Using Brain Mapping in Comparative Study between Demented Patients, Normal Elderly Subjects and Normal Young Subjects

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The main aim of the this study is to evaluate the effect of normal aging process in brain mapping as well as brain mapping changes in demented patients. This study was conducted on three groups; Group I comprised 10 demented patients aged above 65 years. Group II comprised 10 normal elderly subjects aged above 60 years and Group III comprised of 10 young normal subjects aged between 25-30 years. patient and control groups were subjected to: 1- Full psychiatric history taking including DSM-IV-criteria for diagnosis of dementia and mental state examination. 2- Full medical and neurological examination. 3- Minimental state examination (MMSE). 4- Brain electrical activity mapping. The research revealed the following results; A- Normal elderly subjects versus young normal subjects: - According to absolute power; there is significant diffuse decrease in delta and theta bands, increase in alpha band in frontal, central and temporal regions and a decrease in alpha band in parietal and occipital regions and diffuse increase in Beta band among normal elderly subjects. According to interhemispheric coherence; there is a significant decrease in all activities in all regions among normal elderly subjects. B- Demented patients versus normal elderly subjects: - According to absolute power; there is significant diffuse increase in both delta and theta bands and diffuse decrease in both alpha and beta activities among demented patients. - According to interhemispheric; there is significant hypocoherence in delta in all regions, in theta region in frontal central and temporal regions, and in alpha and beta coherence in frontal and central regions.

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Introduction

Interest has developed in computerized frequency analysis of EEG (Benner et al., 1986). Computerized analysis provides quantitative data and has been utilized in the evaluation of normal aging (Dustman et al., 1985) and dementia (Coben et al., 1985). Quantitative electroencephalogram (EEG) studies of normal aging have produced contradictory results (Williamson et al., 1990). Some studies suggest that normal aging is accompanied by the gradual development of slow activity in the theta band and a decrease in the frequency and amount of alpha activity (Busse, 1983).

Breslan et al. (1989) found different cortical areas showing different changes. Occipital area showing the greatest microvolt decrease with aging and temporal the least. On normalized maps, older subjects had relatively more parietal and temporal delta.

Other investigator report that EEG in normal elderly subjects differs a little from that of normal younger subjects (Gueguen et al., 1989).

Duffy et al., (1984) have even found that normal aging may be associated

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with desynchronisation, with a decrease in slow activity and an increase in Beta activity.

Williamson et al., (1990) study suggests a decrease in delta coherence in subjects showing cognitive decline.

Computerized analysis provides quantitative data and has been utilized in the evaluation of dementia (Coben et al., 1985).

Several brain mapping studies demonstrated distinctly more delta and theta and less Alpha and Beta activity, as well as slowed centroid of the total frequency band in senile dementia of Alzheimer type (SDAT) and multiinfract dementia (MID) patients compared to normally aged controls (Saletue et al., 1991 & 1992).

As regard EEG coherence in demented patients, Prichep et al., 1983 found a general decrease in interhemispheric coherence in patients with dementia compared with normal subjects. The decrease of coherence may be interpreted in terms of Alzheimer disease generating diffuse and wide spread cerebral degenerations, which results in fewer neuronal connections (Forstle et al., 1992).

Aim of the Work

1- To study the effect of normal aging in Brain mapping (BEAM) by doing a comparative study between a group of normal elderly subjects and young normal subjects.

2- To study brain mapping changes in determined patients by doing a comparative study between demented patients and normal elderly subjects.

Subjects and Methods

In this study, our subjects consisted of there groups:

Group I: Consisted of 10 demented patients aged above 65 years. They were selected from outpatient clinic and inpatient department of psychiatry, Zagazig University hospital.

Group II: Consisted of 10 old normal subjects aged above 60 years. They were selected from fathers of our colleagues. They were free of neurological or medical disease had no history of head injury or alcohol abuse, an had not taken any prescription medication (with the exception of antihypertensive) for at least 30 days prior to evaluation.

Group III: Consisted of 10 young normal subjects, their age range 25-30 years. They were selected from employers and workers at Zagazig University Hospital, with the same above criteria for normal subjects. It is a control group for normal elderly subjects.

Methods

Our patients and control groups were subjected to:

- Full psychiatric history taking (including DSM-IV diagnostic criteria for demented patients). (Diagnostic and statistical manual of mental disorders-4th ed. 1994), and mental state examination.

