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Effects of Motion-Guided Imagination Training Combined with Eszopiclone on Sleep Disorders after Stroke

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Abstract

Objective: To explore the effects of motion-guided imagination training combined with eszopiclone therapy on sleep status, neurological function, negative emotion and quality of life in patients with post-stroke sleep disorders. **Methods:** A total of 90 patients with post-stroke sleep disorders treated from March 2021 to December 2023 were collected and divided into two groups: study group (n = 45; motion-guided imagination training combined with eszopiclone treatment for 2 weeks) and control group (n = 45; eszopiclone treatment for 2 weeks). The sleep conditions of the two groups were compared at different time points, and the differences of neurological function scores, serum indexes, negative emotions and quality of life indexes before and after treatment were recorded. **Results:** After 1 and 2 weeks of treatment, the Pittsburgh Sleep Quality Index (PSQI) score, awakening frequency and awakening time of both groups were decreased, and the sleeping time was increased. The changes were more apparent in the study group than the control group ($p < 0.05$). After treatment, the scores of National Institutes of Health Stroke Scale (NIHSS), Self Rating Anxiety Scale (SAS) and Self Rating Depression Scale (SDS) were lowered, and the scores of Quality of Life (QOL) scale, 5-hydroxytryptamine (5-HT) and brain-derived neurotrophic factor (BDNF) were elevated in both groups. The changes were more evident in the study group than the control group ($p < 0.05$). **Conclusion:** Motion-guided imagination training combined with eszopiclone may have a good effect in the treatment of sleep disorders after stroke, which can enhance sleep quality, promote neurological function recovery and improve negative emotions and quality of life, with clinical application value.

1 Introduction

Post-stroke sleep disorder is a common complication with a year-by-year increased incidence [1,2]. Stroke patients may experience damage to the thalamus or other brain tissues associated with sleep that leads to sleep disorder, reduced sleeping time, and decreased sleep quality, which can trigger adverse events such as dyslipidemia and anxiety or depression, and in turn affect the prognosis [3,4]. The treatment of post-stroke sleep disorder often requires a complex regimen, including both pharmacological and non-pharmacological interventions (cognitive behavioral therapy, acupuncture) [5]. The treatment faces multiple challenges, including difficulties in diagnosis, high risks of drug side effects, barriers to implementing non-pharmacological therapies, poor patient adherence [6]. Therefore, future research needs to further explore the pathophysiological mechanisms of post-stroke sleep disorder and develop safer and more effective pharmacological and non-pharmacological interventions, find a rational and effective treatment plan to improving the condition of patients with post-stroke sleep disorders [7,8].

Eszopiclone, a non-benzodiazepine drug, can effectively extend sleeping time, alleviate insomnia symptoms, and enhance sleep quality [9]. However, long-term use of eszopiclone may cause liver damage and the potential of drug dependence, resulting in a generally poor prognosis [10]. Motion-guided imagination training, a common clinical psychological relaxation therapy, guides patients to use pleasant and relaxed mental imagination to eliminate negative emotions through audio intervention. This therapy has gradually been applied to patients in intensive care units and after surgery (stroke, cerebral infarction, parkinson's disease), showing significant efficacy in improving sleep quality and negative emotions [11-15]. Motion-guided imagination training combined with duloxetine treatment can significantly improve the negative emotions of patients with post-cerebral infarction depression and promote cognitive and neurological function recovery [16].

Based on this, the present study compared the efficacy of eszopiclone, and motion-guided imagination training combined with eszopiclone in treating post-stroke sleep disorders, and examined the application value of combined therapy, with the aim to provide a reference for the selection of treatment plans for post-stroke sleep disorders in clinical practice.

2 Materials and methods

2.1 General information

A total of 90 patients with post-stroke sleep disorders treated from March 2021 to December 2023 were collected and divided into two groups: study group (n = 45; motion-guided imagination training combined with eszopiclone treatment) and control group (n = 45; eszopiclone treatment). The Ethics Committee of our hospital reviewed and approved this study. All patients signed an informed consent agreement form. There were no significant differences in gender, age, onset time, and disease type between the two groups (p > 0.05, Table 1), which were comparable.

Table 1 Comparison of general information between the two groups of patients.

Group	Study group (n = 45)	Control group (n = 45)	$t/Z/\chi^2$	p
Gender (Male/Female)	28/17	23/22	1.131	0.288
Age (year)	56.58 ± 8.58	55.11 ± 7.78	0.849	0.398
Onset time (day)	9.00 (7.00-10.00)	8.00 (6.00-10.00)	-1.098	0.272
Disease type (Hemorrhagic/ischemic)	17/28	19/26	0.185	0.667

2.2 Inclusion and exclusion criteria

2.2.1 Inclusion criteria

(1) Meet the diagnostic criteria for acute ischemic stroke, and confirmed through cranial computed tomography (CT) or magnetic resonance imaging (MRI) examination [17]; (2) Pittsburgh Sleep Quality Index (PSQI) score >7 points; (3) Normal cognitive function; (4) 45-70 years old.

