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ORIGINAL RESEARCH

Combined Effect of Early Physical Exercise and Stereotactic Hematoma Evacuation in Patients with Cerebral Hemorrhage Undergoing Hemodialysis

Lijun Sun, MM; Shanquan Jing, MM; Lizhuang Zhang, MM

ABSTRACT

Objective • This study investigated the combined effect of stereotactic hematoma evacuation and early postoperative physical function exercise in hemodialysis patients with cerebral hemorrhage.

Methods • A retrospective study was conducted, including a total of 78 hemodialysis patients with cerebral hemorrhage treated at our hospital between January 2021 and June 2022. The patients were equally allocated to two groups based on different postoperative rehabilitation methods. The control group underwent stereotactic hematoma evacuation, while the study group received additional early postoperative physical function exercise in addition to the intervention provided to the control group. The operative conditions of both groups were recorded, and comparisons were made concerning neural function, limb function, daily activity ability, and complications.

Results • There were no significant differences between the two groups regarding operation time, intraoperative blood loss, and hematoma removal rate ($P > .05$). However, the study group demonstrated a significantly shorter hospital stay (12.98 ± 2.01 days) compared to the control group (15.02 ± 2.07 days), $P < .05$. Post-treatment, the study group exhibited substantially lower neurological function scores (NIHSS score) (6.37 ± 1.02) compared to the control group (10.03 ± 1.09), $P < .05$. Additionally, the study group showed significantly higher limb function scores ($P < .05$) and daily activity ability scores ($P < .05$) compared to the control group. Moreover, the incidence of complications in the study group was significantly lower than that in the control group ($P < .05$).

Conclusions • Early postoperative physical function exercise following stereotactic hematoma evacuation showed beneficial effects in hemodialysis patients with cerebral hemorrhage. It effectively reduced operation time, restored nerve and limb function, improved daily activity ability, and reduced the incidence of related complications. These approaches hold crucial clinical significance. (*Altern Ther Health Med.* 2023;29(8):347-351).

Lijun Sun, MM, Department of Nephrology, The First Hospital of Hebei Medical University, Shijiazhuang, China. **Shanquan Jing,** MM, Department of Rehabilitation Medicine, The First Hospital of Hebei Medical University, Shijiazhuang, China. **Lizhuang Zhang,** MM, Department of Neurosurgery, The First Hospital of Hebei Medical University, Shijiazhuang, China.

Corresponding author: Lizhuang Zhang, MM
E-mail: zhanglzhb@163.com

INTRODUCTION

Chronic kidney disease has emerged as a significant global public health concern, with its incidence steadily rising over time.[1] Previous studies have reported a worldwide incidence rate of approximately 13.4% for kidney disease.[2] In China, epidemiological data reveal a prevalence rate of 10.8% for chronic kidney disease among the general population, with approximately 1% of cases progressing to end-stage renal disease, necessitating long-term hemodialysis treatment.[1,2] Though hemodialysis extends the lifespan of patients, studies indicate that 5.6% to 11% of hemodialysis patients die from cerebrovascular accidents.[3] The risk of a cerebral hemorrhage in hemodialysis patients is reportedly 6 times higher than in the general population, leading to fatal outcomes in 35% of cases.[4] Consequently, early and appropriate interventions are crucial for managing hemodialysis patients with cerebral hemorrhage.

Surgical procedures are commonly employed in clinical treatment, and advances in treatment technology for this condition have been achieved through extensive clinical trials and treatment experiences. However, there are various surgical methods available, each with different prognoses. Craniotomy, a conventional surgical treatment for intracerebral hemorrhage, is known for its efficacy in hematoma removal and hemostasis. However, this procedure

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often causes damage to the surgical approach and surrounding normal brain tissue, consequently affecting patient prognosis negatively.[5]

In recent years, advancements in neuroimaging, neuroendoscopy, and microscope technology have led to the development of minimally invasive surgery methods, including minimally invasive surgery and stereotactic hematoma evacuation. These approaches have shown promising therapeutic effects and garnered significant attention and recognition from neurosurgeons and patients.[6] After surgical treatment, rehabilitation should commence promptly, provided that the patients exhibit stable vital signs.[7] However, routine clinical rehabilitation treatments often lack specificity and yield suboptimal outcomes. In contrast, early physical function exercise is characterized by its targeted, scientific, and practical approach, tailored to individual patient conditions post-surgery, to promote limb function recovery and enhance the overall quality of life.[6-7] Despite its potential benefits, limited evidence and literature reviews exist regarding combining stereotactic hematoma evacuation and early postoperative physical exercise in hemodialysis patients with cerebral hemorrhage.

Therefore, this retrospective study investigated the combined effect of early physical exercise and stereotactic hematoma evacuation in hemodialysis patients with cerebral hemorrhage.