- Full medical and neurological examination.

- Mini mental state examination (MMSE).

- Quantitative EEG (Brain mapping):

The quantitative EEG was carried out using a cadewl 32-D/B system.

*Data analysis:

Neurometric EEG feature extraction method (Johanneson et al., 1987). One to two minutes of artifact free data were extracted from the EEG record for quantitative analysis, with the aid of a computerized artifact detection algorithm. All epochs selected for analysis were visually reviewed to exclude any artifacts which excluded this algorithm. The net result of BEAM data analysis for

each of the following frequency band (delta, theta, alpha, beta) was expressed as follows:

1- Digitally expressed as:

a- Absolute power (the electrical power under each electrode) of each of the Delta, Theta, Alpha, and Beta frequency band. All over scalp electrodes.

B- Interhemispheric coherence (means synchrony or coupling of two electrodes in a given frequency band) (Bullock and McClune, 1989).

Coherence has further been shown to depend on the physical distance between EEG electrodes (Glass et al.,1992) due to simultaneous activation of neuronal cell assemblies and current spread in cortical tissue.

In our study, we tried to cope with the over all immediately surrounding electrodes. So we took the mean frontal, mean central, mean parietal and mean occipital coherence in each frequency band in out comparison between old normal subjects and young normal subjects as well as between demented patients and normal elderly subjects.

2- Topographic expressed as:

Topographic mapping of the neurometrically analyzed EEG data.

Results:

1- Comparison between young normal subjects and normal elderly subjects.

a- According to absolute power (Table 1)

Table 1 shows that, there are significant decrease in Delta and Theta activities in all regions (frontal, central, temporal parietal and occipital). Alpha activity increase in frontal, central and temporal regions while in parietal and occipital regions alpha activity decrease with significant difference (a diffuse significant Beta excess) in all regions among normal elderly subjects.

b- According to interhemispheric coherence (Table 2)

There are significant diffuse decrease in interhemishpheric coherence of all activities (delta, theta, alpha and beta) in all regions in normal elderly subjects then young normal subjects.

2- In demented patients versus normal elderly subjects:

a- According to absolute power:

Demented patients showed significant increase in delta and theta activities in all regions and significant decrease in alpha and beta frequency bands in all regions than normal elderly subjects (Table 3).

b- Interhemispheric Coherence (Table 4):

Table 4 shows that there is significant decrease in interhemispheric coherence in delta activity in central region, theta activity in frontal, temporal and central regions and alpha, beta activities in frontal and central regions in demented patients compared with normal elderly subjects.

Discussion

Computerized analysis that provides quantitative data has been utilized in the evaluation of normal aging (Dustman et al., 1985) and dementia (Coben et al., 1985).

In this study we preferred the use of absolute power in each frequency band over the use of the relative power in the comparison of studied groups. As Coben et al., (1990) and Saletu et al., (1992) reported that absolute delta power discrimnated quite well (82%), relative delta power clasified nearly by chance (55%), therefore in studies using relative measures delta activity was not sensitive

while delta activity differed significantly between demented patients and normal subjects in studies using absolute measures.

Anderer et al., (1994) who used the topographic distributions of absolute delta and theta power to classify demented patients and normal subjects, found that absolute theta power showed highest classification accuracy (92%) than relative power variables.

1- Normal elderly subjects versus young normal subjects:

a- According to absolute power:

A significant decrease in both delta and theta activities in all regions among normal elderly subjects than young normal subjects, in agreement with this results (Williamson et al., 1990) who found a decline in delta and theta activities with age.

As a significant increase in alpha activity in frontal, central and temporal regions as well a decrease in alpha activity in parietal and oocipital regions in elderly normal subjects, this agree with Breslau et al., (1989) who found a loss of the typical alpha occipital maximum with age but had diffuse relative increase in alpha amplitude centrally and temporally. The amplitude progressed from oocipital to central location. Also Maurer and Dierks (1992) found with increasing age slightly less alpha activity with a slight anteriorization took place.

