Psychiatria Danubina, 2009; Vol. 21, No. 4, pp 579–584 *Conference paper*

EEG CHARACTERISTICS IN DEPRESSION, „NEGATIVE“ AND „POSITIVE“ SCHIZOPHRENA

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SUMMARY

Objective: *qEEG investigations present differences in the comparison of schizophrenic patients and healthy examinees, as well as of depressive patients and healthy controls. The comparison of "positive" and "negative" schizophrenia also presents differences in the qEEG parameters. Changes in qEEG are various in these studies, but not always consistent. In this research we wanted to compare "positive" schizophrenia, "negative" schizophrenia and depression.*

Subjects and methods: *The sample comprised 55 examinees (all women): 20 patients with "positive" schizophrenia, 15 patients with "negative" schizophrenia and 20 patients with depression. The standard EEG registration was done in all of them. From the recorded material, the 20-second period without artifacts was analyzed by the FFT method. The results were presented as absolute special power values (μV^2) for individual segments of the spectrum: delta (0.5-4.0), theta (4.0-8.0), alpha (8.0-13.0) and beta (13.0-30.0). The observed regions included Fp1, Fp2, F3, F4, F7, F8, T3, T4, P3, P4, O1 and O2.*

Results: *The "positive" type schizophrenia differs from the "negative" in the increase in both delta and theta activities, and in the decline of beta activity over frontal regions. The "positive" type of schizophrenia differs from depression in the increase in delta activity over frontal regions, while the "negative" form of schizophrenia differs from it in the decrease in beta activity over frontal regions.*

Conclusions: *qEEG parameters differ in the comparison of "positive" and "negative" types of schizophrenia. These differences are more numerous and more significant than those obtained in the comparison of each of these types of schizophrenia with depression.*

Key words: *qEEG - "positive" schizophrenia - "negative" schizophrenia - depression*

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INTRODUCTION

Schizophrenia and depression are two separate entities already since Kraepelin. They differ in psychopathological and epidemiological characteristics, etiological hypotheses that strive to explain their cause and occurrence. Their also differ regarding treatment and the prognosis of outcome. They are two groups of various disorders, each one having several subtypes.

The schizophrenia cluster is heterogeneous and encompasses various forms of schizophrenic spectrum: from schizophrenic psychosis, through disorders similar to schizophrenia to schizoid and schizotype personality disorder.

The conceptualization of schizophrenia has not progressed much since Kraepelin and from the division into four basic types. Both ICD and DSM classifications include paranoid, hebephrenic, catatonic and simplex types, adding a few subtypes. The distinction into "negative" and "positive" schizophrenia is one of the most significant attempts at more qualitative classification of the heterogeneous group of schizophrenic psychoses. This attempt of the new conceptualization of schizophrenia has not completely fulfilled its role, but contributed to better understanding of numerous biological bases of schizophrenia with prevalent positive symptoms and of that with negative symptoms. It also enables various therapeutic approaches to these entities, primarily from the perspective of the administration of new (atypical) antipsychotics.

The positive-negative dichotomy has opened a series of new questions and dilemmas. In that way the continuum of "positive" schizophrenia –

“negative“ schizophrenia – depression is emerging, where various investigations examine the relationship of these entities. The results confirm biological variety, but also similarities among these disorders. The method of quantitative electroencephalography (qEEG) is not an exception either, although there are few studies that mutually compare schizophrenia and depression.

Previous qEEG studies

In patients with schizophrenia, abnormal changes in the EEG pattern can be found in 5-80% of the cases (Shagass et al. 1984). The most frequently reported qEEG abnormalities include increased slow activity (Harris et al. 1999, Boutros et al. 2008) and decreased alpha activity (Sponheim et al. 1994), which is normalized after antipsychotic medical treatment (Begić et al. 2000a). Differences in qEEG can even be found between different subtypes of schizophrenia (“positive-symptom” vs “negative-symptom” schizophrenia) (Gerez & Tello 1995, Begić et al. 2000b).

