Article

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Psychological Stress Analysis to Evaluate the Effects of Transcranial Magnetic Stimulation on Mood Regulation and Quality of Life in Patients with Bipolar Disorder

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Abstract

Objective: To explore the impact of transcranial magnetic stimulation on emotion regulation and quality of life in patients with bipolar disorder (BD) and to evaluate the effectiveness of the mental stress analyzer.

Methods: Patients with BD admitted to our hospital from August 2022 to August 2023 were retrospectively selected. For the present study, 60 patients who received drug therapy served as the control group, and the other 60 patients who received repeated transcranial stimulation on this basis served as the observation group. The heart rate variability (HRV) of the two groups of patients was detected by a mental stress analyzer/HRV analysis system. Hamilton Depression Rating Scale (HAMD), Self-Rating Anxiety Scale (SAS), and Self-Rating Depression Scale (SDS) were used to evaluate the mental state of the two groups of patients. The quality of life of the two groups was assessed using the Comprehensive Quality of Life Questionnaire 74 (GQOLI-74). Clinical effectiveness global rating scale-illness severity (CGI-SI) was used to evaluate the clinical symptoms of the two groups of patients, and the incidence of adverse reactions was calculated.

Results: In comparison to the control group, the high-frequency power (HF) of the patients demonstrated an elevation in the observation group, and the low-frequency power (LF) and LF/HF were significantly reduced ($p < 0.05$). The standard deviation of NN intervals (SDNN), standard deviation of all five-minute NN intervals (SDANN), root mean square of successive differences (rMSSD), and percent RR intervals with a difference in duration higher than 50 ms (PNN50) of patients in the observation group showed a notable increase compared to the control group ($p < 0.05$). Compared with the control group, the HAMD, SAS, and SDS scores of the patients in the observation group demonstrated a substantial decline relative to the control group ($p < 0.05$). In contrast to the control group, there was a significant increase in the overall clinical effectiveness rate among patients in the observation group, and the incidence of adverse reactions was significantly reduced ($p < 0.05$).

Conclusions: Repetitive transcranial magnetic stimulation (rTMS) has significant clinical effects in treating BD and can effectively improve patients' anxiety, suppress emotions, and regulate patients' emotions. At the same time, rTMS has high safety and little impact on the balance of patients' autonomic nervous function, reduces the incidence of adverse reactions, accelerates the patient's recovery process, and is suitable for clinical promotion.

Keywords

bipolar disorder; transcranial magnetic stimulation; mood regulation; quality of life; clinical efficacy

Introduction

Bipolar disorder (BD) is a mental illness in which mood disorders and physical symptoms occur [1]. BD symptoms usually become apparent in early adulthood and persist throughout life, with a lifetime prevalence of approximately 0.8–1.1% [2,3]. As a serious mental illness, it has the characteristics of chronic course, high morbidity and mortality [4]. According to the World Health Organization, BD remains the second most significant disease affecting people's normal work and life. At present, the primary clinical treatment for BD is drug therapy. Although certain clinical effects have been achieved, drug therapy has

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obvious limitations including strong side effects, poor patient compliance, and emotional conversion leading to rapid cyclic attacks [5,6]. Studies have shown that serotonin reuptake inhibitors and tricyclic antidepressants have conversion rates of 5% and 9%, respectively. It is reported that the conversion rate of physical therapy is less than 1%, suggesting that physical therapy may be applied in the treatment of BD [7]. Previous research has demonstrated that emotional changes and mental state can affect the patient's autonomic nervous function, and an imbalance in autonomic nervous function can delay the disease, induce other cardiovascular diseases, and increase mortality [8,9].

Repetitive transcranial magnetic stimulation (rTMS) is a widely used non-invasive neuromodulatory technique [10,11]. Studies have shown that rTMS treatment exhibits favorable therapeutic results in patients with bipolar depression, especially in relieving depressive symptoms, improving sleep, and reducing the risk of self-harm and suicide [12,13]. However, few studies have shown rTMS's impact on BD patients' emotional regulation, quality of life, and mental state. Conducting pertinent clinical research holds immense importance in enhancing the quality of life for individuals with BD. Based on previous research, the present study explores the influence of rTMS therapy on BD patients' emotional regulation and quality of life by detecting autonomic nervous function, emotional symptoms, and quality of life scores in BD patients. Furthermore, this study aims to provide a reference treatment for rTMS therapy in treating BD patients and improve clinical efficacy.