Eldery normal subjects recorded increase in beta activity in all regions than young normal subjects, the same result reported by Giaquinto et al., (1989), but Williamson et al., (1991) found beta activity to decrease with age which may be due to the older age of their subjects.

b- According to interhemispheric coherence:

Elderly normal subjects showed a significant hypocoherence in all bands (Delta, theta, alpha and beta) in all regions (frontal, central, temporal, parietal and occipital). Also Williamson et al. (1990) found hemispheric coherence to decrease in delta band in all regions compared with young normal subjects, this differ from our results that the hypocoherence in all bands, this difference in age between our subjects and their subjects or difference in technique.

2- Demented patients versus normal elderly subjects:

a- According to absolute power:

This study revealed that demented patients recorded a significant increase in both delta and theta bands in all regions, the same result reported by Sloan and Fenton (1993), and Signorino et al., (1995) who report that there is increase in theta and delta EEG powers in demented patients.

This result explained by Reikkinen et al., (1991) which have recently been related to a cholinergic deficit. It may be also attributed to episodes of reduced vigilance or drowsiness of ten occurring in these patients or drug related. Yet in our study the effect of drugs can be ruled out on account of the precautions taking during recording.

The finding of decrease alpha activity in all regions (frontal, central, parietal and occipital) in demented patients, similar to previous reports by Maurer and Dierks, (1992); Sloan and Fenton (1993); and Signorino et al., (1995); who found a significant difference in the frequency of the "Alpha type" activity which proves to be lower in demented patients than normal elderly subjects. Signorino et al., (1995) explained this result as this dominant activity probably expresses the fundamental mechanisms activity probably expresses the fundamental mechanisms of thalamocortical and intracortical oscillation on informa-

Table 1

Comparison of Absolute Power in Each Frequency Bands Among Elderly Subjects and Young Normal Subjects

Studies groups	Sites	Frontal				Central				Temporal				Parietal				Occipital			
		Δ	ø	œ	ß	Δ	ø	œ	ß	Δ	ø	œ	ß	Δ	ø	œ	ß	Δ	ø	œ	ß
Normal eldery	X	7.39	6.54	12.75	18.12	9.13+	8.67	18.48	11.82	4.27	4.29	13.17	7.60	8.55	8.17	24.19	12.97	6.29	6.85	25.34	10.03
Subjects	±S.D	±0.19	±0.17	±0.27	±0.44	0.31	±0.29	±0.19	±0.69	±0.14	±0.08	±0.12	±0.38	±0.33	±0.37	±0.39	±0.66	±0.30	±0.25	±0.97	±0.22
Young normal	X	9.3	8.33	10.56	5.06	12.39	11.88	16.93	7.02	5.82	5.09	12.49	4.92	12.26	10.85	28.13	8.31	9.63	8.26	35.83	8.33
Subjects	±S.D	±0.48	±0.44	±0.44	±0.56	±0.81	±0.81	±0.32	±0.87	±0.38	±0.18	±0.09	±0.49	±0.94	±0.64	±0.93	±0.86	±0.87	±0.35	±2.63	±0.35
	t/p	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

Table 2

Comparison of Absolute Power in Each Frequency Bands Among Normal Elderly Subjects and Young Normal Subjects

Studies groups	Sites	Frontal				Central				Temporal				Parietal				Occipital			
		Δ	ø	œ	ß	Δ	ø	œ	ß	Δ	ø	œ	ß	Δ	ø	œ	ß	Δ	ø	œ	ß
Normal eldery	X	24.75	75.50	46.12	28.85	81.41	75.51	67.93	50.87	58.22	32.34	29.54	17.31	85.59	78.25	70.27	59.92	86.65	81.07	77.60	32.59
Subjects	±S.D	±0.47	±0.16	±0.73	±0.81	±0.07	±0.18	±0.62	±0.40	±0.76	±1.91	±0.97	±0.94	0.03	+0.12	+0.57	+0.24	+0.39	+0.62	+0.40	+0.58
Young normal	X	29.12	78.83	52.79	32.59	82.20	76.55	70.71	54.59	59.64	42.15	34.10	21.98	85.72	79.51	72.81	61.47	88.39	83.74	79.42	33.91
Subjects	±S.D	±1.03	±0.42	±1.50	±0.45	±0.18	±0.28	±0.29	±0.83	±0.38	±1.18	±0.52	+0.58	+0.04	+0.12	+0.29	+0.33	+0.19	+0.28	+0.19	+0.41
	t/p	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

