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Clinical effect of modified electroconvulsive therapy on schizophrenia

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Summary. Objective. To investigate the clinical efficacy of modified electroconvulsive therapy (MECT) in patients with schizophrenia and provide a reference for the selection of safe and effective treatment options in clinical practice. **Methods.** A total of 200 patients with schizophrenia, who were admitted to Wuhan Wudong Hospital Psychiatric Hospital from January 2019 to December 2020, were selected as the study subjects. They were divided into an observation group and a control group (100 cases in each group) according to a random number table. The control group was treated with conventional antipsychotics (risperidone and aripiprazole), and the observation group was given conventional antipsychotics (risperidone and aripiprazole) with MECT. After 8 weeks, the clinical efficacy, cognitive and memory functions and the occurrence of adverse reactions between the two groups were compared. **Results.** The total clinical effective rate of the observation group was 90%, which was higher than that of the control group (74%), and the difference was statistically significant (p<0.05). The Wisconsin Card Sorting Test results of the observation group were better than those of the control group, and the cognitive function of the observation group was better than that of the control group (p<0.05). The Wechsler Adult Intelligence Scale-Fourth Edition index of the observation group was higher than that of the control group, and the memory function of the observation group was better than that of the control group (p<0.05). The overall incidence of adverse reactions in the observation group was lower than that in the control group, and the difference was statistically significant (p=0.001). **Conclusion.** The application of MECT in patients with schizophrenia can produce a good clinical curative effect, which is beneficial to the improvement and promotion of memory and cognitive functions in patients. Since the occurrence of adverse reactions is controllable, and safety is ideal, MECT has value in clinical application.

Key words. MECT, modified electroconvulsive therapy, schizophrenia.

Effetto clinico della terapia elettroconvulsivante modificata sulla schizofrenia.

Riassunto. Scopo. Indagare l'efficacia clinica della terapia elettroconvulsivante modificata (MECT) nei pazienti con schizofrenia e fornire un riferimento per la selezione di opzioni terapeutiche sicure ed efficaci nella pratica clinica. **Metodi.** Un totale di 200 pazienti con schizofrenia, ricoverati nel reparto psichiatrico dell'Ospedale Wuhan Wudong da gennaio 2019 a dicembre 2020, sono stati selezionati come soggetti dello studio. Sono stati divisi in un gruppo di osservazione e un gruppo di controllo (100 casi in ciascun gruppo) secondo una tabella di numeri casuali. Il gruppo di controllo è stato trattato con antipsicotici convenzionali (risperidone e aripiprazolo) e al gruppo di osservazione sono stati somministrati antipsicotici convenzionali (risperidone e aripiprazolo) con MECT. Dopo 8 settimane, sono stati confrontati l'efficacia clinica, le funzioni cognitive e di memoria e il verificarsi di reazioni avverse tra i due gruppi. **Risultati.** Il tasso di efficacia clinica totale del gruppo di osservazione era del 90%, superiore a quello del gruppo di controllo (74%) e la differenza era statisticamente significativa (p<0,05). I risultati del Wisconsin Card Sorting Test del gruppo di osservazione erano migliori di quelli del gruppo di controllo e la funzione cognitiva del gruppo di osservazione era migliore di quella del gruppo di controllo (p<0,05). L'indice Wechsler Adult Intelligence Scale-Fourth Edition del gruppo di osservazione era superiore a quello del gruppo di controllo e la funzione di memoria del gruppo di osservazione era migliore di quella del gruppo di controllo (p<0,05). L'incidenza complessiva delle reazioni avverse nel gruppo di osservazione era inferiore a quella del gruppo di controllo e la differenza era statisticamente significativa (p=0,001). **Conclusione.** L'applicazione di MECT in pazienti con schizofrenia può produrre un buon effetto curativo clinico, che è benefico per il miglioramento e la promozione della memoria e delle funzioni cognitive nei pazienti. Poiché l'insorgenza di reazioni avverse è controllabile e la sicurezza è ideale, MECT ha valore nell'applicazione clinica.

Parole chiave. MECT, terapia elettroconvulsivante modificata, schizofrenia.