According to the conventional EEG studies, 20-40% of patients with depression have abnormal EEG findings (Hughes & John 1999). Quantitative EEG studies in patients with depression found increased slow wave activity (Adler et al. 1999). Differences in qEEG indicators were found even between unipolar and bipolar depressive disorders (Pritchep & John 1992). The most consistent findings in depression were abnormal qEEG indicators predictive of therapeutic response (Cook & Leuchter 2001, Bares et al. 2007).

Many studies compared patients with schizophrenia or depression with healthy subjects, whereas only a few studies compared schizophrenia and depression. Even smaller number of studies investigates depression, “positive” and “negative” schizophrenia by the qEEG method.

Due to the scarcity of studies comparing schizophrenia and depression and possible role of qEEG in differential diagnosis between these two disorders, we performed the present study. The aim of the study was to compare qEEG findings in patients with “positive” schizophrenia, patients with “negative” schizophrenia, and patients with depression. We wanted to determine if there were any differences in qEEG indicators between patients with schizophrenia and those with depression. The hypothesis was that “positive” schizophrenia, “negative” schizophrenia and depression differ in qEEG indicators. Specific qEEG findings in patients with schizophrenia and patients with depression may contribute to their clinical differentiation. Thus, the significance of qEEG parameters as possible biological markers of schizophrenia or depression would be confirmed.

SUBJECTS AND METHODS

Subjects

The study was performed at the Psychiatric Clinic, Zagreb University Hospital Center, in 2008 and 2009. It included 35 patients with schizophrenia (20 patients with “positive” schizophrenia, 15 patients with “negative” schizophrenia), and 20 patients with depression. All patients were women. They hospitalized and diagnosed with schizophrenia or depression according to the criteria of Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) by two independent psychiatrists. Patients were either drug-naïve or had not been taking psychopharmaceuticals for one month before the study.

Excluding criteria: neurological disease, head trauma, “soft” neurological signs, or history of EEG changes. All study participants were right-handed and all provided informed consent before inclusion in the study.

Methods

All study participants underwent conventional EEG registration. During the EEG recording, subjects were in supine position, with their eyes closed. Electrodes were placed according to the international “10-20” system using linked-ears as a reference. EEG recordings were performed with Nicolet's BEAM device. All EEG recordings were performed by the same EEG technician.

The sampling rate was 256 Hz, the amplitude bandwidth between 0.5 and 30 Hz, and impedance levels were $\leq$5 kΩ. Epochs contaminated by blinks, eye movements, and movement-related artifacts were excluded from analyses by direct visual inspection. Artifact-free 20-second epochs were selected from the recorded material and analyzed using Fast Fourier Transformation (FFT). The results were presented as absolute spectral power values (μV^2) for individual segments of EEG spectrum: delta (0.5-4.0), theta (4.0-8.0), alpha (8.0-13.0), and beta (13.0-30.0). The observed regions included Fp1, Fp2, F3, F4, F7, F8, T3, T4, P3, P4, O1, and O2.

Table 1. Median values (range) of EEG rhythms in patients with “positive” schizophrenia, patients with “negative” schizophrenia, and patients with depression

