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Comparison of Quantitative Electroencephalography of Schizophrenia Patients With Healthy Controls

KEYWORDS: Quantitative electroencephalography -Fast Fourier transformation

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ABSTRACT *Quantitative electroencephalography holds important role in some organic brain diseases. But It's use is limited in psychiatric disorders like schizophrenia. Previous findings with the schizophrenia were not very consistent with clinical picture of patients. There is definitely altered brain structure in schizophrenia than healthy subjects. The aim of our study is to determine a specific pattern of qEEG for schizophrenia patients which can be useful in early diagnosis and for prognosis. Drug naïve newly diagnosed 28 schizophrenia and 32 healthy subjects were gone through 300 seconds eye close supine resting EEG recording over 20 electrodes. Recorded data analyzed by fast Fourier transformation, and then absolute power analyzed by applying unpaired t- test. Schizophrenia Patients showed increased theta and beta activity then healthy subjects. This could be potentially used in early diagnosis and for prognosis of schizophrenia.*

INTRODUCTION

Schizophrenia is a profoundly disruptive, psychopathology that involves cognition, emotion, perception, and other aspects of behavior. Schizophrenia is characterized by disturbances in thought and verbal behavior, perception, affect, motor behavior and relationship to the external and internal milieu.[1]

The disorder usually begins before the age of 25 years and, persists throughout life, and it affects all social classes. Schizophrenia is equally prevalent in men and women wherein the onset of schizophrenia seems to predate in men as compared to that observed in women. The peak age of onset of schizophrenia in men and women is 20 to 25 years and 25 to 35 years, respectively. About 90% of patients on treatment for schizophrenia fall in the age – range of 15 to 55 years. Onset of schizophrenia before the age of 10 years or after the age of 60 years is extremely rare.[1]

Schizophrenia is found in all societies and geographical areas, and the incidence and prevalence rates are roughly comparable across the globe.[1]

A systemic review of 188 studies in 46 countries published between 1965 and 2002, estimated the median value for point prevalence at 4.6 per 1000 person and for lifetime at 7.2 per 1000. A systemic review of incidence data from some 160 studies from 33 countries, published between 1965 and 2001, yielded a median value of 0.15 and mean value of 0.24 per 1000.[2]

According to the World (Mental) Health Report 2001, about 24 million people world – wide suffer from schizophrenia. The point prevalence of schizophrenia is about 0.5 – 1 %. Schizophrenia is prevalent across racial, sociocultural and national boundaries, with a few exceptions in the prevalence rates in some isolated communities.

Electroencephalogram (EEG) continues to be painless, non – invasive, safe and objective investigations in psychiatry.[3] Among the laboratory indicators of mental diseases qEEG findings are very helpful in epilepsy, polysomnography, lie detector, evoked potential studies etc. Previous studies which were started since 1929 has shown that psychiatric patients exhibits various qEEG abnormalities , which are present in up to 80% of psychiatric patients as compared to 10% of healthy subjects.[4] There are practically no qEEG studies in mental disorders that did not find some qEEG abnormalities.[5]

During the last decade, more than 500 EEG and qEEG papers have reported well – designed studies, concurring that EEG and qEEG abnormalities are found in a high proportion of psychiatric patients. But yet there is no such potentially identified qEEG pattern for diagnosis or for prognosis of schizophrenia.

The present study was undertaken to evaluate the quantitative electroencephalographic (qEEG) pattern in the patients of schizophrenia.

Thus, the significance of qEEG parameters as possible biological markers of schizophrenia would be confirmed.

MATERIAL AND METHODS

The study was conducted in the Upgraded department of Physiology in association with the department of Psychiatry, S.M.S. Medical College, Jaipur. The study design was Hospital based comparative type of observational study.

Participants

Twenty eight schizophrenia patients and thirty two healthy controls of age and sex matched were recruited in the present study. The study group was recruited from the O.P.D. of Psychiatry department of S.M.S Medical College and Attached Hospitals, Jaipur and control group was composed of age and sex matched healthy controls. The study was carried out after the approval of institutional ethics committee. In the schizophrenia group mean age was 31.03 years, and in healthy control group it was 30.4 years. Out of the 28 of schizophrenia patients 21 were male and 07 were female. Out of the 32 of healthy controls 20 were male and 12 were female.

patients of schizophrenia were between age of 18 – 40 yrs. Drug-naïve or newly diagnosed patients of Schizo-

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phrenia according to the criteria of Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-iv TR 2000) included in this study. Healthy subjects were Age and sex matched to schizophrenia patients. Healthy subjects with no personal or family history of neurological/psychotic disturbances were included in present study.