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Introduction

Schizophrenia is a chronic disease, with clinical manifestations of uncoordinated mental activities characterized by recurrent abnormalities in thoughts, emotions and behaviours[1]. The pathogenesis of schizophrenia has not been clarified, and there is no effective cure[2]. At present, antipsychotic drugs are mostly used in clinical treatment, including aripiprazole and risperidone. Although this method can control schizophrenia symptoms, the incidence of adverse reactions in patients during treatment is high, and its efficacy is unstable[3]. Therefore, it is important to actively find safe and effective ways to treat patients with schizophrenia.

Modified electroconvulsive therapy (MECT) has become a major technique for treating schizophrenia due to its safe and effective characteristics, and it can significantly improve patients' symptoms, such as stiffness and agitation. MECT is currently considered an effective treatment option for schizophrenia, especially in patients who are drug resistant, aggressive, stressed, severely depressed, or have suicidal behavior[4]. According to previous studies, MECT was also used as a supplement to antipsychotic treatment and to relieve drug refractory symptoms of schizophrenia[5]. Although MECT has been introduced into the field of psychiatry for 70 years, its mechanism of action on the brain remains unclear. Some scholars believe that it may be the discharge state of the brain after external electrical stimulation, which can alleviate the clinical symptoms of patients and achieve therapeutic effects[6]. However, MECT is also a medical procedure to induce seizures for the treatment of psychiatric disorders, and the main adverse effects are cognitive dysfunction, headache, nausea, vomiting, mild anxiety, and fever[7]. At present, the mechanism of MECT in the treatment of schizophrenia is unclear.

This study aimed to explore the effect of MECT on the memory function, cognitive function and safety of patients with schizophrenia to evaluate its clinical efficacy.

Materials and methods

Research subjects

This study was a prospective randomized controlled study. A total of 200 patients with schizophrenia, who were admitted to Wuhan Wudong Hospital Psychiatric Hospital from January 2019 to December 2020, were selected as study subjects.

The inclusion criteria were: 1) patients met the ICD-10 diagnostic criteria for schizophrenia, 2) with no contraindications to treatment and 3) participated voluntarily in this study. The exclusion criteria were: 1) patients with severe mental retardation, 2) patients with severe physical diseases and 3) patients with a history of drug and alcohol abuse.

Patients with schizophrenia who met the inclusion criteria were randomly divided into an observation group and a control group, with 100 cases in each group using a random number table (version 3)[8]. All patients and their families agreed and signed an informed consent form for MECT anaesthesia and treatment. This study was reviewed and approved by the Medical Ethics Committee of Wuhan Wudong Hospital Psychiatric Hospital.

Treatment method

The patients in the control group were orally administered conventional antipsychotic drugs: risperidone (1 mg/tablet; Xi'an Yangseng Pharmaceutical Co., Ltd., H20010309, production batch number: JIJOC8G) and aripiprazole (5 mg/tablet; Chengdu Kanghong Pharmaceutical Group Co., Ltd., H20060521, production batch number: OK009). The dosage was 2-6 mg/day for risperidone and 10-30 mg/day for aripiprazole from the third week until the end of the study. The drug dosage was adjusted according to the severity of each patient's condition and remained within the above range. The drugs were administered continually for 8 weeks.

The patients in the observation group were given conventional antipsychotics (risperidone and aripiprazole, 2-6 mg/day for risperidone and 10-30 mg/day for aripiprazole from the third week until the end of the study) and MECT. Before treatment, food and water were withheld from the patients for 6 h. During the treatment, the physiological parameters and vital signs of the patients were monitored closely. When the heart rate was lower than 80 beats/min, 0.3-mg/kg atropine, 2-mg/kg propofol and 1-mg/kg succinylcholine were injected intravenously. Short-term electrotherapy was performed in the prefrontal lobe after the patient's muscle relaxation and bond reflex disappeared (Xingmaitong Therapeutic Apparatus, US Somex Co., Ltd., National Machinery Injection 20193092400, model: Thymatron System IV). The size of the electric current was set according to each patient's physical condition and age, with resistance <1,000 Ω and electricity= 4-5 sec. After the shock, an intravenous infusion of a glucose solution (concentration: 25%) was given while a valve balloon was used to supply oxygen under pressure. When the patient regained consciousness, treatment was stopped immediately. The frequency of MECT was adjusted according to individualised schemes (i.e., according to the patient's condition improvement and tolerance, generally, MECT was given 8~12 times in total).

