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Effects of electroconvulsive therapy on certain attention tests in patients with schizophrenia

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Abstract

It is known that patients with schizophrenia have positive and negative symptoms, as well as deterioration in cognitive functions. The main objective of this study was to investigate the effects of electroconvulsive therapy (ECT) on certain attention tests in patients with schizophrenia. The study included 103 patients who were diagnosed with schizophrenia according to the DSM-5 diagnostic criteria (39 outpatients receiving antipsychotic treatment alone, 32 inpatients receiving ECT+antipsychotic treatment, and 32 inpatients receiving antipsychotic treatment alone) and 42 healthy volunteers. The Stroop and digit span tasks were used as attention tests. Disease severity was assessed using the Scales for the Assessment of Positive/Negative Symptoms. There was a significant deterioration in the Stroop 4 and Stroop time difference values in all the three patient groups. No significant deterioration was observed in the digit span test in any of the groups. The Stroop 4, Stroop time difference and Stroop spontaneous correction scores were found to be associated with both negative and positive symptoms in the ECT+antipsychotic treatment group. The Stroop spontaneous correction scores were associated with positive symptoms only in the group receiving antipsychotic treatment alone. The only significant improvement in the number of spontaneous corrections was observed in the ECT group after therapy compared to the baseline. However, no significant change was observed in the Stroop 4 and Stroop time difference results, which were impaired compared to the normal scores. In the group receiving only antipsychotic treatment, there were significant improvements in Stroop 4, Stroop time difference and number of spontaneous corrections after treatment. In this study, it was determined that ECT added to drug treatment had positive rather than negative effects on the patients' performance in attention tests, although not as much as drug treatment. However, it should be considered that the group in which ECT was added to treatment consisted of more severe cases.

Keywords: Chizophrenia, electroconvulsive therapy, cognitive function

Introduction

It has been suggested that in patients with schizophrenia, impairments in cognitive functions, as well as positive and negative symptoms are among the main factors that cause disability and decrease in functional capacity [1]. Considering the lifelong course of symptoms in schizophrenia, positive and negative findings show a fluctuating course while cognitive impairment begins before the onset of the disease and shows a relatively stable course [2]. Research has shown that patients with schizophrenia have deterioration in more than one cognitive area compared to healthy controls. Among the impaired cognitive areas are many functions related to attention, working memory, executive function, visual memory, verbal memory, learning and processing speed [3]. Studies have been conducted to investigate the effects of both symptoms and treatments on cognitive functions in patients with schizophrenia. In a study conducted with 1,493 patients with schizophrenia, it was reported that the patients had widespread and significant impairments in cognitive areas, and the deterioration in cognitive tests was not associated with positive symptoms but had a moderate relationship with negative symptoms [4].

The effect and side-effect mechanisms of electroconvulsive therapy (ECT) applied in the treatment of schizophrenia have not yet been clearly elucidated. Amnesia is the most commonly reported cognitive side effect associated with ECT. Both retrograde and anterograde amnesia can be seen as a result of ECT [5]. When the

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literature on the subject is examined, publications show that ECT does not have a significant effect on simpler attention tasks, such as the digit span test [6] while there are also studies reporting reduced performance in tests measuring executive functions, such as the Stroop, tracing and verbal fluency tests [7]. It is considered that the greatest difficulty in accurately understanding the effect of ECT on executive functions is that these functions are also affected by factors such as cognitive slowdown and impaired attention due to ECT [5].

The primary objective of this study was to compare the pre-treatment and post-treatment attention functions of hospitalized schizophrenic patients receiving ECT and antipsychotic therapy and schizophrenic outpatients receiving only antipsychotic therapy. Thus, we aimed to provide an understanding of the effect of ECT on attention in patients with schizophrenia. At the same time, it was attempted to clarify the effect of the disease on attention by comparing the attention functions of the schizophrenia group and the healthy control group. We consider that the measurement of cognitive control functions in this patient group will contribute to the literature in terms of the clinical, functional and social adaptation of therapeutic strategies.

