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Original Article

Effects of modified electroconvulsive therapy on intracranial pressure in psychotic patients with schizophrenia

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Abstract: Modified electroconvulsive therapy (MECT) is an effective treatment option for schizophrenia, however, concerns on its safety and complications such as increased intracranial pressure (ICP) exists. The purpose of this study was to assess the effects of MECT on ICP in schizophrenic patients and to identify related risk factors. 112 subjects diagnosed with schizophrenia were recruited and allocated into the MECT treatment group and the case-control group without MECT treatment. Results showed that in the case control group, females had significantly higher ICP than males ($P<0.05$). In the MECT treatment group, those experiencing normal seizure had similar ICP before and after MECT treatment ($P>0.05$), suggesting that the MECT treatment did not affect ICP. The right side ICP after 8 MECT in the normal seizure group was significantly higher than the health control group ($P<0.05$). The left side ICP after the first MECT in the prolonged seizure group was significantly higher than the health control group ($P<0.05$). The left side ICP and the average ICP in the prolonged seizure group after the first MECT, fourth and eighth MECT were significantly higher before the treatment ($P<0.05$). The incidence rate of increased intracranial pressure (ICP>200 mmH_2O) of the normal seizure group and the prolonged seizure group were 8% and 14.3%. In summary, the ICP of psychiatric patients may have gender differences. MECT may probably increase the ICP of psychiatric patients, especially the prolonged seizure patients.

Keywords: Modified electroconvulsive therapy, intracranial pressure, schizophrenia, psychotic disorders

Introduction

Intracranial pressure (ICP) is the pressure inside the skull and thus in the brain tissue and cerebrospinal fluid, and human body has various mechanisms to keep it stable within the range from 80-180 mmH_2O. ICP over 200 mmH_2O constantly is considered intracranial hypertension or raised ICP [1]. ICP is a sensitive indicator of intracranial abnormity earlier than other common vital signs and conscious state. Changes in ICP are attributed to volume changes in one or more of the constituents contained in the cranium [2].

Modified electroconvulsive therapy (MECT) is an effective physical therapy for the treatment of mental diseases, especially schizophrenia and depression [3]. Relatively anaerobic or hypoxia state during the course of treatment might result in increased ICP. So far, studies on this aspect are relatively few. The present study focused on studying the influence of MECT on ICP in patients with schizophrenia.

Materials and methods

Study subjects

This study was approved by the ethics committee of Bethune International Peace Hospital of PLA. Written informed consent was obtained from all subjects and/or their relatives before participating. A total of 180 subjects were enrolled in this study in our hospital from February 2014 to July 2014, and allocated into three groups. 71 patients (42 males and 29 females, aged 30±10 years old) who were diagnosed with schizophrenia (disease course 6.1±6.9 years), received the MECT treatment (the MECT

Table 1. Comparisons of ICP in male and female patients (mean ± SD, mmH_2O)

	Male	Female	*T*
Health control group	131.7±17.8	135.2±24.7	-0.646
Case control group	138.7±18.1	150.1±17.4	-2.116*
MECT group	123.1±42.3	141.4±47.1	-1.492

Notes: *P<0.05 for gender comparison.

group). 47 schizophrenic patients (30 males and 17 females, aged 29±9 years old, with mean disease course of 6.2±7.9 years) were allocated to the case-control group without MECT treatment. Inclusion criteria were: (1) diagnosis with schizophrenia was confirmed according to the International Statistical Classification of Diseases and Related Health Problems (ICD, version 10), (2) age from 16-60 years old, and (3) free from the contraindications of the electroconvulsive therapy. Exclusion criteria were: (1) patients with other brain diseases including cerebral trauma, encephaledema, hematencephalon, and space occupying and inflammatory lesions, (2) patients with other mental diseases, and (3) patients with severe cataract, glaucoma, optic atrophy or other severe sight impairment. Patients in these two groups had matching age, gender, similar course of disease and past history of drug treatment. Patients from the MECT treatment group was subsequently divided into the normal seizure group (50 cases, 27 males and 23 females, aged 34±10 years old) and the prolonged seizure group (21 cases, 15 males and 6 females, aged 26±9 years old) according to the duration of convulsive seizure time (details described in the next section). In addition, 62 hospital staffs without mental diseases or family history of mental disease and the above-mentioned exclusive diseases were recruited as healthy controls. No significant difference was found in gender and age among three study groups (P>0.05).

