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Music therapy for coma patients: preliminary results

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Abstract. – OBJECTIVE: The application of quantitative EEG (δ+θ/α+β value) and GCS value to evaluate the role of music therapy for traumatic brain injury coma patients.

PATIENTS AND METHODS: Forty patients of traumatic brain injury coma were selected to meet the inclusion criteria. Twenty cases were selected for the rehabilitation, neurology and neurosurgery ward, whose families could actively cooperate with, and the patients could receive a long-term fixed nursing staff with formal music therapy (music group). Twenty cases were in the intensive care unit of the rehabilitation, neurology and neurosurgery ward. Their families members cooperated poorly, had often changing nursing staff, and without a formal music therapy (control group). After a one monthe follow up, the GCS value and quantitative EEG (δ+θ/α+β value) were compared between the two groups. Between the two groups, except for the presence or absence of formal music therapy, the rest of treatment had no significant difference and was matched by age, gender, and injury types.

RESULTS: In 40 cases of traumatic brain injury patients, the GCS value increased in the music group after treatment when compared to the control group. The difference between the two groups was significant ($p < 0.05$). The quantitative EEG value (δ+θ/α+β value) of music group values were decreased after treatment, and the difference was significant compared with the control group ($p < 0.05$).

CONCLUSIONS: Through the quantitative EEG (δ+θ/α+β value) and the GCS observation score, music therapy in patients with craniocerebral trauma coma has obviously an effect on promoting to regain consciousness. The quantitative EEG (δ+θ/α+β value) can be used as an objective index to evaluate the state of brain function.

Key Words:
Coma, Traumatic brain injury (TBI), Music therapy, Electroencephalography (QEEG).

Introduction

A coma resulting from a traumatic brain injury (TBI), is a common therapeutic problem for the Department of Neurosurgery in the hospitals. The condition is complex, progresses rapidly, is difficult to predict and has high mortality rate. A coma refers to the extreme state of suppression of the central nervous system caused by various causes, which is the most serious disorder of consciousness, including arousal disorders and content of consciousness disorder. It is the main manifestation of brain functional failure[1]. With the development of science and technology, cerebral trauma coma patients caused by motor vehicle traffic accidents have increased year after year. Data shows that there are about 2,000,000 coma patients after TBI caused by various reasons in China each year, including about 200,000 who are in a persistent vegetative state each year[2]. Maintenance of coma patients' life support consumes a large amount of social resources[3-4]. Many long-term coma patients cause a great burden to society and the family. Therefore, early rehabilitation therapy on coma patients, reduction of patients' time in a coma, reduce morbidity, and quality of life improvements has become an important topic for clinical workers[5].

Coma is a severe disease. The integrated use of multi-disciplinary and multi-therapy is required for clinical treatment. At present, wake promoting methods for the coma patients includes medicine promoting wake, hyperbaric oxygen, acupuncture, and physical stimulation (sound, light, electricity, magnetic stimulation and sensory stimulation). In recent years, researchers have paid more attention to coma stimulation therapy because the variety of physical stimulation is both economical and convenient. This will be able to improve the coma state of patients gradually. The domestic and foreign related research has confirmed that coma stimulation therapy (such as acoustic stimuli, light stimulation, etc.,) plays an important role in the wake promoting for patients in a coma[6-8].

Coma stimulation therapy, also called sensory stimulation and coma therapy, is implemented by medical personnel or patients' family members. It

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is a method of treatment by the application of one or more sensory stimulation to increase the patient's reaction[9]. Coma stimulation therapy is an effective treatment method for promoting awake and is increasingly receiving attention by domestic and foreign researchers[10]. Acoustic stimulation is one of them. It is a process that uses sound to stimulate coma patients. Patients with brain injury treated with the sound stimulus (Music) awake earlier than patients with conventional treatment[11]. But there are scholars who studied cerebral vascular elasticity and cerebral blood flow of patients by transcranial Doppler and found that the sound stimulus (Music) therapy combined with routine medicine was better than simple drug treatment[12]. This is because music can help patients maintain normal long-term sensory input, improve the ascending reticular activating system and cerebral cortex neuron activity levels that increase arousal[13]. Neurophysiologists prove that music has a direct impact on the limbic system of the brain and can make the cerebral cortex appear foci of excitation[14]. Early drug and music therapy can promote function restoration and nerve cell recovery. The treatment process of music therapy can be used throughout the length of the coma to promote recovery.

In studies performed by various authors, the evaluation of the treatment effects of the music therapy on coma patients were mainly changes in vital signs, and neurological and electrophysiological functions (evoked potentials, EEG).The Glasgow Coma Scale (Glasgow Coma Scale score, GCS), is the commonly used clinical judgment scale for coma[15]. Although many reports think that there are certain specificity for clinical examination including the GCS coma score and pupillary light reflex for admission to judge prognosis of comatose patients It is not highly sensitive and may have high false positive results. This means that some of these patients may have poor clinical manifestation, but the prognosis is really better, so many scholars think that the value of clinical examination judgment on the prognosis of coma is not excessive[16-17]. Judging the prognosis of comatose patients by the GCS coma scale is not enough[18-19].