Materials and Methods

Research Subjects

Patients with BD admitted to Shayang County People's Hospital from August 2022 to August 2023 were retrospectively selected. In total, 60 patients who received drug therapy served as the control group, and the other 60 patients who received rTMS on this basis served as the observation group. The research received approval from the Shayang County People's Hospital's Medical Ethics Committee (20231211), and the entire procedure was informed by the patient or family member, who signed the informed consent form.

Inclusion criteria: ① Meet the diagnostic criteria for BD in the American Psychiatric Association's "Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition". Two attending physicians made the diagnosis. ② Both are BD stable periods. ③ Age ≥18 years old, no gender limit. ④ The duration of the illness exceeds two years, and no electroconvulsive therapy without convulsions have been administered in the past six months. ⑤ Antidepressants, atypical antipsychotics, or mood stabilizers were administered for less than 14 days, with the omission of benzodiazepines. ⑥ Have a junior high school education or above and possess the capability to read and comprehensively understand the scale utilized in the study.

Exclusion criteria: ① Patients with epilepsy or drug allergy. ② Absence of a history of drug, alcohol, or other psychoactive substance abuse or dependence. ③ Patients with past or present organic brain diseases. ④ Individuals who exhibit abnormalities in brain structure upon plain MRI scan. ⑤ Pregnant or lactating women. ⑥ Patients with severe liver and kidney dysfunction. ⑦ Patients with severe cardiovascular and cerebrovascular diseases.

Treatment Method

Both groups received conventional treatment such as psychological support, and the patients in the control group were given lamotrigine dispersible tablets (specification: 50 mg, GlaxoSmithKline Pharmaceuticals S.A, approval number: National Drug Approval No. H20180093), with a starting dose of 25 mg/day, continuous treatment for two weeks. The dose was then adjusted to 50 mg/day, all taken after meals. Patients in the observation group received rTMS combined treatment based on the drug treatment in the control group, using the Rapid 2 transcranial magnetic stimulation instrument produced by Magstim Company. During treatment, patients were maintained in a calm and comfortable posture while the magnetic stimulation treatment cap was modified to fit appropriately and used an "8"-shaped coil so that the center of the coil is located in the dorsolateral cortex of the left prefrontal lobe. Parameter settings: stimulation intensity is 80% of the motor threshold, frequency is 20 Hz, stimulation method: each stimulation lasts 10 seconds, the treatment is cycled at an interval of 5 seconds, and a total of 800 stimulations are completed.

Treatment was given five times a week, and the efficacy was assessed following four weeks of continuous treatment in both groups. The patient was in a stable stage at the time of testing. Individuals in the control cohort received sham stimulation therapy. The stimulation method was as follows: the stimulation parameters and time were referred to the observation group. When the coil current was cut off, the patients could still hear the sound with the same frequency as the real stimulation.

Detection of Heart Rate Variability

The heart rate variability (HPV) of patients was detected using a mental stress analyzer/heart rate variability analysis system. HPV refers to the fluctuation of consecutive heartbeat intervals and is a non-invasive, quantitative, and sensitive indicator for self-help neurological function assessment. In accordance with the time domain analysis approach and the frequency domain analysis approach, patients' HPV is counted, and time domain indicators are used: overall standard deviation of NN intervals (SDNN), standard deviation of all five-minute NN intervals (SDANN), root mean square of successive differences (rMSSD), percent RR intervals with a difference in duration higher than 50 ms (PNN50). Frequency domain indicators: low-frequency power (LF), high-frequency power (HF), LF/HF. All patients were allowed to rest quietly for 5 to 10 minutes before the examination, and the examination was completed in a comfortable and interference-free room.

Hamilton Depression Rating Scale (HAMD)

The severity of depressive symptoms in both groups was assessed using the Hamilton Depression Rating Scale (HAMD). This scale was introduced by Hamilton in 1960 and is widely utilized for clinically evaluating depressive symptoms. The scale has three versions: 17-item, 21-item, and 24-item. The 17-item version used in this study evaluates the patient's depression over the past week. Based on the scores, categorization is as follows: $\geq$17 points indicate the presence of depressive symptoms; 18 to 24 points signify mild to moderate depression; 24 points and above indicate severe depression; $\leq$7 points indicate the absence of depressive symptoms and clinical recovery.

Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS)

Both groups of patients were assessed for emotional symptoms using the SAS and the SDS. The SAS and the SDS are primarily employed to evaluate the severity of emotional symptoms. These scales are symptom rating instruments, each comprising 20 items utilizing a 4-level scoring system, resulting in a total score of 100 points. Adhering strictly to the scoring standards and guidelines is crucial when administering the scales. The assessment of the patient's emotional state over the past week is conducted within the defined scoring limits. Symptom interpretation is based on the patient's typical condition as a point of reference. Result judgment criteria: SAS $\geq$50 points or SDS $\geq$53 points are considered to have anxiety or depression. As the score increases, the severity of the condition intensifies.

Comprehensive Quality of Life Assessment Questionnaire-74 (GQOLI-74)

Both groups used the Comprehensive Quality of Life Questionnaire-74 (GQOLI-74) to evaluate the patient's quality of life in both groups. The Comprehensive Quality of Life Assessment Questionnaire-74 is mainly used to assess patients' comprehensive quality of life. This scale evaluates four aspects: physical, psychological, social functions, and material life status. Each aspect is scored on a scale of 0 to 100 points. A lower score indicates a poorer quality of life for the patient.

Clinical Effectiveness Global Rating Scale-illness Severity (CGI-SI)

Both groups used the CGI-SI to evaluate their patients' clinical symptoms and illness severity in two groups. They compared the clinical treatment effects of both groups of patients based on the CGI-SI scores. The scale includes three dimensions, each with a score of 7 points. An increase in the score indicates a more severe condition in the patient. The therapeutic efficacy of both patient groups was assessed based on the CGI-SI score. The evaluation criteria are divided into cure, improvement, and ineffectiveness. Cure: Mental symptoms are significantly reduced, and the CGI-SI score reduction rate is $\geq$70%. Improved: Mental symptoms have been alleviated, 30% $\leq$ score reduction rate $<$ 70%. Invalid: Mental symptoms are not relieved, and the score reduction rate is $<$30%. Total effective rate (%) = (cured + improved) number of cases / total number of cases $\times$ 100%. Calculate and compare the overall clinical efficacy rate between the two patient groups.

Incidence of Adverse Reactions

The frequency of adverse reactions post-treatment was tallied for both patient groups. Adverse reactions primarily encompassed symptoms such as headache, dizziness, nausea, drowsiness, and loss of appetite. The occurrence rate of adverse reactions was computed and compared between the two groups.

Table 1. Comparison of general information of the two groups of patients ($\bar{x} \pm s$).

Items	Control group	Observation group	χ^2/t value	p value
Gender (Male/Female)	35/25	33/27	0.136	0.713
Age (years)	34.59 ± 6.54	35.42 ± 6.18	0.715	0.476
Duration of disease (years)	7.85 ± 2.46	8.24 ± 2.63	0.839	0.403
Years of education (years)	10.05 ± 2.68	9.72 ± 2.43	0.707	0.481
Age at first onset (years)	24.04 ± 2.21	23.76 ± 2.15	0.703	0.483
Number of attacks (times)	3.72 ± 1.02	4.01 ± 1.41	1.291	0.199

Table 2. Comparison of HRV (frequency domain) between two groups of patients ($\bar{x} \pm s$).

Groups	Number of cases	LF (ms^2)		HF (ms^2)		LF/HF	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Control group	60	397.13 ± 45.19	453.17 ± 40.32*	310.76 ± 40.18	369.42 ± 40.12*	1.26 ± 0.20	1.22 ± 0.18
Observation group	60	395.88 ± 46.80	493.85 ± 48.38*	311.18 ± 39.87	426.31 ± 52.17*	1.28 ± 0.25	1.19 ± 0.18*
t value		0.149	5.003	0.057	6.696	0.484	0.913
p value		0.882	<0.001	0.954	<0.001	0.629	0.363

Note: HRV, heart rate variability; LF, low-frequency power; HF, high-frequency power; Compared with the same group of patients before treatment, *$p < 0.05$.