Procedure

Informed written consent was obtained from all the subjects and patients who were enrolled in the present study. Following instructions had been given before EEG recording: The subjects should shampoo hair the night before the test and use of hair cream, oils or spray afterwards was restricted. The controls and patient that comprised the study population was asked to avoid all food and drinks containing caffeine for 2 hrs before the test.

EEG was recorded using a stretchable cap which was positioned on the subject's head according to known anatomical landmarks.[6]

Complete medical history and clinical examination were performed on all the patients. QEEG was done on all the patients and controls using BESS (brain electro scan software) of the Axxonet System (India).

The 20 electrodes were positioned on the scalp according to the International 10-20 System with biauricular reference.[7] EEG was recorded for 300 seconds in eye closed resting supine position from frontal (Fz/Fp1/Fp2, F3/F4, F7/F8), temporal (T3/T4, T5/T6), central (C3/C4/Cz), parietal (P3/P4/Pz), and occipital (O1/O2/Oz) regions. Impedance was kept below 5 KΩ and electrical activities, amplified with a band – pass filter of 0.5 Hz – 30.0 Hz, digitized at sampling rate 256 Hz. Artifact – free epochs of 2 seconds each was chosen and their spectral content evaluated by means of Fast Fourier Transform analysis.[8] The following parameters were observed and evaluated. Absolute power values (μV2) for individual segments of EEG spectrum of delta (0.5 – 4.0 Hz), theta (4.0 – 8.0 Hz), alpha (8.0 – 13.0 Hz) and beta (13.0 – 30.0 Hz) waves frequency were calculated. Absolute power is the logarithmic value of a variable in each frequency band of the EEG signals, calculated with a root mean square algorithm.

The Microsoft excel 2010 and Primer[9] of biostatistics version 6.0 by Stanton A. Glantz: 2005 McGraw-Hill was used for statistically analysis of data. The unpaired 't' Test was used for the comparison of all parameters among patients and control subjects.

Results

Table 1 Absolute Power Of EEG Bands Of Delta, Theta, Alpha And Beta In 20 Electrodes, In Schizophrenia And Healthy Control

LEADS	BANDS	DELTA		THETA		ALPHA		BETA	
		MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
FP1	SCH.	15.62	13.76	6.53	5.12	3.74	2.00	4.41	2.23
	HEALTHY	13.76	10.99	4.75	3.27	3.71	2.23	3.45	2.16
FP2	SCH.	20.66	13.78	8.16	4.65	4.97	1.81	6.19	2.40
	HEALTHY	15.66	9.16	5.41	3.64	4.17	2.43	4.26	2.43
F3	SCH.	15.82	7.41	7.32	4.77	4.59	1.92	5.44	2.69
	HEALTHY	12.79	6.51	5.10	2.97	4.01	2.12	3.53	1.59
F4	SCH.	10.96	9.90	4.73	5.49	2.51	2.48	3.61	4.00
	HEALTHY	9.06	4.36	3.18	1.73	2.61	1.67	2.54	1.24
C3	SCH.	13.92	9.02	6.35	4.68	3.74	1.64	4.49	2.00
	HEALTHY	10.38	5.65	4.21	2.75	3.31	2.04	3.02	1.63
C4	SCH.	14.28	6.93	5.66	4.03	3.57	1.88	4.48	2.23
	HEALTHY	10.56	5.37	3.94	2.61	3.29	2.24	2.90	1.56
P3	SCH.	11.34	6.57	4.04	3.86	2.71	2.09	3.37	2.35
	HEALTHY	10.03	4.95	4.47	3.66	3.82	2.58	2.92	1.53
P4	SCH.	15.50	6.85	6.78	4.06	4.93	2.01	5.00	1.61
	HEALTHY	9.99	4.49	4.98	3.36	4.17	2.36	3.09	1.39
O1	SCH.	16.20	5.83	8.09	3.88	6.57	3.66	5.70	1.53
	HEALTHY	10.71	5.35	5.58	4.76	6.36	4.11	3.65	1.95
O2	SCH.	17.04	5.99	8.47	3.61	7.02	3.87	6.02	1.62
	HEALTHY	12.20	5.70	6.34	4.51	7.97	4.25	4.24	1.98
F7	SCH.	16.02	8.77	6.92	3.95	4.52	1.60	5.12	1.66
	HEALTHY	14.17	7.87	5.16	2.88	4.18	2.53	4.19	2.32
F8	SCH.	19.08	13.59	7.38	4.52	4.77	2.02	5.94	3.55
	HEALTHY	15.10	8.30	5.41	3.11	4.16	2.02	4.35	2.31
T3	SCH.	15.53	10.32	6.75	4.64	4.19	2.05	5.31	3.41
	HEALTHY	11.16	6.53	4.33	2.41	3.42	1.84	3.43	1.90