Application of MECT treatment

The modified electroconvulsive therapy (MECT) was applied by using a Somatics Type IV electroconvulsive therapeutic apparatus (Americal Somatics Corporation, San Diego, USA). The DGX mode and the bitemporal electrical stimulation method were adopted. The entire therapeutic process was conducted according to the ECT operation standard stipulated by the Chinese Society of Psychiatry and the Chinese Medical Association [4]. Before treatment, patients received anesthesia and muscle-relaxing drugs through intravenous injection, at the dose of 0.15 mg/kg body mass for etomidate fat emulsion and 1.5 mg/kg body mass for succinylcholine chloride. During the MECT treatment, patients with convulsive seizure time >120 seconds were classified as prolonged seizure [5] and included in the sub-group with prolonged seizure. Those with seizure time ≤120 seconds were considered as normal seizure group. Treatment course of MECT was 8 times, 3 times a week.

Method of ICP detection

ICP measurement was taken by using a MICP-1A non-invasive flash visual evoked potential intracranial detection analyzer (Chongqing Minxi Medical Instrument Co., Ltd, Chongqing, China). All subjects were asked to lie in a horizontal position with their eyes closed. Eye-patches were fixed to their eye sockets closely. Two electrodes were placed 2 cm away from the external occipital protuberance, one on each side. Two other electrodes were placed on the forehead and the middle geisoma, respectively. The FVEP value was measured and recorded for 3 consecutive times in 15 minutes, and the mean value was taken for analysis. For patients in the MECT group, their ICP was recorded at baseline (before receiving the treatment) and after the 1st, 4th and the final treatments. For those in the case control and the health control groups, the ICP was taken just once after recruitment.

Statistical analysis

Statistical analysis was performed by using the SPSS21.0 statistical software (IBM Company, New York, US). Data were presented as mean ± standard deviation (SD). Comparison on the IPC from different groups was examined using Student's t test, chi-square test, and variance analysis. P<0.05 was considered statistically significant.

Results

The females' average ICP was higher than that for the males in the MECT group (before MECT),

Table 2. Comparisons of ICP among different groups (mean ± SD, mmH_2O)

	Right side ICP	Left side ICP	Mean ICP
Health control group	136.1±16.8	136.2±17.4	133.8±22.2
Case control group	144.1±19.6	141.4±20.2	142.8±18.5
Normal seizure group before the first treatment	140.1±21.0	135.9±28.7	139.2±20.7
Normal seizure group after the first treatment	136.7±17.6	136.07±28.0	138.8±17.8
Normal seizure group after the fourth treatment	143.7±27.1	144.1±27.9	143.9±26.4
Normal seizure group after the eighth treatment	150.7±33.0[a]	146.8±36.3	148.4±34.4
Prolonged seizure group before the first treatment	142.5±47.0	105.1±73.8[a]	106.0±74.5[a]
Prolonged seizure group after the first treatment	138.7±25.3	154.8±41.4[a,b]	148.4±34.4[b]
Prolonged seizure group after the fourth treatment	139.5±31.1	141.8±30.5[b]	140.7±30.4[b]
Prolonged seizure group after the eighth treatment	134.9±14.8	136.4±17.0[b]	135.1±15.4[b]

Notes: [a]$P<0.05$, comparison among three groups; [b]$P<0.05$ comparison before and after MECT treatment.

the health control group and the case control group. Significant difference in ICP between the two genders was found in the case control group only ($P<0.05$, **Table 1**).

Table 2 shows that the normal seizure group's right side ICP after the eighth MECT was higher than the health control group ($P<0.05$), and the differences of normal seizure group's ICP before and after treatment had no statistical significance ($P>0.05$). The left side ICP before MECT was significantly lower in the prolonged seizure group than the other groups ($P<0.05$), and the left side ICP after first MECT was higher in the prolonged seizure group than other groups ($P<0.05$). When compared with healthy control group, the ICP before and after MECT in the normal seizure group was statistically different ($P<0.05$). The prolonged seizure group's average ICP before MECT was lower than other groups, and differences had statistical significance ($P<0.05$). The average ICP in the prolonged seizure group after first MECT was higher than that in the other groups, but the differences had no statistical significance ($P>0.05$). The prolonged seizure group's left ICP, average ICP after first MECT, the fourth ICP and the eighth ICP were higher than those before MECT treatment, and the differences had statistical significance ($P<0.05$, **Table 2**).