Materials and Methods

The study was carried out at the Psychiatry Clinic of İnönü University Turgut Özal Medical Center between January 2014 and January 2016. A total of 103 patients aged 18-65 years, who were diagnosed with schizophrenia according to the DSM-5 diagnostic criteria and treated as an outpatient or inpatient in the psychiatry outpatient clinic and ward were included in the sample [8]. The healthy control group consisted of healthcare professionals who were not diagnosed with any psychiatric disorder in their current state after an interview with a psychiatrist, had no previous psychiatric disease history and no known physical disease. Forty-two participants matched with the patient group in terms of age and gender were included in the healthy control group. As the control group, 42 healthy volunteers with similar age and gender characteristics to the patient groups were recruited. The procedures to be performed were explained in detail to all patient and control groups participating in the study, and informed consent was obtained. The study was conducted in accordance with the tenets of the Declaration of Helsinki. Ethics committee approval was received from Malatya Clinical Research Ethics Committee with the protocol number 2014/128 and date 21.01.2015. Individuals with an educational level below primary school, those with any medical disease that could affect cognitive functions, those with mental retardation, and those with a history of serious head trauma, alcohol or substance abuse/dependence, an additional psychiatric disorder diagnosis according to DSM-5 other than the diagnosis of schizophrenia were not included in the study.

A sociodemographic and clinical data collection form was applied to all the patients and controls by the physician who conducted the study. The Scale for the Assessment of Positive Symptoms (SAPS) and the Scale for the Assessment of Negative Symptoms (SANS) were administered to 39 patients who were followed up in the outpatient clinic following an interview with the same physician. During the same session, these patients were asked to complete the Stroop and digit span tasks.

The Stroop and digit span tests were applied to the 64 patients receiving inpatient treatment at the psychiatry ward, following an interview with the physician conducting the study, and the same procedure was repeated at the time of their discharge. For the 32 inpatients receiving ECT, SAPS, SANS and neuropsychological tests were administered twice before therapy and one day after the last ECT session. The same scales and neuropsychological tests were also applied to the 32 inpatients who received only antipsychotic treatment at the end of the treatment.

ECT application

ECT was administered to patients with sudden/recently onset of positive symptoms or who had a good response to ECT before. In 32 of the 64 inpatients, eight to 10 sessions of ECT were performed under general anesthesia for three days a week, not on consecutive days. This therapy was added to the existing pharmacological treatment of the patients. Before ECT, 0.5 mg atropine sulfate, 0.5 mg/kg succinylcholine, and 1.0 mg/kg propofol were intravenously administered to the patients. The sessions were undertaken between 9 a.m. and 11 a.m. following overnight fasting. Bilateral ECT was applied to the patients with the Thymatron TM DG device (Somatics, Inc., Lake Bluff, IL, USA) with the bipolar short-pulse square wave pulse using standard settings. The parameters of the ECT device were as follows: maximum load delivered, 504 mC; current, 0.9; pulse range, 0.5 mg; frequency, 10-70 Hz; and maximum time, 8 seconds. During ECT, motor seizures were observed and electroencephalography monitorization was performed by wrapping a blood pressure cuff around an arm and inflating the cuff [9].

Stroop test

This is a neuropsychological test that was first developed by Stroop in 1935 and reflects frontal lobe function. The standardization of this test in Turkey was performed by Karakaş et al. in 1999 [10]. The Stroop interference effect results from the tendency of an individual to also say the ink color of a presented word when asked only to focus on the name of the word. The Stroop test measures selective attention, reading and color naming, and the individual's ability to actively suppress non-essential information. In the current study, the Stroop test was applied to the patient groups and the healthy controls using the following tasks: Stroop 1, reading color names printed in black ink; Stroop 2, saying the ink color of rectangles printed in different inks; Stroop 3, reading color names printed in different inks; and Stroop 4, saying the ink color of words printed in different inks. The duration of each section was separately calculated, and the time difference between the third and fourth tasks was evaluated as the 'Stroop time difference'.

