7	8
10.7	1	0	1
11.2	0	1	1
11.7	2	0	2
	12	16	28

Table 6. Second recordings: frequency spectral peaks (in Hz) during memorization task.

Peak	Control	MCI	Total
8.2	8	11	19
9.7	0	1	1
10.2	0	5	5
10.7	1	2	3
	9	19	28

cation in this study was unable to differentiate between the control groups and the group with MCI, the diagnostic change in these three patients had no impact on the results obtained.

The conclusion of this study was that, for the sample group analyzed, the method of spectral analysis of EEGs showed results consistent with the clinical stability of the group evaluated, but was unable to differentiate the control group from the MCI group.

Future studies should include a larger sample group and a longer follow up time.

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