Usually, after the end of the first treatment, MECT was performed three times per week for the first 2 weeks, with a gradual reduction in frequency from the third week to once per week. Treatment was given continually for a total of 8 weeks[9].

Observation indexes and evaluation criteria

- *Clinical efficacy*: after 8 weeks of treatment, a positive and negative symptom scale (PANSS) was used as the evaluation standard, and the efficacy was evaluated by the reduction rate. The PANSS was divided into a positive scale, a negative scale and a general psychopathology scale. It included a total of 30 items in seven grades: 'none', 'very light', 'mild', 'moderate', 'heavy', 'severe' and 'very severe', with a total score of 30~210 points. Reduction rate= (score of pre-treatment anxiety and depression – score of post-treatment anxiety and depression)/(score of pre-treatment anxiety and depression) × 100%. A score reduction rate of >75% was deemed markedly effective, a 50%-75% reduction rate was effective, and a score reduction rate of <50% was invalid. The total effective rate= (markedly effective + effective)/the total number of cases × 100%.
- *Memory function*: the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) was used to evaluate the memory ability and working memory of the patients in detail[10]. The WAIS-IV included five basic subscales (logical memory, word pairing, graphic reset, visual reproduction and spatial superposition). The basic scale scores were converted into five indexes: auditory memory index, visual memory index, visual working memory index, immediate memory index and delayed memory index. The full-scale memory quotient (FsMQ) comprised nine subscales. The higher the score, the better the memory function.
- *Cognitive function*: the Wisconsin Card Sorting Test (WCST) was used to evaluate the changes in cognitive function in the two groups of patients, and the test was completed on a computer. The WCST indicators were recorded as 'complete classification', 'error response', 'correct response' and 'persistent response'.
- Incidence of adverse reactions: the incidence of adverse reactions during treatment in the two groups was observed and recorded, including weight gain, drowsiness, salivation and constipation.

Power analysis

Post hoc power analysis was performed using G-Power 3.1 software[11] to detect the reliability of the results. The analysis used the Z test in a post hoc setting and found that with an α level of 0.05 and the group sample sizes being 100 per group, respectively, the critical z was 1.58 and the power (1-α error probability) was 0.80. This suggested this study included sufficient patients to detect a true difference in the groups examined if one had actually existed. This supported the statistical accuracy of the analysis and effectively ruled out type one error.

Statistical methods

The SPSS 25.0 software package was used for data processing. All variables were tested for normal distribution. Measurement data in line with a normal distribution were expressed as mean ± standard deviation. A paired *t* test was used for comparisons before and after treatment, and an independent-samples *t* test was used for comparisons between the two groups. Count data were expressed as *n* (%) and were compared between groups by a Chi-squared test or the exact probability method. A value of $p<0.05$ indicated that the difference was statistically significant.

Results

Baseline characteristics of research subjects

In the observation group, there were 42 males and 58 females; the course of disease from the first onset was 2-9 months, with an average of (5.43 ± 1.33) months. The patients were aged between 21 and 65 years, with an average age of (39.12 ± 12.60) years. The PANSS score before treatment was (89.05 ± 11.32). In the control group, there were 54 males and 47 females; the course of disease from the first onset was 3-9 months, with an average of (5.49 ± 1.34) months. The patients were aged between 22 and 67 years, with an average age of (38.46 ± 8.32) years. The PANSS score before treatment was (90.34 ± 10.67). There was no significant difference in gender, age, course of disease and PANSS score before treatment between the two groups ($p>0.05$), indicating comparability (table 1).

Comparison of clinical efficacy between the two groups

After 8 weeks of treatment, the total clinical effective rate of the observation group was 90%, which was higher than that of the control group (74%), and the difference was statistically significant ($p<0.05$). Among the groups, the clinical effective rate and the effective rate of the observation group were significantly higher than those of the control group (table 2).

Table 1. General information of two groups of patients.

Variable	Observation group n=100	Control group n=100	t/χ^2	P value
Gender			2.426	0.119
Male	42 (42.0)	53 (53.0)		
Female	58 (58.0)	47 (47.0)		
Age			3.534	0.372
$\chi \pm s$	39.12 ± 12.60	38.46 ± 8.32		
Min, Max	21, 65	22, 67		
Course			2.452	0.435
$\chi \pm s$	5.43 ± 1.33	5.49 ± 1.34		
Min, Max	2, 9	3,9		
PANSS score	89.05 ± 11.32	90.34 ± 10.67	1.265	0.643

Legend: PANSS = Positive and Negative Symptom Scale.