Digit span test

This test was developed to measure the learning ability of individuals [11]. The digit span learning test consists of two parts, namely 'forward digit span' and 'backward digit span' to evaluate verbal attention and working memory, respectively. During this test, the examiner reads numbers aloud at a rate of one number per second and asks the individual to repeat these immediately after him/her in the same order. First, sequences with a small number of digits are used, and as the individual succeeds, the sequences are continued by adding one more number to the digit. The number of digits in the sequence of numbers that an individual can repeat

accurately is calculated as the score of that part. The maximum score that can be obtained is 8 for the forward digit span and 7 for the backward digit span. Since this test specifically shows the function of the medial temporal area and hippocampus, individuals with disorders of these regions are expected to perform poorly in the digit span test.

The Scale for the Assessment of Positive Symptoms

SAPS was first developed by Andreasen in 1990 [12]. The reliability and validity studies of the Turkish version of the scale were undertaken by Erkoç et al. in 1991 [13]. SAPS measures the level, distribution and severity of positive symptoms in patients with schizophrenia. It consists of 34 items presented under four subscales, namely hallucinations, delusions, bizarre behavior, and positive formal thought disorder. The total score of each subscale is calculated by adding the score of each item in that subscale, and the total scale score is calculated by adding the total scores of all subscales. Each subscale item is scored from 0 to 5, and the total score of the scale also varies between 0 and 170. In the validity and reliability study of the Turkish version, Cronbach alpha was 0.75 for positive symptoms [13].

The Scale for the Assessment of Negative Symptoms

SANS was first developed by Andreasen in 1990 [12]. The reliability and validity studies of the Turkish version of the scale were conducted by Erkoç et al. in 1991 [13]. SANS measures the level, distribution and severity of negative symptoms in patients with schizophrenia. It contains 25 items under the following five subscales: flattening or blunted affect, alogy, apathy, anhedonia, and attention deficit. The total score of each subscale is calculated by adding the score of each item in that subscale, and the total scale score is calculated by adding the total scores of all subscales. Each subscale item is scored from 0 to 5, and the total scale score varies between 0 and 125. In the validity and reliability study of the Turkish version, Cronbach alpha was 0.77 for negative symptoms [13].

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) for Windows, version 17.0 was used for the statistical evaluation of our data. Arithmetic mean ± standard deviation were was to define quantitative data, and numbers (n) and percentage (%) were used to define qualitative data. Variables with quantitative data were tested with the Shapiro-Wilk normality test. Pearson's chi-square analysis was used in the evaluation of qualitative (categorical) variables, unpaired t-test was used in the statistical evaluation of quantitative variables, and one-way analysis of variance in independent groups. Pearson correlation analysis was used for the variables showing a normal distribution and Spearman correlation analysis was used for those not showing a normal distribution. A p value of <0.05 was considered statistically significant.

Results

Table 1 presents the sociodemographic characteristics of the patient and control groups and the descriptive statistics on the age of disease onset and duration of disease in the patient groups. When the disease duration was compared, there was a statistically significant difference between the patient groups. The mean duration of disease was 168±107 months in the outpatient group, 103.94±86.3 months in the group receiving ECT + antipsychotic treatment, and 94.5±72.4 months in the hospitalized group receiving only pharmacological treatment (p=0.001).