2.2.2 Exclusion criteria

(1) Severe complications; (2) History of stroke; (3) Presence of sleep disorders prior to stroke; (4) Immune function disorders; (5) Coagulation dysfunction; (6) Insufficient functions of heart, liver, kidney, and other major organs; (7) Mental disorders, and poor treatment compliance; (8) Incomplete clinical data; (9) Pregnant or lactating women.

2.3 Methods

Both groups received routine treatments, including antithrombotic therapy and blood oxygen control. The control group, in addition to routine treatment, also took oral eszopiclone tablets (1 mg/tablet; 2 mg/dose; Jiangsu TASLY DIYI Pharmaceutical Co., Ltd., National medicine permission number (NMPN): H20090210) once daily before bedtime. The study group, based on the treatment in the control group, additionally adopted motion-guided imagination training. (1) Before treatment, the general process was introduced to patients, and training applicable images were present in PPT format to enhance patients' memory. Patients were instructed to adjust breathing and relax body and mind before with the audio at approximately 40 decibels; (2) Through guiding words, patients were guided to use various sensory organs, such as touch, sight, and hearing, to imagine the natural scenery of the seaside, physically experience the caress of the sea breeze, imagine various flowers on the golden beach, and listen to the sounds of the wind blowing through the leaves and waves hitting the stones, etc., and after patients were completely relaxed, they were guided to alternately relax muscles and joints from feet to head in order; (3) After relaxation, patients were guided to stand and assisted in experiencing free walking and other body visualization exercises as needed. Training was conducted twice a day and 20-30 min/time, before lunch break and sleep at night. The treatment lasted for 2 weeks in both groups.

2.4 Collection of indicators

2.4.1 Sleep status at different time points

The sleep status of patients in both groups was collected and compared before treatment, after 1 week of treatment, and after 2 weeks of treatment. The PSQI was applied to assess sleep quality, with a total score ranging from 0 to 21, where a higher score indicated poorer sleep quality [18]. A polygraph sleep monitor (Jiangxi Nuocheng Electric Co., Ltd.) was adopted to detect awakening frequency, awakening time, and sleeping time.

2.4.2 Neurological function score

The neurological function scores of patients in both groups were recorded before treatment and after 2 weeks of treatment. The National Institutes of Health Stroke Scale (NIHSS) was utilized to assess neurological deficits, with a total score ranging from 0 to 42, where a higher score reflected more severe neurological deficits [18].

2.4.3 Serum indicators

The levels of 5-hydroxytryptamine (5-HT) and brain-derived neurotrophic factor (BDNF) in patients were collected and contrasted in both groups before treatment and after 2 weeks of treatment. 5 mL fasting peripheral venous blood was drawn from all patients in the early morning, placed at room temperature for 30-60 min and centrifuged at 3000 r/min for 10 min. The separated serum was stored at -20 ℃. The enzyme-linked immunosorbent assay was

conducted to detect the above indicators, with kits provided by Shanghai Zhenke Biotechnology Co., Ltd.

2.4.4 Negative emotions and quality of life

The negative emotions and quality of life of patients in both groups were collected and contrasted before treatment and after 2 weeks of treatment. The Self Rating Anxiety Scale (SAS) and Self Rating Depression Scale (SDS) were used to assess negative emotions. The SAS had 20 items with 50 points as the boundary, where 50-59 points indicated mild anxiety, 60-69 points indicated moderate anxiety, and > 69 points indicated severe anxiety. The SDS had 20 items, with 53 points as the boundary, where 53-62 points hinted mild depression, 63-72 points hinted moderate depression, and ⩾ 73 points hinted severe depression. The Quality of Life (QOL) scale was employed to evaluate quality of life, including four dimensions such as social function and psychological function, with higher scores indicating better quality of life [19-21]. These score were assessed on site by two trained neurologists.

2.5 Statistical methods

SPSS 25.0 software was exploited for statistical analysis. Count data were represented as percentage (%), and comparisons between two groups were made using the χ^2 test. Measurement data were tested for normality using the Shapiro-Wilk test, and data that met the normal distribution were represented as mean ± standard deviation. Comparisons of various indicators were performed using the independent samples t-test, and comparisons of all indexes in the same group before and after treatment were conducted using the paired samples t-test. Data that did not conform to normal distribution were represented using the quartile method. Various indicators were contrasted using the Mann-Whitney U test. Indicators before and after treatment in the same group are made using the Wilcoxon signed-rank test. Multiple groups at different time points (three or more) were compared using the generalized estimating equation. A bilateral p-value of less than 0.05 was considered statistically significant.