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LEADS	BANDS	DELTA		THETA		ALPHA		BETA	
		MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
T4	SCH.	16.83	10.99	7.16	4.56	4.73	1.99	5.93	3.54
	HEALTHY	10.49	5.26	4.38	2.57	3.57	1.93	3.30	1.73
P7 (T5)	SCH.	15.23	13.64	5.80	3.95	4.88	3.00	5.17	4.65
	HEALTHY	10.48	4.97	4.59	2.74	4.70	2.35	3.28	1.59
P8 (T6)	SCH.	13.72	6.97	4.77	2.18	4.14	2.55	4.30	1.64
	HEALTHY	10.76	5.34	4.84	3.19	5.06	3.13	3.37	1.71
Fz	SCH.	14.71	14.82	6.32	4.42	4.02	1.96	4.59	2.24
	HEALTHY	10.62	5.32	4.48	2.99	3.50	2.01	3.07	1.50
Cz	SCH.	16.18	8.73	7.30	4.35	4.56	1.45	5.40	2.07
	HEALTHY	11.72	5.53	5.07	3.39	3.88	2.12	3.24	1.50
PZ	SCH.	15.09	7.08	7.15	4.44	4.80	1.86	4.91	1.76
	HEALTHY	11.21	5.44	5.60	5.11	4.40	3.18	3.28	1.77
OZ	SCH.	9.11	5.22	3.00	2.67	1.84	1.50	2.72	1.87
	HEALTHY	5.38	3.69	1.63	1.54	1.28	1.77	1.41	0.88

Table 2. Statistically significant differences of EEG rhythms between schizophrenia patients, and healthy subjects

	Rhythm			
electrode	Delta	Theta	Alpha	Beta
Fp1				
Fp2		***		***
F3				
F4				
C3		***		***
C4				***
P3				
P4				***
O1	***	***		***
O2				
F7				
F8				
T3		***		***
T4	***	***	***	***
P7 (T5)				***
P8 (T6)				
FZ				***
CZ		***		***
PZ				***
OZ	***	***		***

[* p<0.05]**

Schizophrenia Vs. healthy control

Power of delta activity in patients with schizophrenia was increased in comparison with that in healthy subjects over T4 (p<0.005), O1 (p<0.001), and Oz (p<0.001) regions.

Patients with schizophrenia had significantly higher theta power over Fp2 (p<0.017), C3 (p<0.046), T3 (p<0.016), T4 (p<0.005), O1 (p<0.05), Cz (p<0.046) and Oz (p<0.009) regions than healthy subjects.

Power of alpha activity was increased over only one electrode T4 (p<0.003) region in patients with schizophrenia than healthy control.

Whereas power of beta activity was increased over Fp2 (p<0.005), C3 (p<0.002), C4 (p<0.011), P4 (p<0.002), O1 (p<0.001), T3 (p<0.009), T4 (p<0.001), T5 (p<0.029), Fz (p<0.002), Cz (p<0.001), Pz (p<0.002) and Oz (p<0.001) regions in with schizophrenia than healthy control.