Electroencephalogram (EEG) is the sum of local neuronal activity recording from the extracranial or intracranial. Because the craniocerebral trauma coma patients cannot speak or describe their illness, there is a need to assess and predict the brain function state of patients with EEG. EEG monitoring technology can provide information on the dynamic state of brain function[20]. Many researchers use dynamic EEG monitoring in patients with coma by Synek EEG grading, Young EEG grading, Zhang Zhifang EEG grading and other grading methods to evaluate the effect of music therapy. Various EEG grading methods provide a better prognosis[21-23]. The degree of brain injury and EEG changes in most cases can reflect the degree of cerebral function injury and coma depth, and have good correlation. Reading the dynamic EEG level requires specialized technicians. For untrained doctors and nurses, there is a certain degree of difficulty of correctly interpreting the EEG. Even professional and technical personnel also need a long time to analyze the original EEG data, and there is subjectiveness and great bias when interpreting the data[24]. Therefore, because of the limitation of traditional analysis of the spontaneous EEG, a more simple and objective quantitative electroencephalogram has emerged.

Quantitative electroencephalogram (QEEG) emerges from the original EEG quantification by mathematics and computer technology and transforms amplitude with time changes into a digital signal that the EEG changes with frequency and provides intuitionistic quantitative parameters[25]. The relative power value is a band value percentage in the brain region of total power value that is a relatively stable indicator[26]. The relative power value iδ+θ/α+β in the EEG power spectrum is the most common, and most sensitive index in brain function research[27]. Leon-Carrion[28], think that the damage to the state of brain function in the EEG power spectrum shows an increased slow wave frequency band and fast frequency band reduction. The increasing relative power value δ+θ/α+β indicates an increase in a slow wave band or a decrease in a fast wave band. On the other hand, reducing the value can be understood as slow wave reduction or fast wave band growth. From the neurophysiological angle, that δ, θ is slow wave, and the power increasing is interpreted as the awakening deficiency or activation decreasing[29]. Quantitative EEG is a non-invasive examination that can make an accurate evaluation of patients' cerebral function.

Therefore these studies use quantitative EEG (δ+θ/α+β) as a relative power value and as an observation index to evaluate the main music stimulation effect on brain electrical activity of coma patients with TBI, and combines with GCS score index to evaluate the wake promoting effect of music therapy on coma patients with TBI.

Patients and Methods

Materials

Type NATION8128 EEG Shanghai Nuocheng Electric Co., Ltd. 1.2 Glasgow coma scale, GCS

Patients

The study included 40 coma patients with TBI that met the inclusion criteria in the rehabilitation department of the Department of Neurosurgery.

Inclusion criteria was as follows:

1. With the exact history of craniocerebral trauma.
2. Brain CT results show that the fracture of the skull or intracranial hematoma, except the cerebellum and brainstem lesions.
3. The patients whose course of the disease in 2 weeks with stable vital signs of, aged 18-55 years old.
4. The patient in a coma, Glasgow Coma Scale score $3 \leq GCS \leq 8$ when admission.
5. EEG monitoring wave is dominated by. Δ, θ.
6. The patients who have at least one side without injury auditory by brainstem auditory evoke.
7. The guardian has been informed consent and signed the consent form.

Exclusion criteria was as follows:

1. Coma caused by low temperature or drug.
2. Dementia and mental illness. Alcohol, drug abuse or dependence history.
3. The history of severe visual or hearing impairment, aphasia and limb movement disorder.
4. Need respiratory support that disturbs EEG.
5. The subjects researchers consider who cannot comply research program.
6. Patients with persistent vegetative state.

Methods

The grouping criteria of the 40 coma patients with TBI who meet the inclusion criteria were as follows: The 20 patients in the rehabilitation department in the Department of Neurosurgery with formal music therapy (music group). Twenty patients in the intensive care ward in the Department of Neurosurgery, without formal music therapy (control group). Except for the formal music therapy, there were no obvious differences between the two groups, and the general data of patients of the two groups such as age, gender, type and duration of cerebral trauma were matched.

The evaluation method for the coma patients with TBI who conformed to the standards were as follows: two weeks after admission, a complete monitoring of the GCS score and quantitative EEG was performed. The GCS scale score was evaluated by the same rehabilitation physician using the same criteria.

Monitoring both before and after treatment of quantitative EEG was done by the same physician, and the scores were calculated under the condition of unchanged EEG parameters.

The specific grading standards of rating scale was made as follows: eyes open, speech and motor skills, and the degree of disturbance of consciousness (Table I).

Table I. GCS.