Table 1. Comparison of data on the sociodemographic characteristics of the schizophrenia and control groups

		Inpatients receiving ECT + drug treatment (n=32) Mean±SD	Inpatients receiving drug treatment alone (n=32) Mean±SD	Outpatients receiving drug treatment (n=39) Mean±SD	Control group (n=42) Mean±SD	p
Age, years		32.8±7.7	31.8±8.8	35.4±11.3	38.7±9.6	0.01
Age of onset, years		24.06±6.5	23.9±7.3	24.9±6.6	-	0.780
Disease duration (months)		103.94±86.3	94.5±72.4	168±107	-	0.001
Number of episodes		5.19±3.35	3.78±2.22	5.64±4.03	-	0.095
Gender (F/M)		8/24	13/19	7/35	14/25	0.095
Education level n (%)	**Primary school**	6 (18.8%)	5 (15.6%)	7%17.9	12 (28.6%)	0.102
	Middle school	7 (21.8%)	7 (21.9%)	15 (38.5%)	4 (9.5%)	
	High school	14 (43.8%)	17 (53.1%)	11 (28.2%)	16 (38.1%)	
	University	5 (15.6%)	3 (9.4%)	6 (15.4%)	10 (23.8%)	
Family history of psychotic disorder	**Present**	46.9%	53.1%	69.0%	0	0.134
	Absen	53.1%	46.9%	31.0%	0	
Smoking (+/-)		21/11	16/26	31/11		

Statistically significant at p<005. Results of the Shapiro-Wilk normality test, Pearson's chi-square analysis, unpaired t-test, and one-way analysis of variance in independent groups are given.
ECT, electroconvulsive therapy; SD, standard deviation

The data regarding the comparison of the Stroop test results of the patient and control groups are given in Table 2. There was a significant difference between the groups in the Stroop 4 and Stroop time difference values (p=0.017 and p=0.007, respectively). The Stroop 4 and Stroop time difference values were the highest in the group receiving ECT + antipsychotic treatment (118.96±50.00 and 79.71±46.37, respectively while the lowest values were observed in the healthy control group (93.76±21.95 and 55.00±18.99, respectively).

The comparison of the Stroop and digit span tasks before and after treatment in schizophrenic patients receiving ECT + antipsychotic treatment was performed with the paired t-test. After treatment, Stroop 3 was found to be long enough to create a statistically significant difference compared to the pre-treatment values (p=0.048). The number of spontaneous corrections was found to be lower after treatment compared to the baseline values (p=0.013) (Table 3).

The SANS and SAPS scores were statistically significantly lower after treatment compared to before treatment ($p < 0.001$ for both).

The paired t-test was used to compare the Stroop and digit span test scores before and after treatment in schizophrenic patients who only received antipsychotic treatment and were followed up as inpatients. Compared to pre-treatment, the post-treatment results of Stroop 2, Stroop 4, Stroop time difference and number of spontaneous corrections were low enough to create a statistically significant difference (p=0.040, p=0.006, p=0.001, and p=0.013, respectively) (Table 3).

After treatment, the SANS and SAPS scores were found to be statistically significantly lower compared to the pre-treatment values (p<0.001 and p<0.001) (Table 4).

Tables 5 and 6 show the Pearson correlation analysis results of normally distributed data and the Spearman correlation analysis results of data without a normal distribution. There was a positive correlation between the pre-treatment SANS values and the Stroop 4 and Stroop time difference scores of the patients who received ECT + antipsychotic treatment (r=0.385, p=0.030 and r=0.424, p=0.016, respectively). In the same group, a significantly positive correlation was observed between the post-treatment SANS scores and the Stroop 4 value, number of errors, and number spontaneous corrections (r=0.358, p=0.044; r=0.0381, p=0.032, and r=0.448, p=0.010, respectively). In the group that received antipsychotic treatment alone, there was a negative significant correlation between the pre-treatment SANS score and the backward digit span value (r=-0.362, p=0.042). In the same group, a significant negative correlation was detected between the post-treatment SANS score and only the forward digit span value (r=-0.351, p=0.049).