Table 3
Comparison of Absolute Power in Each Frequency Bands between Normal Elderly Subjects and Demented Patients

Studies groups	Sites	Frontal Δ	Frontal θ	Frontal α	Frontal β	Central Δ	Central θ	Central α	Central β	Temporal Δ	Temporal θ	Temporal α	Temporal β	Parietal Δ	Parietal θ	Parietal α	Parietal β	Occipital Δ	Occipital θ	Occipital α	Occipital β
Demented	X	13.19	19.61	9.79	7.85	11.09±	25.59	4.30	9.81	6.65	12.93	8.50	4.48	10.09	24.73	11.17	6.36	8.75	17.60	10.65	4.75
Patients	±S.D	±0.1	±8.56	±0.60	±8.92	0.67	±16.85	±0.13	±8.64	±2.94	±8.88	±0.29	±2.87	±0.21	±18.52	±0.12	±4.46	±3.63	±7.40	±0.42	±3.57
Normal eldery	X	7.39	6.54	12.75	8.12	9.13	8.67	18.48	11.82	4.27	4.29	13.17	7.60	8.55	8.17	24.19	12.97	6.29	6.85	25.34	10.03
Subjects	±S.D	±0.19	±0.17	±0.27	±0.44	±031	±0.29	±0.19	±0.69	±0.14	±0.08	±0.12	±0.38	±0.33	±0.37	±0.39	±0.66	±0.30	±0.25	±0.97	±0.22
t/p		S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

Table 4
Comparison between Normal Eldery Subjects and Demented Patients According to Interhemispheric Coherence in Each Frequency Band

Interhemispheric Coherance / Studies groups		Frontal Δ	Frontal θ	Frontal α	Frontal β	Central Δ	Central θ	Central α	Central β	Temporal Δ	Temporal θ	Temporal α	Temporal β	Parietal Δ	Parietal θ	Parietal α	Parietal β	Occipital Δ	Occipital θ	Occipital α	Occipital β
Demented	X	34.20	43.00	15.84	23.91	55.96	51.93	43.42	32.67	57.86	21.13	27.21	25.04	83.40	80.48	58.11	62.82	88.39	83.74	80.67	28.00
Patients	±S.D	±23.67	±21.10	±5.34	±0.41	±16.43	±16.17	±18.86	±17.02	±20.21	±15.1	±13.29	±15.12	±14.1	±19.42	±25.05	±12.35	±12.19	±20.28	±7.53	±21.45
Normal eldery	X	24.75	75.50	46.12	28.85	81.41	75.51	67.93	50.87	58.22	32.34	29.54	17.31	85.59	78.25	70.27	59.92	86.65	8.07	77.60	32.59
Subjects	±S.D.	±0.47	±0.16	±0.73	±0.81	±0.07	±0.18	±0.62	±0.40	±0.76	±1.91	±0.97	±0.94	±0.03	± 0.12	±0.57	±0.24	±0.39	± 0.62	±0.40	±0.58
t/p		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

tion scanning and information processing one may deduce that these mechanisms become slower without being abolished.

The decrease in absolute power in beta frequency band in all regions among demented patients, this finding agrees with Isse et al. (1990) and Helkala (1991) who found decreased beta activity in even mildly demented patients. Maurer and Dierks (1992) explained this diminution of beta activity in demented patients-correlates best with disturbed cognitive function.

b- According to interhemispheric coherence:

The finding of hypocoherence in delta banding central region among demented patients, is similar to the result of Baggio et al. (1992) and Frostl et al. (1992).

The hypocoherence in theta band particularly in frontal, central and temporal regions in demented patients, this agrees with Petche et al. (1992)and Schrieter-G. et al. (1993) who found that theta coherence is significantly decreased at frontocentral locations in demented patients compared with control. Also, Leuchter et al. (1992) found lower theta coherence in temporal region in demented patients.

This study also revealed decrease in alpha and beta coherence in frontal and central regions among demented patients, the same results reported by Petsche et al. (1992) and Shrieter-G et al. (1993).

The decreased coherence may be interpreted in terms of dementia generating diffuse and widespread cerebral degeneration, which result in fewer neural connection (Forstl et al. 1992). Thus a signal has to be transferred from one neuron to another on a longer path, i.e. the inter neuronal distance in terms of information propagation grows (Bullock and McClune, 1989) and coherence is lowered.