Inspection item	Reactions of patients score
Eyes open reaction	Eyes were not opened by any stimulation 1
	Eyes were opened by pain stimulation 2
	Eyes were opened by verbal stimuli 3
	Eyes were opened himself 4
Verbal response	No language 1
	Indigestion 2
	Can understand without even spoil 3
	Dialogue vague 4
	Normal 5
Motor skills	No response to any pain 1
	Extension reaction to pain stimulation 2
	Buckling response to pain stimulation 3
	Escape response to pain stimulation 4
	Can open out the doctor's hand when pain stimulation 5
	Normal (execute instructions) 6

Note: The highest score of GCS score is 15 points, that means clear consciousness 12-14 points mean mild disturbance of consciousness 9-11 points mean the moderate disturbance of consciousness 8 points below mean coma lower score means heavier disturbance of consciousness. GCS score of 3-8 means bad GCS score and 9-14 means good GCS score.

The quantitative EEG reads each amplification path signal from the computer and carries on the classification according to the different signal frequencies. It calculates mean by the ratio of emergence time and the total amplitude. The patients were examined by EEG, and the original EEG data was obtained. After sampling, computer software was used to carry out fast Fourier transform (FFT) for the power spectrum analysis. In terms of frequency, the power spectrum is divided into δ (0.5-3.5 Hz), θ (4.0-7.5 Hz), α1 (8.0-11.0 Hz), α2 (11.5-13.5 Hz), β1 (14.0-18.5 Hz), β2 (19.0-30.0 Hz) of 6 frequency bands. The absolute power, the value of relative power values, etc. can be obtained at each frequency band. Because the variation of the absolute power of the individual is very large, it is difficult to develop comprehensive diagnostic criteria. The relative value of the power is a relatively stable indicator. It is because the relative power can make each frequency band in the same baseline to eliminate interference. The relative power value δ+θ/α+β in the EEG power spectrum is the most common, and the most sensitive index in brain function research.

Empirical Method

Methods of music are stimulating Give patients their favorite and familiar music that their families provide used 60dB-70dB volume corresponding with the rhythm of the human body, plug type earphone, dichotic listening with MP3 play. Play 15-30 min every morning, afternoon, before sleeping at night. When given music therapy, patients should be given songs of lively and relieved rhythm or different music style, rotation playing to prevent the patient from a song tolerance, and keep fresh stimulus. Continuous treat for 4 weeks.

EEG Monitoring Method

All patients had EEG examination using the portable electroencephalograph Shanghai Nuocheng Electric Co Ltd within 2 weeks after being admitted to the hospital. The equipment was used according to the international 10/20 standard system by placing the electrodes on the scalp, using a 16 lead monopolar sampling (Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T3, T4, T5, T6), with the ear electrode as reference electrode and the forehead central frontal pole as the grounding electrode. The sensitivity of the waveform was 100 uV/cm, the paper speed was 3.0 cm/s and the time constant was 0.3s, low pass was 30 Hz, and the notch was 50 Hz.

Patients were in a supine position, without a pillow, with a towel folded on the back of the neck so that the patients' posterior occipital was exposed and made it easy to install the electrode. After the electrode had been installed, the lead wire was connected. The instrument was used to collect and record the EEG. The EEG examination was taken on patients in a coma with TBI who met the grouping criteria. After a month of tracking the observation results, the EEG examination was taken again. Midway discharge or death was considered as a visit lost.

This experiment was also conducted with music therapy in the music group, at the same time. Real-time monitoring of EEG was taken to observe whether there was any difference in EEG in the coma patients with different GCS score during music stimulation.

All the experiments were performed by the same physician in a quiet environment, and the original EEG select brain waves were recorded without obvious effects (eliminated interference caused by eye movement, sweating, ECG monitoring, muscle contraction). The brain waves were recorded during a continuous 6S as a collection unit. With the aid of computer software carrying out FFT, we chose the power spectrum that reflected the original EEG, divided the power spectrum according to the frequency into δ (0.5-3.5 Hz), θ (4.0-7.5 Hz), α1 (8.0-11.0 Hz), α2 (11.5-13.5 Hz), β1 (14.0-18.5 Hz), β2 (19.0-30.0 Hz) of six frequency bands, and calculated the absolute power value of each frequency band and the relative power δ+θ/α+β value. We then took the average of five times as the data acquisition.

Statistical Analysis

For statistical processing, the SPSS l6.0 software (SPSS Inc., Chicago, IL, USA) was used for statistical analysis on the data. Qualitative data were compared with χ^2 test and quantitative data as mean ± standard deviation (± s). The obtained data was taken using normality and homogeneity variance test, according to the characteristics of data in line with the conditions. The two groups were compared by independent sample *t* test, and paired *t* test was used to compare the data before and after the treatment. For the data that did meet the requirements, the non-parameter examination was used; the correlation analysis was obtained by Spearman rank correlation. A = 0.05 was the level of test, and the $p < 0.05$ signified that the difference has statistical significance.

Table II. General data comparison of music group and the control group.