In the ECT + antipsychotic treatment group, there was a positive correlation between the pre-treatment SAPS scores and the values of Stroop 4, Stroop time difference, and number of spontaneous corrections (r=0.420, p=0.017; r=0.416, p=0.018; and r=0.361, p=0.042, respectively). In the same group, a significant positive correlation was found between the post-treatment SAPS score and the forward digit span value (r=0.352, p=0.048). In the group that received drug therapy alone, the post-treatment SAPS score had a positive correlation with the number of spontaneous corrections (r=0.368, p=0.038) and a significant negative correlation with the forward and backward digit span values (r=-0.463, p=0.008 and r=-0.476, p=0.006, respectively).

Table 6 presents the comparison of the median values of the Stroop test, digit span test, SANS, and SAPS between the hospitalized schizophrenia groups. The median post-treatment values of Stroop 2, Stroop 3, Stroop 4, and Stroop time difference were statistically significantly higher in the ECT + antipsychotic treatment group compared to the group that received antipsychotic treatment alone (p=0.0001, 0.018, 0.001, and 0.012, respectively).

Table 2. Comparison of the sociodemographic data between the schizophrenia and control groups

	Inpatients receiving ECT + drug treatment (n=32) Mean±SD	Inpatients receiving drug treatment alone (n=32) Mean±SD	Outpatients receiving drug treatment (n=39) Mean±SD	Control group (n=42) Mean±SD	p
Stroop 1	38.37±13.3	34.25±9.98	36.79±10.58	34.40±8.61	0.310
Stroop 2	56.53±15.3	48.59±11.98	51.92±18.07	49.88±14.27	0.164
Stroop 3	39.25±12.3	25.59±9.61	39.28±8.98	38.23±13.91	0.522
Stroop 4	118.9±50.0	101.62±30.8	100.21±28.5	93.76±21.95	0.017
Stroop time difference	79.71±46.3	66.03±25.31	63.16±22.78	55.00±18.99	0.007
Number of spontaneous corrections	3.41±2.698	3.75±2.929	2.13±1.657	3.05±3.162	0.062
Number of errors	1.84±1.917	2.03±2.584	1.10±1.314	2.43±4.597	0.428
Forward digit span	5.16±1.394	5.41±0.837	5.38±1.407	5.55±916	0.482
Backward digit span	4.09±1.802	3.66±0.701	3.79±0.645	4.08±0.984	0.161

Statistically significant at p<005. Results of the unpaired t-test and one-way analysis of variance in independent groups are given.
ECT, electroconvulsive therapy; SD, standard deviation

Table 3. Comparison of the pre-treatment and post-treatment SANS, SAPS, Stroop and digit span results between the inpatient schizophrenia groups

		ECT + drug treatment		Drug treatment alone	
		Mean ± SD	p value	Mean ± SD	p value
Stroop 1	**Pre-treatment**	38.37±13.33	0.360	34.25±9.98	0.106
	Post-treatment	36.71±10.17		32.40±7.21	
Stroop 2	**Pre-treatment**	56.53±15.37	0. 675	48.59±11.98	0.040
	Post-treatment	57.53±17.03		45.75±9.84	
Stroop 3	**Pre-treatment**	39.25±12.32	0. 048	35.59±9.61	0.454
	Post-treatment	43.25±12.33		36.62±9.42	
Stroop 4	**Pre-treatment**	118.96±50.00	0. 755	101.62±30.85	0.006
	Post-treatment	121.46±45.27		88.12±23.27	
Stroop time difference	**Pre-treatment**	79.71±46.37	0. 743	66.03±25.31	0.001
	Post-treatment	76.96±45.15		51.81±19.78	
Number of spontaneous corrections	**Pre-treatment**	3.41±2.698	0.013	3.75±2.929	0.013
	Post-treatment	2.72±2.275		2.47±2.110	
Number of errors	**Pre-treatment**	1.84±1.917	0.058	2.03±2.584	0.058
	Post-treatment	2.63±5.874		1.06±1.343	
Forward digit span	**Pre-treatment**	5.16±1.394	0.054	5.41±0.837	0.054
	Post-treatment	5.34±1.516		5.72±0.772	
Backward digit span	**Pre-treatment**	4.09±1.802	0.197	3.66±0.701	0.197
	Post-treatment	4.09±1.304		3.81±0.859	