Discussion:

Schizophrenia

In the present study, qEEG changes were observed in schizophrenic patients in comparison with healthy subjects in all bands of the EEG spectrum . qEEG changes were less prominent in delta and alpha bands. With respect to the topographic distribution, most EEG abnormalities were found over occipital regions, followed by temporal and central regions. Abnormalities in qEEG over so many regions in patients with schizophrenia could be associated with disturbed neural circuits in schizophrenia.[10] In patients with schizophrenia, abnormal changes in the EEG pattern can be found in 5- 80% of the cases.[11] Furthermore, in previous studies , qEEG findings in schizophrenia show a wide range of abnormalities. The symptoms of schizophrenia are caused by the dysfunction of multiple cortical and subcortical brain structures.[12] which may explain inconsistent and sometimes contradictory qEEG findings in these patients.

Theta Band

In our study there was significantly increased theta rhythm over Fp2 (right superior frontal gyrus)[13] (p<0.017), C3(left precentral frontal gyrus) (p<0.046), T3 (left medial temporal gyrus) (p<0.016), (T4 right medial temporal gyrus) (p<0.005), O1 (left medial occipital lobe) (p<0.05), Cz (superior frontal gyrus) (p<0.046) and Oz (p<0.009) leads than healthy subjects. Table 4. These findings are consistent with the most frequently reported qEEG abnormalities of increased slow activity in schizophrenia. [14,15,16]

The changes in theta and alpha activity may indicate GABA-ergic inhibition of the thalamus.[17] From the electrophysiological point of view, hallucinations in schizophrenia are associated with increased theta activity in the superior temporal gyrus. [18]

The theta range is associated with perceptual processing, learning, memory, and synaptic plasticity.[19] Cortico-hippocampal circuits have been found as key generators of

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this rhythm.[20]

Recent studies have implicated the anterior cingulate cortex (ACC) as a potential generator of frontal midline theta activity.[21] In a recent study integrating electrical (EEG) and metabolic (PET) measurements of brain activity, It was found that the ACC (Brodmann's area 24/32) was the largest region with significant positive correlations between theta current density and glucose metabolism.[22]

Physiologically, the septo-hippocampal system has been strongly implicated in the generation of theta oscillations, although theta has also been recorded in numerous other limbic regions, including the ACC, entorhinal cortex, and the medial septum, among others.[23]

Beta Band

In the present study absolute power of beta activity was significantly increased over Fp2 (right superior frontal gyrus) ($p<0.005$), C3 (left precentral frontal gyrus) ($p<0.002$), C4 (right precentral frontal gyrus) ($p<0.011$), P4 (right inferior prietal gyrus) ($p<0.002$), O1 (left medial occipital lobe) ($p<0.001$), T3 (left medial temporal gyrus) ($p<0.009$), T4 (right medial temporal gyrus) ($p<0.001$), P7 (left medial temporal lobe) ($p<0.029$), Fz (medial frontal lobe) ($p<0.002$), Cz (superior frontal gyrus) ($p<0.001$), Pz (precuneus parietal lobe) ($p<0.002$) and Oz ($p<0.001$) regions in schizophrenia patients than healthy control.

Increased beta activity in patients with schizophrenia observed in our study was consistent with that reported previously.[24,25] One of the reasons of increased beta activity in patients with schizophrenia could be damage to the deeper brain structures.[24]

Numerous studies have reported increased beta activity in schizophrenia.[26] Oscillations are believed to be generated in overall cortical structures and are involved in sensory gating, attention, and long-term synchronization.[27] The increase in beta activity generally reflect increased excitatory activity, particularly during diffuse arousal and focused attention.[28]

Increased beta activity may be induced by a number of different drugs, particularly barbiturates , benzodiazepine compounds, neuroleptics, antihistaminics, methylphenidate and cocaine.[29] Drug induced fast activity is typically diffuse and symmetric over the two hemispheres. Focal or lateralized spontaneous beta activity, or asymmetric drug induced fast activity, raises the possibility of localized cerebral pathology.

Conclusions: The finding with schizophrenia differed from healthy subjects in absolute power values of theta and beta waves.increasing beta waves in schizophrenia shows localized pathology or damage to deeper structure of brain. This could be due to excitatory activity of the cerebral cortex of schizophrenia. Which could be potentially used in early diagnosis and for prognosis of schizophrenia.

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