Item	Music group	Control group	Statistic	*p*
Age n =	39.35 ± 10.23	40.05 ± 10.05	t = -0.218	0.828
Sex male/female	15/5	15/5	χ^2 = 0.0	1.0
Main damage side (left/right)	7/13	12/8	χ^2 = 2.506	0.113
Course when grouping ($\bar{x}$ ± s day)	6.55 ± 2.82	6.70 ± 3.08	t =-0.161	0.873

Results

General Comparison of the Patients in the Groups

According to the case inclusion criteria, this study collected 40 patients in coma by TBI from December 2012 to December 2013 in the rehabilitation department of the Central Hospital. When grouping, the patients' course was less than 2 weeks, with 30 male cases and 10 female cases. In the music group, there were 15 male cases and five female cases, aged 18-53 years old. The mean age was (39.35 ± 10.23) years old. When grouping, the patients' course was 2-12 days, with an average of (6.55 ± 2.82) days. There were seven cases with left brain injury, 13 cases of right brain injury, 12 cases resulting from traffic accident injury, high fall injury in five cases, and impact lesions in three cases. In the control group, 15 were male, 5 were female, aged 22-50 years old, and the mean age was (40.05 ± 10.05) years old. When grouping, the patients' course was calculated in days with an average of (6.70 ± 3.08) days. There were 12 cases of left brain injury, eight cases of right brain injury; 15 cases of traffic accident, falling injury in 3 cases, and impact lesion in two cases. The two groups were matched for gender, age, course of the disease and other aspects, and there was no significant difference for statistical analysis ($p > 0.05$) (Table II).

Index Comparison Before and After the Treatment

GCS score comparison of music group and control group before and after the treatment (Table III).

GCS score comparison of the music group and control group before the treatment: $p > 0.05$, the difference has no statistical significance.

GCS score comparison of music group before and after the treatment: $p < 0.05$, the difference has no statistical significance.

GCS score comparison of the control group before and after the treatment: $*p < 0.05$ the difference has no statistical significance.

GCS score comparison of music group and control group after the treatment: $\Delta*p < 0.05$ ($p = 0.041$), and the difference was significant.

Quantitative EEG (δ+θ/α+β) comparison of music group and control group before and after the treatment (Table IV):

δ+θ/α+β comparison of music group and control group before the treatment: $p > 0.05$ the difference has no statistical significance.

δ+θ/α+β comparison of music group before and after the treatment: $*p < 0.05$, the difference has no statistical significance.

δ+θ/α+β comparison of the control group before and after the treatment: $*p < 0.05$, the difference has no statistical significance.

Table III. GCS score comparison of music group and control group before and after treatment (n = 40, $\bar{x}$ ± s).

Group	GCS value before treatment	GCS value after 1 month treatment
Music group	5.55 ± 1.61	11.30 ± 2.66$^{*,\Delta}$
Control group	5.65 ± 1.46	9.45 ± 2.86*

Table IV. δ+θ/α+β comparison of music group and control group before and after treatment (n = 40, $\bar{x}$ ± s).

Group	δ+θ/α+β before treatment	δ+θ/α+β after 1 month treatment
Music group	9.38 ± 2.62	6.30 ± 2.12$^{*,\Delta}$
Control group	9.54 ± 3.06	7.99 ± 2.81*

δ+θ/α+β comparison of music group and control group after the treatment: $\Delta p < 0.05$ ($p = 0.038$), the difference has statistical significance.

GCS Score of Patients and QEEG (δ+θ/α+β) Correlation Analysis

The 40 patients are all in accordance with the group standard. Before the treatment, the GCS score was at 3-8, and a correlation analysis and QEEG (δ+θ/α+β) was performed. The QEEG (δ+θ/α+β) and the GCS score after inspection did not conform to normality, so the Spearman correlation analysis was conducted, and the analysis showed that both were highly negatively correlated (r = -0.482, $p = 0.002$). Its correlation scatters diagram showed a significant negative correlation trend (Figure 1).

GCS Score After the Treatment and QEEG (δ+θ/α+β) Correlation Analysis

Amongst all patients after treatment, there are 31 cases who is GCS score was 9-15 points. A correlation analysis and the QEEG (δ+θ/α+β) was conducted. The QEEG (δ+θ/α+β) and the GCS score after inspection did not conform to normality, so using the Spearman correlation analysis, the analysis showed that both were highly negatively correlated (r = -0.493, $p = 0.005$), and the correlation scatter diagram showed a significant negative correlation trend (Figure 2).