Rhytm	δ			θ		
Lead	positive sch	negative sch	depression	positive sch	negative sch	depression
Fp1	37.71 (172.5)	16.62 (48.1)	25.06 (243.3)	19.35 (775.9)	18.16 (42.5)	20.31 (384.9)
Fp2	51.51 (385.8)	32.27 (46.7)	23.95 (504.6)	19.91 (167.9)	14.59 (45.8)	19.00 (222.39
F3	37.29 (134.3)	15.49 (107.6)	26.75 (241.7)	20.32 (754.1)	17.27 (43.4)	20.75 (334.8)
F4	47.95 (489.2)	28.92 (46.4)	20.47 (535.1)	26.54 (141.9)	17.33 (42.1)	21.10 (229.2)
F7	32.09 (160.9)	13.95 (84.9)	20.41 (279.8)	20.81 (681.29)	13.81 (37.9)	21.66 (262.06)
F8	39.45 (441.2)	26.85 (41.7)	18.16 (497.6)	25.73 (141.6)	14.15 (35.8)	19.48 (215.9)
T3	18.51 (72.4)	13.79 (34.5)	18.83 (260.4)	11.365 (676.1)	9.12 (54.1)	12.48 (273.54)
T4	21.68 (398.5)	15.00 (37.4)	12.08 (487.9)	13.74 (86.2)	10.67 (21.4)	13.48 (183.2)
P3	27.21 (179.2)	21.08 (105.9)	22.07 (252.7)	25.29 (684.7)	26.44 (102.5)	17.91 (265.8)
P4	35.56 (422.6)	35.45 (82.9)	21.45 (453.1)	29.91 (110.5)	17.9 (83.5)	23.74 (247.9)
O1	28.46 (115.6)	20.81 (121.5)	20.26 (271.8)	22.47 (721.8)	26.81 (139.8)	19.88 (228.9)
O2	35.83 (384.9)	19.93 (81.8)	20.46 (481.42)	20.56 (81.8)	12.27 (56.7)	20.72 (195.2)
Rhytm	α			β		
Lead	positive sch	negative sch	depression	positive sch	negative sch	depression
Fp1	28.57 (278.9)	31.77 (82.4)	27.08 (126.8)	28.71 (144.2)	22.62 (94.2)	37.37 (160.1)
Fp2	28.16 (139.6)	30.01 (76.9)	25.84 (241.5)	26.81 (101.8)	15.62 (56.8)	29.04 (143.7)
F3	30.28 (282.6)	25.07 (77.5)	32.43 (157.5)	31.09 (141.5)	23.56 (111.6)	37.08 (183.3)
F4	26.59 (116.5)	24.49 (88.5)	32.59 (237.4)	29.68 (141.9)	18.48 (86.3)	33.1 (158.4)
F7	18.74 (263.8)	21.45 (74.5)	22.59 (147.7)	27.71 (143.9)	17.25 (131.2)	44.45 (112.8)
F8	20.62 (98.3)	16.81 (86.4)	24.57 (290.3)	28.49 (176.7)	16.09 (103.9)	36.14 (149.1)
T3	12.44 (275.1)	21.40 (75.5)	17.03 (183.8)	19.87 (113.3)	14.00 (92.3)	27.08 (94.3)
T4	16.21 (69.8)	22.10 (109.3)	21.09 (201.7)	21.18 (196.3)	22.61 (141.2)	21.26 (134.7)
P3	46.86 (426.9)	59.47 (273.4)	54.53 (471.8)	39.63 (66.6)	31.23 (220.1)	36.75 (144.2)
P4	47.97 (314.5)	85.22 (461.5)	67.68 (520.9)	35.73 (100.8)	33.40 (287.3)	36.83 (140.8)
O1	46.00 (514.7)	52.71 (518.2)	61.18 (632.5)	31.23 (82.3)	21.03 (80.6)	40.74 (84.1)
O2	45.62 (293.1)	99.13 (189.1)	50.27 (366.4)	32.21 (113.1)	22.98 (75.2)	24.86 (87.5)

Statistical analysis

The Mann-Whitney non-parametric test was used to evaluate the differences between the groups. The level of significance was set at $p<0.05$. Data were analyzed with Statistical Package for the Social Sciences (SPSS), ver. 11.5. (SPSS Inc., Chicago, IL, USA).

RESULTS

We compared qEEG findings between patients with “positive” schizophrenia, patients with “negative” schizophrenia, and patients with depression. The mean age (±standard deviation) in patients with “positive” schizophrenia, those with “negative” schizophrenia, and patients with depression was 31.3±10.6, 37.3±11.9, and 55.1±12.6 years, respectively.

Patients with depression were significantly older than the other two groups of participants ($F_{2.83}$= 27,72; $p<0.001$). There was no significant correlation between age and qEEG parameters (the correlation ranged from -0.035 to 0.11).

Patients with “positive” schizophrenia differed from patients with “negative” schizophrenia in delta, theta and beta activities. Patients with “positive” type had the increase in delta activity over the following regions: Fp1, Fp2, F3, F4 and F7, the increase in theta activity over the F4 and F8 regions, and the decrease in beta activities over the regions Fp2, F4, F7 and O2.

The comparison of the results in patients with “positive” type schizophrenia and depressive ones showed difference only in delta activities. Patients with the “positive” type had increased delta activity over Fp1, Fp2, F4 and F8 regions.