Statistical Analysis

SPSS 21.0 software (IBM, Amenk, NY, USA) was used for statistical analysis of the collected data. The measurement data were tested for normality, normally distributed, and presented as mean ± standard deviation ($\bar{x} \pm s$). The independent sample t-test was applied for intergroup comparisons. Count data were expressed as [n (%)], and the χ^2 test was employed for data contrasts. $p < 0.05$ was indicated as statistically significant.

Results

Comparison of General Information between the Two Groups of Patients

There was no statistically significant difference in general information, such as gender, age, disease course, education level, age of first onset, and number of attacks among the two groups of patients ($p > 0.05$, Table 1).

Comparison of HRV (Frequency Domain) between Two Groups of Patients

The results showed that there was no significant difference in HRV (frequency domain) between the two groups before treatment ($p > 0.05$, Table 2). After treatment, LF and HF in both groups were significantly higher than before treatment. LF and HF in the observation group were significantly higher than in the control group, and the difference was statistically significant ($p < 0.05$, Table 2).

Comparison of HRV (Time Domain) of Patients in Each Group

The results showed that there was no significant difference in HRV (time domain) between the two groups before treatment ($p > 0.05$, Table 3). After treatment, SDNN, SDANN, rMSSD, and PNN50 in both groups were significantly higher than before treatment. SDNN, SDANN, rMSSD, and PNN50 in the observation group were significantly higher than in the control group, with statistical significance ($p < 0.05$, Table 3).

Comparison of HAMD, SAS, and SDS Scores between the Two Groups of Patients

The results showed no significant difference in HAMD, SAS, and SDS scores between the two groups before treatment ($p > 0.05$, Table 4). After treatment, HAMD, SAS, and SDS scores in both groups were significantly lower than before treatment. HAMD, SAS, and SDS scores in the observation group were significantly lower than those in the control group, with statistical significance ($p < 0.05$, Table 4).

Comparison of Clinical Efficacy between Two Groups of Patients

The results demonstrated a statistically significant increase in the overall clinical efficacy rate among patients in the observation group compared to the control group ($p < 0.05$, Table 5).

Table 3. Comparison of HRV (time domain) of patients in each group ($\bar{x} \pm s$).

Groups	Number of cases	SDNN (ms)		SDANN (ms)		rMSSD (ms)		PNN50 (%)	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Control group	60	82.19 ± 27.61	93.06 ± 8.36*	74.38 ± 16.12	86.49 ± 17.75*	16.14 ± 4.67	21.56 ± 5.07*	1.77 ± 0.87	8.18 ± 0.69*
Observation group	60	82.78 ± 26.30	118.33 ± 12.73*	74.81 ± 15.57	96.50 ± 18.51*	16.87 ± 4.28	27.55 ± 5.59*	1.73 ± 0.67	9.43 ± 0.85*
t value		0.120	12.853	0.149	3.023	0.893	6.148	0.282	8.844
p value		0.905	<0.001	0.882	0.003	0.374	<0.001	0.778	<0.001

Note: SDNN, standard deviation of NN intervals; SDANN, the standard deviation of all five-minute NN intervals; rMSSD, root mean square of successive differences; PNN50, percent RR intervals with a difference in duration higher than 50 ms; Compared with the same group of patients before treatment, $^{*}p < 0.05$.

Table 4. Comparison of HAMD, SAS, and SDS scores between the two groups of patients ($\bar{x} \pm s$, score).

Groups	Number of cases	HAMD		SAS		SDS	
		Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Control group	60	36.97 ± 4.83	25.56 ± 2.59*	71.38 ± 13.60	46.58 ± 4.59*	56.74 ± 6.31	48.36 ± 4.65*
Observation group	60	37.12 ± 4.89	20.40 ± 2.27*	71.87 ± 14.03	40.82 ± 4.05*	56.08 ± 6.17	41.71 ± 4.21*
t value		0.169	11.606	0.194	7.289	0.579	8.212
p value		0.866	<0.001	0.846	<0.001	0.564	<0.001

Note: HAMD, Hamilton Depression Rating Scale; SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale; Compared with the same group of patients before treatment, $^{*}p < 0.05$.