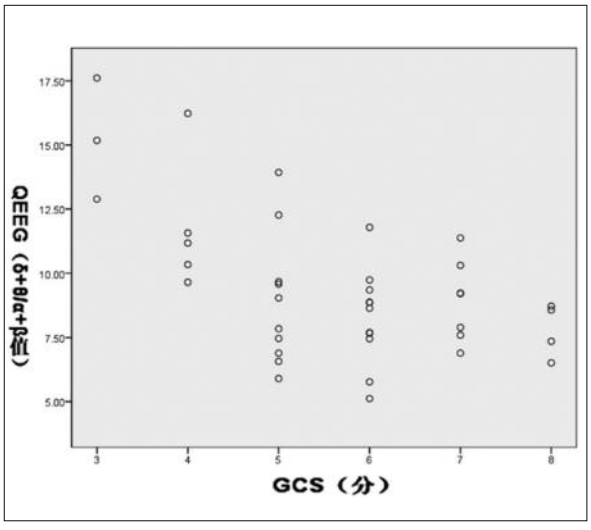

Figure 1. QEEG (δ+θ/α+β) of all the patients before treatment and the GCS score correlation scatter diagram (n = 40).

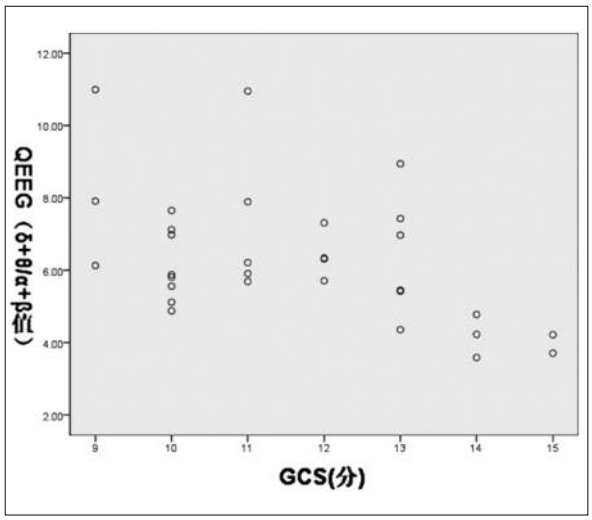

Figure 2. QEEG (δ+θ/α+β) of all the patients before treatment and the GCS score correlation scatter diagram (n = 31).

Discussion

In recent years, with the development of the social aid system, treatment technology and intensive care, the mortality of patients with severe craniocerebral injury rate decreased significantly, but the disability rate is still high[30]. The patient is often in a state of consciousness disorder after severe craniocerebral trauma, and prolonged coma or deep coma often cause all sorts of complication, bring economic burden and great psychological pressure on patients' families[31]. In many wake promoting therapies, the implementation of music therapy is simple with little investment and medical expenses and reliable curative effect. Through the wake promoting effect of patients, the coma period is shortened, promoting the recovery of brain function, reducing the incidence of disability, and promoting an early recovery of patients, improving the life quality of patients, so as to reduce the economic burden to the family[32].

Music therapy in recent years has received more attention in the coma wake therapy. There are many authors[32-35] who study on the wake promoting effect of music therapy. Music therapy has been confirmed to have the wake promoting effect on coma patients that can promote the early recovery of coma patients. Music therapy has a scientific and systematic use of music characteristic, influencing people through music, help patients achieve physiological and psychological integration in the illness or disability, through

harmonious rhythm, and stimulate the muscle to make the person produce a pleasant mood and change physical and mental state in the course of treatment or medical process[36]. In the human brain, the main auditory stimulation originates from the music, as music activates a series of cognitive and affective components of the brain, and these components are neural specific matrix[8]. Listening to music can promote the brain to produce neural substrate that improves cognition and emotion[37]. The improvement of neuroendocrine, cardiovascular, digestive system function and exciting the cerebral cortex increases the release of acetylcholine, so as to improve the cognition of patients[38]. In the music therapy process, the information enters the brain to improve the excitability of cortical neurons, in order to promote the repairing ability of the nervous system[39]. Music nerve stimulation can make the blood flow increase in most brain regions and regulate the mediation function of limbic system and the brain stem reticular formation, to compensate non-involvement of brain cells, so as to make up for the degeneration of damaged brain cell function, self-adjust and accelerate the recovery of consciousness. Neurophysiologists prove that music has a direct impact on the limbic system of the brain and brainstem reticular system that can make the cerebral cortex appear new foci of excitation[14]. Therefore, the early rational drug therapy, and music therapy can promote function restoration and nerve cell recovery, and music therapy can promote the recovery of coma patients.

Based on the tracking observation of 40 cases of coma patients with TBI in the experiment, the GCS scores of music and control group significantly increased ($p < 0.05$), and after one month of treatment, we compared GCS scores of music group and control group. The GCS score of the music group is (11.30 ± 2.66) points, GCS score of the control group is (9.45 ± 2.86), and both have significant statistical difference ($p = 0.041$). That illustrates that the formal music therapy on coma patients with TBI has obvious arousal effects. But if the evaluation of the effect of music therapy is only assessed by the commonly used GCS score change, it has certain subjectivity, so this experiment considers quantitative EEG as an objective evaluation index to confirm the wake promoting effect of music therapy.