Statistically significant at p < 005. Results of the unpaired t-test and one-way analysis of variance in independent groups are given.
ECT, electroconvulsive therapy; SD, standard deviation

Table 4. Correlation of the SANS score and Stroop test parameters before and after treatment according to the treatment method used

	SANS	
	r	p
ECT + drug treatment, pre-treatment		
Stroop 4	0.385	**0.0030**
Stroop time difference	0.424	**0.016**
ECT + drug treatment, post-treatment		
Stroop 4	0.358	**0.044**
Number of spontaneous corrections	0.448	**0.010**
Number of errors	0.0381	**0.032**
Drug treatment alone, pre-treatment		
Backward digit span	0.362	0.42
Drug treatment alone, post-treatment		
Forward digit span	-0.351	**0.049**

Statistically significant at p < 005. Results of Pearson's and Spearman's correlation tests are given
ECT, electroconvulsive therapy; SANS, the Scale for the Assessment of Negative Symptoms

Table 5. Correlation of the SAPS score and Stroop test parameters before and after treatment according to the treatment method used

	SANS	
	r	p
ECT + drug treatment, pre-treatment		
Stroop 4	0.420	**0.017**
Stroop time difference	0.416	**0.018**
Number of spontaneous corrections	0.361	**0.042**
ECT + drug treatment, post-treatment		
Forward digit span	0.352	**0.048**
Drug treatment alone, post-treatment		
Number of spontaneous corrections	0.368	**0.038**
Forward digit span	-0.463	**0.008**
Backward digit span	-0.476	**0.006**

Statistically significant at p < 005. Results of Pearson's and Spearman's correlation tests are given.
ECT, electroconvulsive therapy; SAPS, the Scale for the Assessment of Positive Symptoms

Table 6. Comparison of the median values obtained from the Stroop test, digit span test, SANS and SAPS between the inpatient schizophrenia groups

	ECT + drug treatment	Drug treatment alone	p value
	Median (min-max)	Median (min-max)	
Stroop 1	34 (23-62)	32 (21-50)	0.122
Stroop 2	54 (33-126)	45 (32-78)	**0.0001**
Stroop 3	42 (29-80)	34.5 (25-59)	**0.018**
Stroop 4	108 (50-251)	83 (60-143)	**0.001**
Stroop time difference	65.5 (10-209)	46 (16-109)	**0.012**
Number of errors	0 (0-26)	1 (0-5)	0.977
Number of spontaneous corrections	3 (0-9)	2 (0-8)	0.688
Forward digit span	6 (2-9)	6 (4-7)	0.310
Backward digit span	4 (1-9)	4 (2-6)	0.298
Backward digit span	9.5 (3-18)	9.5 (6-12)	0.94
SANS score	46 (5-92)	48.5 (8-75)	0.633
SAPS score	24 (0-92)	36 (8-81)	0.108

Results of the unpaired t-test and one-way analysis of variance in independent groups are given.
ECT, electroconvulsive therapy; SANS, the Scale for the Assessment of Negative Symptoms; SAPS, the Scale for the Assessment of Positive Symptoms