Table 2. Comparison of clinical efficacy between the two groups.

Group	Effectual	Effective	Invalid	Total effective rates
Observation group (*n*=100)	30 (30.0)	60 (60.0)	10 (10.0)	90 (90.0)
Control group (*n*=100)	23 (23.0)	51 (51.0)	26 (26.0)	74 (74.0)
χ^2				8.765
P value				0.012

Comparison of cognitive function changes between the two groups before and after treatment

Before treatment, there was no significant difference in WCST indicators between the two groups (p>0.05). After treatment, the number of WCST complete classifications and correct responses in the observation group increased, with a higher number than that of the control group, and the difference between the numbers was statistically significant (p<0.05). The number of WCST error responses and persistent errors in the observation group was lower than that before treatment, and the number of these two indicators was lower than that of the control group, with a statistically significant difference (p<0.05) (table 3).

Table 3. Comparison of WCST indexes between two groups before and after treatment.

Time	Group	Completed classification number	Number of error responses	Number of correct responses	Number of persistent errors
Before treatment	Observation group (***n*=100**)	2.24 ± 1.34	52.53 ± 3.64	53.25 ± 4.65	14.86 ± 2.65
	Control group (***n*=100**)	3.12 ± 0.56	51.23 ± 4.82	54.32 ± 4.27	15.12 ± 2.23
	t	0.345	2.436	2.632	1.564
	P	0.124	0.352	0.145	0.742
After treatment	Observation group (***n*=100**)	5.43 ± 2.36	38.64 ± 3.56	64.35 ± 2.12	8.64 ± 0.43
	Control group (***n*=100**)	4.56 ± 1.64	41.74 ± 4.15	58.67 ± 3.35	10.43 ± 1.06
	t	1.874	3.872	2.024	1.462
	P	<0.001	<0.001	<0.001	<0.001

Comparison of memory function between the two groups before and after treatment

Before treatment, there was no significant difference in WAIS-IV indexes between the two groups (p>0.05), and there was no significant difference in FsMQ. After treatment, the memory indexes of the two groups increased. The FsMQ of the observation group was higher than that of the control group, and the difference was statistically significant (p<0.05). The auditory memory, visual memory, immediate memory and delayed memory indexes were significantly higher in the observation group than in the control group (table 4).

Comparison of incidence of adverse reactions between the two groups

The overall incidence of adverse reactions in the observation group was lower than that in the control group (18% vs 36%), and the difference was statistically significant (p<0.05). Among them, the incidences of weight gain, sleepiness, salivation, constipation, and nausea and vomiting were lower than those in the control group (table 5).

Discussion

This study found that the total clinical effective rate of the observation group was higher than that of the control group. The cognitive function and the memory function of the observation group were better than those of the control group. The overall incidence of adverse reactions in the observation group was lower than that in the control group.

Because of the insidious early symptoms in patients with schizophrenia, abnormal mental activity after onset prevents adaption to the normal living environment; this greatly affects the daily autonomous life of patients, resulting in a severe reduction in patients' quality of life and a burden on families and society[12]. At present, traditional antipsychotic drugs are mainly used in clinical treatment, but there is no uniform standard for safe and effective drug doses; it easily causes a series of adverse reactions in patients, leading to reduced treatment compliance, reduced safety and poor efficacy[13]. Therefore, many attempts have been made in the treatment of patients with schizophrenia in the previous studies, for example, the application of atypical drugs (e.g. ziprasidone and

Table 4. WAIS-IV indexes of two groups before and after treatment.