Conclusions and Recommendation:

It may be said that mapping of EEG in healthy young persons, old normal subjects and demented patients with moderately and severely pronounced symptoms is able to visualize age dependent and dementia related EEG changes.

The advantages of this method lay in their non invasivity, allowing follow up studies as often as needed, and their extreme short analysis - times allow analysis of cognitive processes within the millisecond range.

The mini mental state examination is a brief cognitive test that accurately separated patients with moderately - severe dementia from controls that it's language items are fairly easy tasks that can be understood and performed well demented patients with mild aphasia.

Although brain mapping tests are not equal the exquisite localizing ability of CR or magnetic resonance yet it provides information about physiology that is not available from purely anatomic tests. Brain mapping tests are usually less costly, use to radiation, cause no claustrophobia and can be done portably or continuously in an intensive care unit.

The results of our study suggest that BEAM may well have clinical utility in the follow -up of demented patients and to evaluate the efficiency of the different therapeutic methods.

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Une ´etude Comparative Entre Les Patients En Démence , Les Personnes Agées et les Jeunes en utilisant le " Brain Mapping "

Les but de cette étude est d'évaluer les changements du " Brain Mapping " dans les patients en démence et les agés mormaux . On a étudié 3 groupes :

Groupe I : 10 patients en démence de l ' age > 65 ans , Groupe II : 10 personnes normalles > 60 ans et Groupe III : 10 personnes de l 'âge de 25 à 30 ans . Le groupe de patients et le groupe témoin ont été éxaminé par : (1) Une histoire psychiatrique et une diagnose selon le DSM-IV "

(2) Une examination medicale et neurologique . (3) M. M.SE

(4) " Brain Mapping "

Les resul tats des 3 groupes ont étè discutés dans cette étude .

عقد مقارنة باستخدام جهاز رسم المخ التخطيطى بالكمبيوتر بين مجموعة من مرضى عته الشيخوخة ومجموعة من كبار السن الطبيعيين ومجموعة من صغار السن الطبيعيين

كان الهدف من الدراسة محاولة الكشف عن التغيرات الكهروفسيولوجية التى تحدث لمرضى عته الشيخوخة بمقارنتهم بمجموعة من كبار السن الطبيعيين، وكذلك محاولة الكشف عن التغيرات الكهروفسيولوجية التى تحدث نتيجة لكبر السن، بمقارنة مجموعة من كبار السن الطبيعيين مع مجموعة من صغار السن الطبيعيين.

شملت الدراسة ثلاثين شخصاً قسموا إلى ثلاث مجموعات: المجموعة الأولى: شملت عشرة مرضى مصابين بمرض عته الشيخوخة. المجموعة الثانية: شملت عشرة أشخاص من كبار السن الأصحاء كمجموعة ضابطة للمجموعة الأولى. المجموعة الثالثة: شملت عشرة أشخاص من صغار السن الأصحاء كمجموعة ضابطة للمجموعة الثانية. أجريت مقابلة إكلينيكية لجميع المرضى بهدف جمع المعلومات والتشخيص طبقاً للتقسيم الأمريكى الرابع، وكذلك تم عمل فحص إكلينيكى شامل لإستبعاد أى أمراض عضوية أو عصبية كما تم رسم المخ التخطيطى بالكمبيوتر لجميع المجموعات.

وكانت أهم نتائج هذه الدراسة:

إن كبار السن الأصحاء أظهروا الآتى: نقص موجات دلتا وثيتا فى جميع مناطق المخ وزيادة موجات ألفا فى المنطقة الأمامية الوسطى للمخ ونقصها فى المنطقة الخلفية للمخ وزيادة موجات بيتا فى جميع مناطق المخ. لوحظ أيضا نقص فى معدل الإرتباط والتزامن لموجات دلتا وثيتاً وألفا وبيتا فى جميع مناطق المخ.بينما مرضى عته الشيخوخة أظهروا الآتى: زيادة موجات دلتا وثيتاً ونقص موجات ألفا وبيتا فى جميع مناطق المخ. لوحظ أيضا نقص فى معدل الارتباط والتزامن لموجات دلتا فى المنطقة الوسطى للمخ ولموجات ثيتا وألفا وبيتا فى المنطقتين الأمامية والوسطى للمخ.