Discussion

One of the main results of this study is that the patients diagnosed with schizophrenia had deterioration in attention-related cognitive functions evaluated with the Stroop and digit span tests compared to the healthy controls, and there was an improvement in hospitalized patient groups in the attention-related cognitive functions after treatment. In addition, in the group that received ECT + antipsychotic treatment, the severity of the disease was associated with patient performance in the Stroop tasks, while it was related to the digit span test performance in the group that only received antipsychotic treatment. Currently, there are many scientific studies showing that cognitive functions are impaired in schizophrenia [3, 14]. In our study, the Stroop test values were worse among the inpatients with schizophrenia than in the healthy controls, which supports previous studies. Alptekin et al. showed that patients with schizophrenia performed lower in the backward digit span test than healthy controls, and also exhibited poorer

performance in working memory, as well as complex attention [15]. In the same study, it was reported that the perceived quality of life in patients with schizophrenia was affected by cognitive impairment, but this was not related to disease severity or drug side effects. Similarly, we determined that the schizophrenic patients had lower performance in the digit span test compared to the healthy control group, but there was no statistically significant difference. This can be explained by the shorter duration of the disease in the schizophrenic patient group in our study compared to the previous research. Although there are studies showing that cognitive dysfunction in schizophrenic patients regresses with regular antipsychotic treatment [16,17], there are also those suggesting that there is no significant change over time [18,19]. In the current study, when the cognitive functions of patients receiving antipsychotic treatment were compared before and after treatment, a significant improvement was observed in cognitive functions after treatment.

The main objective of the current study was to observe the effect of ECT applied in addition to drug treatment on the attention-related cognitive functions of schizophrenic patients. Based on the available data, it has not been yet clearly shown whether ECT causes cognitive impairment in patients with schizophrenia or in those with depression [20]. In a study published by Viswanath et al. in 2013, bilateral ECT was performed in 30 patients with bipolar mania, schizophrenia, unipolar depression, and bipolar depression, and the cognitive functions of the patients were measured after the first, third and sixth ECT sessions. As a result, it was reported that in schizophrenic patients, unlike the other patient groups, there was a gradual statistically significant improvement in the digit span test as ECT sessions progressed [21]. This difference in the effect of ECT between schizophrenia and other diseases can be explained by the cognitive functions having already been deteriorated among the patients with schizophrenia before treatment. According to the results of our study, when the cognitive functions of the schizophrenic patient group that received ECT + antipsychotic treatment were compared before and after treatment, there was a significant decrease in the number of spontaneous corrections in the Stroop test. In another study conducted by Rami et al. in 2008 with patients with depression, bipolar disorder, schizophrenia, and schizoaffective disorder, after a standard bilateral frontotemporal ECT application, there was a significant difference in total learning, digit span, verbal fluency in the patient group (n=12) compared to the pre-treatment values [22]. The data of that study can be considered to present similar implications to our research. However, in our study, a significant improvement was found in the number of spontaneous corrections in the Stroop test, suggesting that ECT does not cause any deterioration in the attention functions of patients with schizophrenia; rather, they can contribute to improvement. Although we did not observe any significant change in the Stroop test duration (except for Stroop 3) after ECT, there was a significant decrease in the number of spontaneous corrections. In other words, the patients took similar time to complete the Stroop 4 task when the pre-treatment and post-treatment values were compared, but they achieved less spontaneous corrections after ECT. Considering the limited data on this subject, we think that our study will contribute to a better understanding of the cognitive effects of ECT on patients with schizophrenia.

When we evaluated the relationship between disease severity and cognitive test results before and after treatment in the group that received ECT + antipsychotic treatment, we determined that the relationship between negative symptoms and cognitive functions, which was especially evaluated based on the patients' performance in the Stroop test, continued after ECT. Many studies have explored the relationship between positive and negative symptoms and cognitive functions in patients with schizophrenia. The general view is that positive psychotic symptoms are not associated with cognitive performance [23]. However, the relationship between negative symptoms and cognitive performance has not yet been clearly demonstrated [24]. While some publications reported a positive relationship between cognitive functions and negative symptoms [25,26], others do not confirm this finding [27, 28]. The results of our study support the presence of a positive relationship between cognitive functions and negative symptoms in schizophrenic patients. In another study, Liddle and Baxter reported a relationship between the severity of schizophrenia and cognitive functions [29], which is consistent with the results of our study. In a follow-up study conducted by Hoff et al., a relationship was observed between improvement in positive symptoms and improvement in cognitive functions in schizophrenic patients; however, the authors noted that there was no relationship between negative symptoms and cognitive functions [30]. Meta-analysis studies, on the other hand, generally refer to the presence of a relationship ranging from mild to moderate between negative symptoms and cognitive performance [23]. According to our research, deterioration in attention function was associated with both positive and negative symptoms but this was stronger for the latter. In a study conducted in 2012, Phutane et al. detected a stronger correlation between the number of ECT sessions and its cognitive side effects than between the number of ECT sessions and clinical symptoms [31]. In our patient group, there was also a significant improvement in negative symptoms after ECT. This can explain the improvement in the attention functions of our patients after ECT. In addition, we determined that negative symptoms were associated with the post-treatment attention functions of the patients, especially their performance in the Stroop tasks.