Comparisons of the incidence of increased intracranial pressure

The incidence rate of increased intracranial pressure after MECT in normal seizure group and prolonged seizure group was 8% (4/50) and 14.3% (3/21), respectively, and the difference was not statistically significant ($P>0.05$).

Discussion

The intracranial pressure detection technology presented in this paper has several advantages such as non-invasiveness, high security and bedside monitoring, which may facilitate its wide application in clinical practice. Flash-visual evoked potential is easy and simple to control, and is less affected by visual acuity. Smooth manipulation during examination became possible independent of patients' cooperation. It is thus very suitable for monitoring critically ill patients, especially those in a coma [6]. At present, many studies have demonstrated that flash-visual evoked potential has a good coherence with invasive intracranial pressure detection [7, 8], with a correlation index over 0.8 [9]. These findings have provided evidence for its clinical application and research.

Our study showed that before MECT, ICP was higher in females than in males in the MECT group. When the case control group and health control group were compared, significant difference was found, indicating that ICP might also be higher in females than in males, especially in psychotic patients. Studies have shown that [10], compared with males, females were more likely to have increased benign intracranial hypertension. But the underlying mechanism was still unclear. It might be related to internal secretion or metabolism in patients of different genders. Some studies also showed that, under the same condition, the oxygen pressure of brain tissue was significantly lower in females vs males [11, 12], indicating that females were more likely to have cerebral anoxia and thus resulted in increased ICP. Whether there was anything special in psychotic patients, the rela-

tionship between intracranial tension and gender and antipsychotics still required further studies.

Our study results showed that the normal seizure group's right side ICP after the eighth MECT was significantly higher than the health control group, that the prolonged seizure group's left side ICP and average ICP after MECT treatment were significantly higher than those before treatment, that the prolonged seizure group's left side ICP and average ICP after first treatment was higher than other groups', and left side ICP increased the most significantly, indicating that MECT might elevate the intracranial pressure of psychotic patients, especially prolonged seizure patients.

It may be because in the process of MECT, anaesthetic and muscle relaxant drugs would result in unconsciousness of the patients, reduction of the patients' muscular tension, glottic edema and unsmooth sputum discharge, which would further result in upper airway obstruction, and the residual of muscle relaxant drugs would lead to pulmonary ventilation volume to reduce. All of these factors could result in anoxia and CO_2 retention [13], increased oxygen radicals in blood, NO metabolic disturbance and the impairment of cerebrovascular automatic adjustment functions, relax the vascular smooth muscles, expand cerebral vessels, increase cerebral blood flow [14, 15], and thus result in brain tissue congestion, vasogenic cerebral edema, and intracranial pressure increase. Studies have shown that timely treatment with ventilation could greatly reduce most patients' ICP levels and even recover their ICP levels to normal [16]. Therefore, as for the prolonged seizure patients, we shall pay more attention to their respiratory conditions, try to clear away their respiratory secretions, improve their oxygen flow rate, monitor their blood gas analysis, reduce their intracranial pressure, and prevent the intracranial pressure increase from resulting in further cerebral injuries.

Derikx *et al* reported that ECT itself could not lead to increased intracranial pressure and that the increased intracranial pressure was in fact resulted from the increased blood pressure after ECT [17]. He *et al* also discovered that the patients' blood pressure after anesthesia of etomidate had no significant changes, but gradually increased after electrical stimulation [18]. The patients' blood pressure, after the injection of succinylcholine, would increase, but the influence was not as significant as electrical stimulation [19]. So the increased blood pressure after MECT was not only related with drugs, but also with MECT itself [20, 21], which indirectly confirmed the influence of MECT on intracranial pressure.

Our study had some limitations. For example, the influence of different kinds of diseases and different ages on intracranial pressure and the influence of anaesthetic on intracranial pressure either have not been studied. In our further investigations, these weaknesses will be modified.

Conclusions

Our study showed that the incidence of increased intracranial pressure (ICP>200 mmH_2O) in the normal seizure group and the prolonged seizure group after MECT were 8% (4 out of 50 cases) and 14.3% (3 out of 21 cases), respectively, indicating that MECT might lead to increased intracranial pressure. Further studies, however, are required to verify this conclusion using a lager sample size.

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Disclosure of conflict of interest

None.

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