The patients with “negative” type schizophrenia differed from depressive patients in beta activities. Patients with “negative” type of the disease had the fall of beta activity over Fp1, Fp2, F3, F4, F7 and F8 regions.

Table 2. Statistically significant differences of EEG rhythms between the groups (patients with “positive” schizophrenia, patients with “negative” schizophrenia and patints with depression)

Rhytm	δ			θ		
Lead	positive - negative sch	positive sch - depr	negative sch - depr	positive – negative sch	positive sch - depr	negative sch - depr
Fp1	**	*				
Fp2	**	*				
F3	**					
F4	*	*		*		
F7	*					
F8		*		*		
T3						
T4						
P3						
P4						
O1						
O2						
Rhytm	α			β		
Lead	positive – negative sch	positive sch - depr	negative sch - depr	positive – negative sch	positive sch - depr	negative sch - depr
Fp1						*
Fp2				*		**
F3						*
F4				*		*
F7				*		**
F8						*
T3						
T4						
P3						
P4						
O1						
O2				*		

Note: ** p<0,01; * p<0.05

Median values and range of delta, theta, alpha, and beta rhythms in patients with “positive” schizophrenia, patients with “negative” schizophrenia, and patients with depression are shown in Table 1.

Statistically significant differences between the groups are presented in Table 2.

DISCUSSION

The symptoms of schizophrenia are caused by the dysfunction of multiple cortical and subcortical brain structures (Gross et al. 2006), which may explain inconsistent and sometimes contradictory qEEG findings in these patients.

In our investigation the most significant qEEG changes were observed in the comparison of patients with “positive” and those with “negative” type of schizophrenia. Regarding the topographic distribution, the most numerous deviations were found over frontal regions (delta, theta and beta activities). The finding of differences in beta activity over the O2 region was an isolated one.

Abnormalities in qEEG over so many regions in patients with schizophrenia could be associated with disturbed neural circuits in schizophrenia (Benes et al. 2000).

Changed power values of all EEG activities over frontal regions in patients with schizophrenia are compatible with “hypofrontality”. Many brain imaging studies using different methods also reported on “hypofrontality” in schizophrenia (Winterer et al. 2000).

Thus, it is believed that neocortical-striatal-thalamocortical dysfunction is associated with dopaminergic dysbalance (Carlsson et al. 1995).

In addition to frontal dysfunction, fronto-limbic dysfunction was also observed in patients with schizophrenia (Gross & Huber 2008).

“Positive” symptoms (especially hallucinations) in schizophrenia are associated with increased theta activity in the upper temporal gyrus (Ishii et al. 2000).

Increased beta activity in patients with schizophrenia included in our study was consistent with that reported previously (Begić & Jokić-Begić 1998).

One of the reasons of increased beta activity in patients with schizophrenia could be damage to the deeper brain structures (Dierks 1992).

There are many areas of the brain responsible for depression: dorsolateral and ventromedial prefrontal cortex, n. accumbens, basal ganglia, amygdales, temporal and parietal cortex, and hypocampus (Deslandes et al. 2008).

Lesions to these structures in patients with depression elicit EEG changes.

In our study, comparison between patients with depression and patients with “positive” schizophrenia showed that patients with depression had significantly lower delta power values over frontal regions. Increased beta activity over frontal regions was also found in patients with depression in comparison with patients with “negative” schizophrenia.

These results are in accordance with some previous findings (Sponheim et al. 2000).

Our results confirm that schizophrenia and depression have different biological basis, despite the fact that both disorders differ from healthy subjects in a wide range of similar or identical findings.

Nevertheless, the question remains whether it is possible to discern between these two disorders, especially between “negative” schizophrenia and depression, on the basis of qEEG parameters.

CONCLUSION

According to the obtained results, the qEEG parameters differ in the comparison of “positive” and “negative” type of schizophrenia. This is especially valid for delta activity over frontal regions.

These differences are more numerous and more significant than in the comparison of each of these schizophrenic types with depression.

The possible role in differentiation of “positive” schizophrenia and depression could have delta, and between “negative” type and depression beta activities.

The presented results are derived from the scientific project (Quantitative EEG characteristics in depressive and schizophrenic patients), carried out with the financial support of the Ministry of Science, Education and Sports of the Republic of Croatia.

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