Time	Group	Auditory memory	Visual memory	Immediate memory	Delayed memory	Total memory
Before treatment	Observation group (***n*=100**)	70.56 ± 2.34	76.32 ± 1.25	80.04 ± 3.13	67.42 ± 3.78	90.43 ± 1.42
	Control group (***n*=100**)	71.43 ± 2.53	77.14 ± 2.09	79.45 ± 3.64	65.23 ± 4.01	90.02 ± 2.56
	t	3.543	4.642	3.145	4.103	2.043
	P	0.564	0.098	0.775	0.465	0.148
After treatment	Observation group (***n*=100**)	78.43 ± 1.52	82.54 ± 1.01	85.64 ± 2.01	72.76 ± 1.54	100.52 ± 0.89
	Control group (***n*=100**)	76.04 ± 1.43	80.76 ± 1.23	82.87 ± 2.24	70.69 ± 1.58	98.45 ± 1.02
	t	0.434	1.057	2.045	0.652	0.723
	P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Table 5. Comparison of incidence of adverse reactions between the two groups.

Group	Weight gain	Lethargy	Salivation	Constipation	Nausea and vomiting	Total occurrence
Observation group (***n*=100**)	4 (22.2)	5 (27.8)	3 (16.7)	2 (11.1)	4 (22.2)	18 (18.0)
Control group (***n*=100**)	7 (19.4)	9 (25.0)	5 (13.9)	6 (16.7)	9 (25.0)	36 (36.0)
t						0.432
P value						0.001

olanzapine) to inhibit and regulate neurotransmitters (e.g. serotonin) in patients; however, the overall efficacy is poor, and long-term medication leads to increased drug resistance in patients[14,15]. Another study investigated the efficacy of etomidate combined with propofol, with the results showing that its efficacy is not exact, and the incidence of adverse reactions in patients is high[16].

In recent years, MECT has been applied gradually in clinical practice and is considered to be a rapid, safe and effective treatment for schizophrenia[17]. It is a physical therapy method involving electrospasms, which stimulate the central nervous system of patients via transient quantitative pulsed currents and change patients' neurophysiological systems, resulting in generalised discharges in the cerebral cortex. This is used to improve neuronal sensitivity and induce corresponding responses and changes in specific cells, ultimately achieving the purpose of improving schizophrenia symptoms and enhancing clinical efficacy[18,19]. A retrospective review of 19 patients with refractory schizophrenia and schizoaffective disorder who received ECT maintenance therapy suggested that ECT maintenance therapy in combination with pharmacotherapy may be an effective alternative compared with pharmacotherapy alone[20]. Our results were consistent with the above results. MECT plus risperidone maintenance is superior to risperidone monotherapy in clinical effect of patients with schizophrenia, and the overall response rate was as high as 90%, which was similar to that (93.02%) reported by Cui[21].

After treatment, the cognitive and memory functions of the observation group were improved to a certain extent, and the functional levels of the two groups were significantly higher than those of the control group. These results suggest that MECT is more beneficial to the improvement of brain function than conventional antipsychotic treatment, which is similar to the findings of Li et al.[22]. Treatment with MECT exerts therapeutic effects by stimulating the patient's brain with microcurrents to produce relevant repair factors or by the self-healing of brain neural cells, but such microcurrent stimulation does not negatively affect the patient's brain function.

The incidence of adverse reactions in this study was higher than that reported in other studies[2,21]. The overall incidence of adverse reactions in the observation group (18%) was lower than that in the control group (36%), and the incidences of weight gain, drowsiness, salivation, constipation, and nausea and vomiting were lower than those in the control group, possibly due to the following reasons: 1) the mean age of the study subjects was around 40 years, and the course of the disease was long; 2) the presence of underlying diseases resulted in more adverse reactions, but generally, they were within the controllable range and had little effect on overall efficacy.

Limitations

The present study also has some limitations. First, the patients with schizophrenia included in this study were not selected according to a specific disease classification, and there is some subjectivity regarding the selection of patients with schizophrenia. This study cannot completely rule out the effect of concomitant medication during the MECT procedure. And the neuropsychological assessment of the patients was not assessed, we could not determine the association between cognitive changes and brain changes.

Conclusions

In summary, the use of MECT in the treatment of patients with schizophrenia on the basis of conventional drug therapy can provide good clinical efficacy, which is conducive to the improvement of memory and cognitive functions in patients. The occurrence of adverse reactions is controllable, the technique is safe, and it has value in clinical application.

Ethics approval and consent to participate: this study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Wuhan Wudong Hospital (No.WX17C20). All participants signed an informed consent form for inclusion in the study.

Availability of data and materials: all data generated or analyzed during this study are included in this published article.

Competing interests: all of the authors had no any personal, financial, commercial or academic conflicts of interest separately.

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