QEEG is a technology of raw EEG quantification by mathematics and computer technology, and it is an intelligent brain electrical signal processing system of non-invasive assessment of brain function. The main contents include time domain analysis, frequency domain analysis, domain analysis, chaos-fractal, etc. Amongst them, the frequency domain analysis includes power spectral analysis, compressed spectrum array, EEG topography, and significance probability mapping[41]. Power spectrum analysis is the core part of quantitative EEG and the most commonly used. Power spectrum analysis technology with the aid of computer, uses FFT method, to transform the original EEG brain waves amplitude with time changes into brain power with frequency changes, so as to directly observe the brainwave frequency distribution of α, β, θ, δ and change of circumstances[42]. Quantitative EEG power spectrum analysis and specific operation method as follows: After through the digital EEG/EEG topography acquisition of brain waves with conventional method, the representative original brain wave is selected artificially, FFT is carried out with the help of the computer, the EEG signal is changed from time domain to frequency domain to obtain the EEG power spectrum (table) that varies with frequency[43]. It is original EEG quantification that has overcome the traditional eye subjective judgment, made the EEG results expressed by quantitative digit[44]. In a word, the quantitative EEG transforms the complex and changeable brain functions change the distribution of data that reflects quantitatively brain function change by modern computer technology and signal processing technology, do dynamic observation records at the same time for the study of the characteristics and regularity of brain activity under the physiological and pathological conditions, thus that provides objective and strong basis for assessment of early diagnosis, treatment effects and the prognosis of brain disease[45].

The main characteristic of the EEG of patients with TBI in the early period is δ, θ slow wave increasing and α, β wave power often weakened with diffuse increasing[46]. The important reason for slow wave in the early period is because after mitochondria head focus and hedge positions injured in a few minutes, cerebral cortex pyramidal cells swell, that affects the release of postsynaptic electrical potentials, so as to produce slower wave[47]. Coma patients with TBI recruited for this study are dominated by coma patients with the slow wave δ, θ. In this experiment, through one month tracking

observation of 40 cases of coma patients with TBI, neither the music group or the control group whose value of δ+θ/α+β reduced more significantly than before treatment ($p < 0.05$). After treatment, the proportion of slow wave δ, θ relatively reduces, fast wave α, β increases relatively, which is consistent with the view of many authors[25,28]. And in the experiment the correlation analysis of GCS score and the value of δ+θ/α+β, GCS score 3-8 points of 40 patients before treatment was taken correlation analysis with its value of δ+θ/α+β, showing a significant negative correlation (r = -0.482, p = 0.002), after treatment, 31 cases of patients with GCS score 9-15 was taken correlation analysis with its value of δ+θ/α+β, that showed significant negative correlation (r = -0.493, p = 0.005), and it can be obtained that with the increasing GCS score, the value of δ+θ/α+β of patients with was in decreasing trend, that explained that the higher GCS scores, the smaller δ+θ/α+β would be, and the level of consciousness of patients would be higher, on the contrary, then the level of consciousness of the patient would be lower. After one month treatment, δ+θ/α+β of the music group was (6.30 ± 2.12), control group was (7.99 + 2.81), both had significant statistical difference (p = 0.037), therefore, through the comparison of δ+θ/α+β of quantitative EEG between the music and the control group proved that through the standard music therapy the overall arousal of patients with coma of the music group was higher than after that of the control group. That means δ+θ/α+β has a certain value in the evaluation of music therapy on wake promoting treatment of coma patients with TBI. Therefore, the change of δ+θ/α+β ratio objectively proves that the music stimulus has obvious improvement to electrical activity of coma patients with TBI and provides strong theoretical basis for music therapy on patients with coma.

When music therapy was being taken by music group in the experiment, at the same time, real-time observation of brain electrical monitoring was on as well, it was found that when there was music stimulus the quantitative EEG (δ+θ/α+β) decreased comparing with patients in calm state, that was the slow wave component decreased relatively of patients with music stimulation, fast component relatively increased, that meant the electrical activity of the brain was improved by music for patients with coma and the state of consciousness of the brain function of patient was towards conscious direction. During music stimuli, EEG could be changed may be because of the music as an acoustic wave, when nerve impulses caused by the stimulation of the cochlear nerve transferred to the pons, the brainstem reticular could be stimulated ascending to activate system, when the system was excited, the uplink impulse increased, that would cause the foci of excitation of the focal cerebral cortex increased, and wakefulness brain waves appeared[48].

But it was also observed that with GCS scores of patients increasing, during music stimulus, the extent of the change of δ+θ/α+β value was larger than patients in calm state, through the tracking observation of the music group, with a lower GCS score, the extent of decreasing of δ+θ/α+β value was smaller; with a higher GCS score, the extent of decreasing of δ+θ/α+β value was larger. Speculate that in real-time music stimulation, GCS score, and quantitative EEG may also have a negative correlation. Due to the small sample size, there is no statistical analysis; the sample size should be larger in the later work, refine packet of GCS to observe quantitative EEG (δ+θ/α+β) change rule under the stimulation of real-time music.