3 Results

3.1 Motion-guided imagination training combined with eszopiclone treatment improve sleep status

Before treatment, there was no significant difference in PSQI scores, awakening frequency, awakening time, and sleeping time between the two groups ($p > 0.05$). Following 1 and 2 weeks of treatment, the PSQI scores, awakening frequency, and awakening time of both groups were decreased ($p < 0.05$), while sleeping time was increased ($p < 0.05$), and the change in the study group was greater than that in the control group ($p < 0.05$, Table 2).

3.2 Motion-guided imagination training combined with eszopiclone treatment decreased NIHSS scores

Prior to treatment, there was no significant difference in NIHSS scores between the two groups ($p > 0.05$). After treatment, the NIHSS scores of both groups were diminished ($p < 0.05$), and were lower in the study group than the control group ($p < 0.05$, Table 3).

3.3 Motion-guided imagination training combined with eszopiclone treatment increased serum indicators

Before treatment, no significant difference was determined in the levels of 5-HT and BDNF between the two groups ($p > 0.05$). Through treatment, the levels of 5-HT and BDNF were elevated in both groups ($p < 0.05$), and were higher in the study group than the control group ($p < 0.05$, Table 4).

Table 2 Comparison of sleep status between two groups at different time points.

Group		Study group (n = 45)	Control group (n = 45)	t/Z	p
PSQI score (score)	Before treatment	16.00 (14.00-18.00)	17.00 (14.00-18.00)	-0.581	0.561
	1 week after treatment	12.00 (11.00-15.00) *	15.00 (12.00-16.00) *	-2.327	0.02
	2 weeks after treatment	10.00 (7.00-12.00) *^	11.00 (9.00-13.00) *^	-2.313	0.021
Awakening frequency (times)	Before treatment	10.00 (8.00-11.00)	10.00 (8.00-11.00)	-0.792	0.429
	1 week after treatment	5.00 (3.00-6.00) *	7.00 (6.00-8.00) *	-4.248	< 0.001
	2 weeks after treatment	2.00 (2.00-3.00) *^	4.00 (3.00-5.00) *^	-5.17	< 0.001
Awakening time (minute)	Before treatment	71.20 ± 12.84	71.11 ± 11.37	0.035	0.972
	1 week after treatment	50.09 ± 6.73 *	60.33±8.85 *	-6.181	< 0.001
	2 weeks after treatment	29.00 (21.00-33.00) *^	41.00 (37.00-50.00) *^	-7.188	< 0.001
Sleeping time (minute)	Before treatment	265.00 (246.00-287.00)	260.00 (250.00-288.00)	-0.085	0.932
	1 week after treatment	316.73 ± 18.68 *	302.62 ± 15.28 *	3.922	< 0.001
	2 weeks after treatment	358.00 (347.00-365.00) *^	326.00 (319.00-337.00) *^	-7.238	< 0.001

Note: Compared to before treatment within the same group, * $p < 0.05$; compared to 1 week after treatment within the same group, ^ $p < 0.05$.

Table 3 Comparison of NIHSS scores in patients between the two groups before and after treatment (score).

Group	Study group (n = 45)	Control group (n = 45)	Z	p
Before treatment	9.00 (8.00-11.00)	9.00 (8.00-11.00)	-0.414	0.679
After treatment	3.00 (2.00-5.00) *	6.00 (4.00-8.00) *	-4.644	< 0.001

Note: Compared to before treatment within the same group, * $p < 0.05$.

Table 4 Comparison of serum indicators in patients between the two groups before and after treatment (μg/L, mean ± standard deviation).

Group		Study group (n = 45)	Control group (n = 45)	t	p
5-HT	Before treatment	12.58 ± 2.31	12.76 ± 2.67	-0.349	0.728
	After treatment	18.36 ± 3.27 *	15.70 ± 2.97 *	4.045	< 0.001
BDNF	Before treatment	11.99 ± 2.93	11.76 ± 2.89	0.374	0.709
	After treatment	17.83 ± 3.26 *	14.60 ± 2.59 *	5.208	< 0.001

Note: Compared to before treatment within the same group, * $p < 0.05$.

3.4 Motion-guided imagination training combined with eszopiclone treatment improved negative emotions and quality of life

Without treatment, the SAS, SDS and QOL scores had no evident difference in both groups. Due to treatment, the SAS and SDS scores were declined ($p < 0.05$) and QOL score was augmented ($p < 0.05$), and the changes were more notable in the study group than the control group ($p < 0.05$, Table 5).

Table 5 Comparison of negative emotions and quality of life before and after treatment between the two groups (score).