Table 5. Comparison of clinical efficacy between two groups of patients [*n* (%)].

Groups	Number of cases	Cure	Improved	Invalid	Always valid
Control group	60	26 (43.33%)	22 (36.67%)	12 (20.00%)	48 (80.00%)
Observation group	60	30 (50.00%)	26 (43.33%)	4 (6.67%)	56 (93.33%)
χ^2 value					4.615
p value					0.032

Table 6. Comparison of the incidence of adverse reactions between the two groups of patients [*n* (%)].

Groups	Number of cases	Headache	Dizziness	nausea	Lethargy	Anorexia	Incidence of adverse reactions
Control group	60	4 (6.67%)	3 (5.00%)	1 (1.67%)	2 (3.33%)	5 (8.33%)	15 (25.00%)
Observation group	60	1 (1.67%)	0 (0%)	1 (1.67%)	1 (1.67%)	2 (3.33%)	5 (8.33%)
χ^2 value							6.000
p value							0.014

Comparison of the Incidence of Adverse Reactions between the Two Groups of Patients

The results revealed that adverse reactions in the observation group were markedly reduced compared to the control group, and the difference was statistically significant ($p < 0.05$, Table 6).

Discussion

BD is divided into bipolar I, bipolar II, cyclothymia, and other states to be classified according to its manifestations [14]. Recently, rapid progress has been made in BD's pathogenesis and pathological changes. Histologically, BD is thought to be caused by an imbalance between the levels of monoaminergic neurotransmitters, such as serotonin, norepinephrine, and especially dopaminergic neurotransmitters [15,16]. Except for depressive episodes, the clinical manifestations of BD patients also include prominent manic episodes. When in a depressed state, the clinical symptoms are the same as those of unipolar depression, which are characterized by low mood, negativity, pessimism, reduced behavioral activities, and in severe cases, suicidal behavior [17]. The manic/hypomanic state is characterized by high mood and "tireless" activities. During a manic episode, hospitalization is required due to extreme emotional instability, disordered behavior, and even impulsive and hurtful behavior [18]. Studies have found that BD patients often have an imbalance of autonomic nervous function [19]. An imbalance in autonomic nervous system function is one of the important impacts on the body of extreme mood changes. Furthermore, it serves as a pivotal factor contributing to the elevated incidence and fatality rates of various conditions, such as cardiovascular disease. Autonomic nervous system imbalance is mainly affected by the sympathetic and vagus nerve activity and their relative balance. Although drug treatment can work by blocking central dopamine receptors and 5-hydroxytryptamine receptors, it is not practical in improving the patient's emotional regulation ability and autonomic nervous system balance. Hence, the pursuit of safer and more efficacious treatment alternatives holds significant importance in enhancing the quality of life for individuals with bipolar disorder.

rTMS can effectively relieve negative emotions such as depression, thereby improving the overall efficacy of the disease. Studies have found that rTMS has established efficacy in the treatment of depression and has begun to establish a certain evidence base in the treatment of BD [20]. This study retrospectively selected 120 BD patients as the participants for research. It explored the impact of rTMS therapy on BD patients' autonomic nervous function, emotional regulation ability, and quality of life by detecting their HRV indicators, emotional symptom scores, and quality of life scores. The findings indicated that compared to the control group, the HF of the patients in the observation group exhibited an increase, and both LF and LF/HF experienced significant reductions. The SDNN, SDANN, rMSSD, and PNN50 of patients in the observation group were significantly higher than those in the control group. It is suggested that the change in HRV index in the observation group after rTMS therapy was not as obvious as that in the control group, and the decrease in HRV index in the control group was more obvious, indicating that drug treatment caused more obvious damage to the patient's overall autonomic nervous function imbalance and reduced vagus nerve activity. HRV is a sensitive indicator for assessing the activity of the cardiac autonomic nervous system, primarily influenced by the activity and equilibrium of the sympathetic and vagus nerves [21]. The mental stress analyzer uses the principle of heart rate variability to analyze the patient's mental and physical stress quantitatively. Heart rate variability refers to the small differences in the intervals between heartbeats, which results from the adjustment of the sinoatrial node of the heart by the autonomic nervous system [22]. This subtle distinction can mirror the functioning of the autonomic nervous system, indicating its level of activity, balance, and coordination, thereby objectively reflecting the stress on the brain. Therefore, heart rate variability is an ideal indicator of human mental stress. After scientific experiments and repeated demonstrations, heart rate variability has become an objective, accurate, and direct method for measuring human mental stress. rTMS mainly stimulates the cerebral cortex or remote cerebral cortex area by changing the magnetic field, and the nerve cells generate depolarization with the help of the brain-induced current generated, thereby exerting a therapeutic effect [23]. Since the intensity of this signal will not attenuate when it passes through the skull, it can have a more significant effect on the cranial nerves. Its high efficiency, non-invasiveness, and painlessness make rTMS gradually become one of the main treatments for BD. In addition, in this study, the total clinical efficacy rate among patients in the observation group was notably superior to that of the control group, and there was a considerably lower occurrence of adverse reactions. It shows that rTMS therapy has certain safety, fewer adverse reactions, and can achieve higher clinical efficacy. Many domestic and foreign studies have provided evidence of the safety and tolerability of rTMS treatment [24]. Common adverse reactions include headache, nausea, and other symptoms, all of which are mild adverse reactions. rTMS can effectively promote the recovery of BD's cognition, executive, and social functions and help the nervous system return to normal, thereby improving BD patients' quality of life and clinical outlook.