Music therapy compared to drug treatment is simple, convenient and economical. Quantitative EEG as a new index overcomes routine EEG subjectivity and provides a new field to the assessment of functional status of brain of patients with coma. Music therapy and quantitative EEG respectively have important value in the wake promoting treatment and the state of brain function evaluation for coma patients with TBI. That makes the coma therapy jump a new step in the clinical treatment of good economic and social benefits.

As the cases of the study are relatively small, in order to evaluate the value of the music treatment more accurately and understand quantitative EEG (δ+θ/α+β value)'s role in the state of brain function evaluation, and observe the number of the patients that will eventually wake up further, the quantity of samples remains to be increased. For different scores of GCS to patients, after real-time music stimulation whether quantitative EEG (δ+θ/α+β) changes has certain regularity with the score variation of GCS, the amount of sample should be increased, and statistical analysis should be carried on. This is the experimental imperfection and will continue to be improved in the next step of the experiment.

Conclusions

Under the experimental conditions:

1. Based on the observation of quantitative EEG (δ+θ/α+β value) and the GCS score, it shows that music therapy has a patent effect on promoting awakeness for coma patients with craniocerebral trauma, and may be a valid support with the other medical component to treat these patients.

2. Quantitative EEG (δ+θ/α+β value) as an objective and quantitative brain function detection means, has important value to evaluate the functional state of the brain of patients with coma.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

References

1) Huang W. Coma diagnosis thinking. Chin J Crit Care Med 2009; 2: 6-13.
2) Fei L, Hong Z, Hongjian Z, Yongqiang Z. Wake promoting clinical observation of 51 cases of coma patients. Med J Natl Defending Forces Southwest Chin 2007; 17: 573-574.
3) Kaplan PW, Genoud D, Ho TW, Jallon P. Clinical correlates and prognosis in early spindle coma. Clin Neurophysiol 2000; 111: 584-590.
4) Celesia GG. EEG and coma: is there a prognostic role for EEG? Clin Neurophysiol 1999; 110: 203-204.
5) Li S, Jianmei D, Yi Y, Mei H. Wake promoting effect of Multi-sensory stimulation on coma with severe craniocerebral injury. Med J Chin People's Armed Police Forces 2012; 23: 14-16.
6) Wenjian P, Jianzhong F, Zhang J. A preliminary study on somatosensory music therapy to the treatment of craniocerebral trauma. Chin J Clin Rehabil 2011; 26: 192-194.
7) Qiuli B, Xiaoqing X, Lingli S, Qingyu J, Yanqiu X. The influence of music combined touch on the electrical activity of the brain and auditory evoked potential of coma patients with craniocerebral injury. J Nurs Sci 2011; 26: 26-27.
8) Peretz I, Zatorre RJ. Brain organization for music processing. Annu Rev Psychol 2005; 56: 89-114.
9) Bos S. Coma stimulation. Online J Knowl Synth Nurs 1997; 4: 1.
10) Karma D, Rawat AK. Effect of stimulation of coma. Indian Pediatr 2006; 43: 856-860.
11) Xue X, Mou Y. Observation of the effect of music therapy in the treatment of patients with severe brain injury. J Nurs Sci 2001; 16: 484-485.
12) Tan X. Clinical study on the comparison of two kinds of therapy of cerebral arteriosclerosis. Chin J Modern Med 1996; 6: 17-20.
13) Gerber CS. Understanding and managing coma stimulation: are we doing everything we can?. Crit Care Nurs Q 2005; 28: 94-108.
14) Bu C, Xiao LX, Zhang Y. Awaking and nursing of patients with coma after severe craniocerebral injury. Jilin Med J 2002; 23: 161.
15) Xiuling P, Changhu X, Xiru Y, Xiang D. Evaluation of brain function and prognosis evaluation of coma patients by ambulatory EEG monitoring. Shaanxi Med J 2013; 42: 305-308.
16) Chen R, Bolton CF, Young B. Prediction of outcome in patients with anoxic coma: a clinical and electrophysiologic study. Crit Care Med 1996; 24: 672-678.
17) Juan L. Significance of ambulatory EEG on the prognosis evaluation of coma patients. Med Univ Fujian, 2011.
18) Abend NS, Licht DJ. Predicting outcome in children with hypoxic Ischemic encephalopathy. Pediatr Crit Care Med 2008; 9: 32-39.
19) Horn J, Zandbergen EG, Koelman JH, Hijdra A. Prognosis for patients in a coma following cardiopulmonary resuscitation. Ned Tijdschr Geneeskd 2008; 152: 308-313.
20) Magis D, Vigano A, Sava S, d'Elia TS, Schoenen J, Coppola G. Pearls and pitfalls: electrophysiology for primary headaches. Cephalalgia 2013; 33: 526-539.
21) Ming Y, Feifei J, Haiyan Y, Weili Y. Value of dynamic electroencephalogram monitoring in evaluating the prognosis of comatose patients. Prev Treat Cardiocerebral Vasc Dis 2012; 12: 376-378.
22) Shuangyi F, Honglin W, Jing W. Prognosis of stroke patients with coma by dynamic EEG and evoked potential. J Epilepsy Electroneurophysiol 2009; 18: 13-17.
23) Shen Y, Fangbo N, Yunlin L. Research on the evaluation of prognosis of patients with severe cerebrovascular diseases by continuous EEG monitoring. Chin J Pract Nervous Dis 2008; 11: 17-19.
24) Lu Z. The research of prognosis forecast of patients with supratentorial consciousness disorder by quantitative electroencephalogram. Southern Med Univ 2011.
25) Yanwei C, Xiangyu W, Chengjin X. Conscious appraisal of patients with long-term barrier and severe head trauma by quantitative EEG. Chin J Neurosurg 2011; 27: 56-58.
26) Chen Y. Effect of Quantitative EEG on the evaluation of cognitive ability of patients with Alzheimer's disease. Chin Gen Pract 2012; 15: 209-210.
27) Xiaoying T, Liying S, Ying M. The effects of music on brain function of patients with severe cognitive dysfunction. Chin J Rehabil 2008; 23: 241-242.