	Group	Study group	Control group	t/Z	p
	Case	45	45		
SAS	Before treatment	63.73 ± 8.69	63.36 ± 8.76	0.205	0.838
	After treatment	29.27 ± 7.65 *	44.31 ± 6.72 *	-9.915	< 0.001
SDS	Before treatment	64.00 (53.00-69.00)	63.00 (53.00-70.00)	-0.258	0.796
	After treatment	26.00 (20.00-34.00) *	39.00 (34.00-46.00) *	-6.34	< 0.001
QOL	Before treatment	150.31 ± 17.40	151.29 ± 18.92	-0.255	0.799
	After treatment	200.31 ± 14.21 *	181.02 ± 16.48 *	5.947	< 0.001

Note: compared to before treatment within the same group, * $p < 0.05$.

4 Discussion

To enhance the therapeutic effect on post-stroke sleep disorder and improve patients' survival outcomes, this study explored the application effects of motion-guided imagination training combined with eszopiclone therapy. The results indicated that the combined treatment may have better efficacy for post-stroke sleep disorder.

The NIHSS score is a commonly used scale in clinical stroke assessment, reflecting the status of neurological deficits [22]. Eszopiclone, a γ-aminobutyric acid (GABA) receptor agonist, reduces sympathetic nerve excitability and the speed of delayed neuronal apoptosis via binding to benzodiazepine receptors, thereby protecting neurological function. It also positively and allosterically regulates GABA-A receptors, exerting sedative and hypnotic effects and effectively reducing awakening frequency and time [8]. Previous study showed that Eszopiclone treatment can effectively improve sleep quality in patients with Parkinson's disease and comorbid sleep disorders, alleviate anxiety, and promote the alleviation of Parkinson's symptoms [23]. In the current study, compared to eszopiclone alone, motion-guided imagination training combined with eszopiclone can effectively improve negative emotion and quality of life, sleep conditions and better recovery of neurological function. Therefore, the combination of motion-guided imagination training and eszopiclone may have better efficacy on the sleep quality and neurological function of patients with post-stroke sleep disorder.

In light of existing research, neurological function-related factors, 5-HT and BDNF, are neurotransmitters that participate in regulation of psychological and neurological functions. 5-HT plays a key role in emotional regulation, and BDNF is critical in the growth and apoptosis of neurons and its level is linked to neuropathological conditions including

depression and anxiety [24,25]. Previous study showed that motion-guided imagination training, through audio intervention, helps patients relax, which can mitigate somatic symptoms and stress levels, increase the concentrations of 5-HT and BDNF in the serum, boost the transmission and secretion of neurotransmitters in neural networks, improve brain circulation, and thus achieve the effects of improving neurological function and inducing sedation and hypnosis [26]. Post-stroke sleep disorder can severely impact patients ' emotion and quality of life. Eszopiclone has anti-anxiety and sedative and hypnotic effects, which can effectively mediate cerebral cortex activity, increase slow wave amplitude of sleep, normalize sleep-awakening cycle, and regulate sleep structure, thereby improving anxiety, depression and other negative emotions, elevating treatment positivity, promoting restoration of daily activity abilities, and enhancing quality of life [27,28]. Motion-guided imagination training can reduce sympathetic nerve excitability, dampen the secretion of neurotransmitters such as adrenaline and dopamine, relieve pain, and alleviate anxiety and depression; meanwhile, it can help patients relax joints and muscle, contribute to restoring limb function, facilitating early rehabilitation training and improve quality of life [29-31]. Hence, motion-guided imagination training combined with eszopiclone was conducive to improving negative emotion and quality of life in post-stroke patients with sleep disorder.

However, due to the limited retrospective time and sample size in this study, the results have limitations, and no analysis was conducted regarding safety, adverse reactions (such as drowsiness, dizziness, dependence), or other aspects. Further, post-stroke sleep disorder may be affected by many other factors, and so bias (such as stroke location, Lifestyle and Environment, comorbidity) may have been present in the research results. Further trials, exploration, and validation are needed to refine the theoretical research on the efficacy of motion-guided imagination training combined with eszopiclone.

Collectively, motion-guided imagination training combined with eszopiclone for the treatment of post-stroke sleep disorder may have promising therapeutic effects, contributing to improved sleep quality, enhanced neurological function recovery, better management of negative emotions, and an improved quality of life, with high clinical application value.

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Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

Author Contributions

Substantial contributions to conception and design: Q.G. Data acquisition, data analysis and interpretation: Y.C. Drafting the article or critically revising it for important intellectual content: All authors. Final approval of the version to be published: All authors.

Ethics Approval and Consent to Participate

This study was approved by Medical Ethics Committee, and patients were informed and agreed.

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Availability of Data and Materials

The analyzed data sets generated during the study are available from the corresponding author on reasonable request.

Supplementary Materials

Not applicable.

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