In many studies in the literature, the measurement of cognitive functions was performed after the first ECT session. In contrast, we made the first measurement before the ECT sessions started, which is a strong aspect of our study. However, since the schizophrenic group included in our study received pharmacological treatment, we were not able to exclude the effects of antipsychotic treatment on cognitive functions. This can be considered as a limitation of our research. Considering that the disease itself has negative effects on cognition, the fact that we did not evaluate according to the year of the disease is another limitation of ours. Another limitation of our study is that we only examined the cognitive symptoms associated with attention and only the cognitive side effects of ECT. Another limitation of our study is that we did not differentiate between typical and atypical antipsychotic treatments. Furthermore, neuropsychological tests used to evaluate the attention functions of our patients (the Stroop and digit span tests) have certain limitations in evaluating all these functions. In addition, our exclusion of patients who did not complete neuropsychological tests should also be taken into account when evaluating the results of our study. Our primary aim in this study was to compare the pre-treatment and post-treatment attention

functions of hospitalized schizophrenic patients receiving ECT and antipsychotic therapy and schizophrenic outpatients receiving only antipsychotic therapy. It has been concluded that in patients with schizophrenia, with the improvement of psychotic symptoms with treatment, functional network patterns in the brain can switch from the disease state to a healthy state, and lower functional network capacity before treatment predicts better treatment response. Moreover, it has been reported that this change was associated with symptom improvement only in the ECT group, but not in the group receiving only medical treatment [32]. As a result of the study, we determined that the patients with severe schizophrenia who were on drug treatment and required ECT had impaired performance in the Stroop and digit span tests and showed improvements in these tests after both antipsychotic treatment and ECT. It was observed that impaired attention was associated with the severity of the disease, mostly with negative symptoms. When the effects of ECT were examined, it was seen that it made some positive contributions, especially to the patients' performance in attention tests. Studies examining the short- and long-term cognitive side effects of ECT showed only transient cognitive deficits after ECT with no permanent change [33,34]. In our study, we evaluated attention-related cognitive functions one day after ECT application. In future studies, it would be appropriate to examine the long-term effects of ECT on attention-related cognitive functions.

Conclusion

Our results showed that ECT added to antipsychotic drug treatment had positive rather than negative effects on attention functions, although not as much as drug treatment. However, it should be taken into account that the group that received ECT in addition to antipsychotic treatment consisted of more severe cases. Future studies that apply tests measuring more cognitive functions in a larger sample including patients that do not take regular medication can further elucidate the effects of ECT. Considering that improvement in positive and negative symptoms will not only positively affect cognitive functions in schizophrenic patients but also increase the functionality of these patients, their participation in social life, and their quality of life, schizophrenia treatment should be planned accordingly. In future studies, it is recommended to examine the causality and long-term effects of ECT on attention-related cognitive functions.

Conflict of interests

The authors declare that they have no competing interests.

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Ethical approval

Ethics committee approval was received from Malatya Clinical Research Ethics Committee with the protocol number 2014/128 and date 21.01.2015.

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