Overactivation of emotions and reduced ability to regulate emotions are characteristics of BD patients. Emotion regulation is divided into active and automatic processes, which are participated by different subregions of the prefrontal cortex. Research shows that traditional treatment options have diffuse effects on the brain, affecting the cerebral cortex and deep structures. This dispersed influence makes it difficult to establish a causal relationship between brain stimulation and emotional symptoms [25]. Compared with existing clinical treatment options, rTMS uses the principle of electromagnetic conversion to stimulate specific parts of the brain outside the skull. This affects the activity of functionally related nerve cells and contributes to regulating mood swings in BD patients. This study found that after rTMS treatment, the observation group's HAMD, SAS, and SDS scores were significantly lower than those of the control group. The results show that rTMS adjuvant therapy can effectively improve the mental state of patients with bipolar disorder, facilitate the recovery of patients, relieve their depression, and have a significant impact on the emotional regulation function. These findings are consistent with Bai X's [26] systematic review and meta-analysis of randomized hypothetical controlled trials of bipolar disorder via repetitive transcranial magnetic stimulation and Montesinos J *et al*.'s [27] study on the efficacy of rTMS in the treatment of bipolar depression. Patients with BD have specific cognitive dysfunctions and poor social function. After transcranial magnetic stimulation treatment, patients' social function, cognitive function, and attention are improved, which can better enhance their quality of life. The results of a series of studies, such as systematic reviews and meta-analyses, are consistent. During rTMS treatment, it not only regulates the nerve function of the head when stimulating the head, but also has a significant regulating effect after the stimulation is completed, which can maintain the brain's biochemical reactions, physiological functions, and tissue structure. Studies have shown that rTMS can significantly improve the neural activity of BD patients to regulate the excitability of neurons, thereby regulating mood disorders. rTMS magnetic stimulation can increase the cerebral cortex's excitability and enhance synaptic plasticity regulation [28].

Conclusions

In summary, rTMS has significant clinical effects in treating BD and can effectively improve patients' anxiety, suppress emotions, and regulate patients' emotions. At the same time, rTMS has high safety and little impact on the balance of patients' autonomic nervous function, reduces the incidence of adverse reactions, accelerates the patient's recovery process, and is suitable for clinical promotion. Nevertheless, the study's sample size is restricted, leading to limitations in the results that may not entirely align with the actual situation. Further validation is necessary following an expansion of the sample size to mitigate potential errors.

Availability of Data and Materials

The data used to support the findings of this study are included within the article, and during the present study are available from the corresponding author on reasonable request.

Author Contributions

YKQ, WJY and BY designed the research study. YKQ and WJY performed the research. WJY and BY analyzed the data. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The research received approval from the Shayang County People's Hospital's Medical Ethics Committee (20231211), and the entire procedure was informed by the patient or family member, who signed the informed consent form.

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Conflict of Interest

The authors declare no conflict of interest.

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