28) Leon-Carrion J, Martin-Rodriguez JF, Damas-lopez J. Brain function in the minimally conscious state: aquantitative neurophysiological study. Clin Neurophysiol 2008; 119: 1506-1514.

29) Kui Z, Li G, Tan X. Research on the evaluation of rehabilitation of patients with skull reconstruction of brain function by quantitative EEG. Sichuan Med J 2010; 31: 1425-1427.

30) Dong H, Bi X, Fu H. Sober prediction model of coma patients with severe craniocerebral injury. Chin J Neuromed 2013; 12: 296-300.

31) Jiaxi L. Evaluation of clinical effect of electro acupuncture combined with western medicine on promoting waking effect of coma patients with severe traumatic brain. Guiding J Trad Chin Med Pharm 2013; 19: 79-81.

32) Chen C, Wang H. Observation of the effect of music therapy on the implementation of promoting waking in patients with neurosurgery coma. Today Nurse (Special Edition) 2011; 2: 54-55.

33) Le Meifen WS, Jin X. Discussion of wake promoting effect of music on brain injury consciousness disorder in the early period. Shanghai Nursing J 2001; 1: 1-3.

34) Fei W, Wang J, Li R. Observation of the curative effect of music therapy combined with acupuncture on the improvement of consciousness of patients with severe craniocerebral injury. Hebei J Trad Chin Med 2013; 35: 31-32.

35) Liang F. Observation of the curative effect of music therapy on the patients of neurosurgery coma. Chin Med Guides 2008; 5: 146-147.

36) Liang Q, Li Y. The effect of music therapy on mental recovery of patients with cerebral hemorrhage in basal ganglia in conscious rehabilitation period. Modern J Integr Trad Chin Western Med 2010; 19: 2967-2968.

37) Ashby FG, Isen AM, Turken AU. A neuropsychological theory of positive affect and its influence on cognition. Psychol Rev 1999; 106: 529-550.

38) Tao X, Sun L, Ying M. The effects of music on brain function of patients with severe cognitive dysfunction. Chin J Rehabil 2008; 23: 241-242.

39) Man Li GM. The status quo of music therapy on the application of nursing work. Chin J Nursing Educ 2003; 38: 205-206.

40) Huang W, Mo J, Xie C. The effect of call type nursing intervention on coma patients with brain injury. Modern Clin Nursing 2007; 6: 4-6.

41) Liu X. Clinical electrophysiology of the nervous system (electroencephalography) [M]People's Medical Publishing House, 2004; pp. 288-293.

42) Masdeu JC, Zubieta JL, Arbizu J. Neuroimaging as a marker of the onset and Progression of Alzheimer's disease. J Neurol Sci 2005; 236: 55-64.

43) Qing X, Xu W, Zhang Y. Study on quantitative EEG wave frequency difference between vascular dementia disease and Alzheimer's. Chin Gen Pract 2013; 16: 2584-2588.

44) Chen Z. Review of EEG quantitative analysis method. J Modern Electrophysiol 2011; 18: 60-63.

45) Wallace BE, Wagner AK, Wagner EP. A history and review of quantitative electroencephalography in traumatic brain injury. J Head Trauma Rehabil 2001; 16: 165-190.

46) Tao Z, Tang X, Hua P. Effects of hyperbaric oxygen treatment on quantitative EEG of patients with mild and moderate diffuse axonal injury in the early period. Chin J Nautical Med Hyperb Med 2013; 20: 76-79.

47) Lew HL, Lee EH, Pan SS. E1ectrophysiologic abnormalities of auditory and visual information processing in patients with traumatic brain injury. Am J Physiol Med Rehabil 2004; 83: 428-433.

48) Zhang L. Clinical studies of wake promoting interventions on patients with severe craniocerebral injury in the early period. Chin J Rehabil Med 2008; 23: 76-77.