METHODS AND MATERIALS

Study Design

A retrospective study was conducted at the First Hospital of Hebei Medical University between January 2021 and June 2022. Based on the inclusion and exclusion criteria, a total of 78 hemodialysis patients with cerebral hemorrhage were enrolled in this study and subsequently allocated into two groups: a control group and a study group, each receiving different postoperative rehabilitation methods. The study group comprised 21 males and 18 females, aged 30 to 78 years and an average age of (55.98 ± 12.93) years. Similarly, the control group consisted of 23 males and 16 females, aged 30 to 79 years, with an average age of (55.81 ± 12.79) years. The general data of the two groups were comparable ($P > .05$). The research protocol follows the Helsinki Declaration of the World Medical Association and has been approved by the Ethics Committee of The First Hospital of Hebei Medical University.

Selection Criteria

Inclusion criteria were as follows: (1) Patients who met the diagnostic criteria for chronic renal failure as per the Guidelines for Diagnosis and Treatment of Chronic Renal Failure[8] and received hemodialysis three times a week; (2) Patients who met the diagnostic criteria for intracerebral hemorrhage according to the Chinese Guidelines for Diagnosis and Treatment of Intracerebral Hemorrhage (2019).[9]

Exclusion criteria were as follows: (1) Patients with epilepsy, mental disorders, and a history of neurological diseases that may hinder treatment cooperation; (2) Patients with liver, heart, and lung dysfunction; (3) Patients with malignant tumors; (4) Patients who received treatment with hormones, immunosuppressants, or antibacterial drugs within the past month; (5) Patients with coagulation dysfunction; (6) Patients with subarachnoid hemorrhage; (7) Patients with intracranial hemorrhage caused by trauma or brain malignant tumor; (8) Patients unwilling to participate in this study; (9) Patients with operation contraindication, including those with unstable vital signs or dilated and fixed pupils, were excluded from this study.

Stereotactic Hematoma Evacuation Procedure

Both groups underwent stereotactic hematoma evacuation.[10] The procedure involved installing the head positioning reference frame, followed by a head CT scan to determine the coordinates of the target point, ensuring avoidance of important brain functional areas, and selecting the optimal puncture path. Subsequently, the arc arm and guide were installed, and the operating distance was adjusted to 190mm based on the measured target point's coordinates and the determined puncture site. A puncture needle was used to guide the insertion into the hematoma, puncturing the skull and dura mater. A drainage tube was connected, fixed in place, and the hematoma was aspirated with gentle, uniform suction. Once active bleeding was cleared, the hematoma cavity was flushed with an equal amount of normal saline to drain the blood, and the drainage tube was closed when the flushing fluid became clear.

To dissolve coagulated blood, 50 000 U of urokinase diluted with 2 mL of normal saline was injected into the hematoma cavity. Two hours after the urokinase injection, the drainage tube was opened to drain the blood. The exact dosage and urokinase administration methods were repeated three times a day for three consecutive days after the operation until the fourth-day post-operation. The puncture needle and drainage tube were removed after a CT reexamination confirmed satisfactory drainage.

Control Group Rehabilitation Training

The control group received routine rehabilitation training after the operation, which included exercises to improve sitting-standing balance and small passive limb movements. Additionally, patients were guided to perform appropriate active rehabilitation training five days after the operation.

Study Group: Early Postoperative Physical Function Exercises

Patients in the study group received early postoperative physical function exercises in addition to routine rehabilitation training. These exercises encompassed the following components:

Keeping Correct Limb Position. Patients were instructed to maintain the correct functional position of the affected limb after the operation. They were encouraged to avoid lower limb

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extension, upper limb flexion, foot varus, and foot droop patterns during paralysis. A support plate was utilized to fix the foot position and prevent foot droop during paralysis.

Passive Exercise of Limbs in Bed. Joint activities followed the principle of starting from the healthy side to the affected side, progressing from the upper limb to the lower limb and from the proximal end to the distal end. The exercises started with small amplitudes and gradually increased. Patients performed these exercises 3 to 4 times a day, with each session lasting 5 to 10 minutes. Family members were instructed to assist patients in performing flexion, extension, adduction, and peripheral exercises on the affected limbs.

Sitting Exercise and Endurance Training. Patients adopted a semi-lying position of approximately 30° and then gradually increased the height to maintain an 80°-90° sitting position based on their physical condition. They were encouraged to exercise endurance and improve their sitting time continuously.

Active Exercise of Upper and Lower Limbs. Patients were encouraged to perform active exercises of their limbs without assistance. This included the Bobath cross grip exercise for the upper limbs and various activities for the lower limbs, such as adduction and abduction, bridge training, flexion and extension, knee flexion, and hip extension.

Personal Physiological Ability Exercise. Patients engaged in exercises to enhance their physiological abilities, including toileting, eating, dressing, and washing.

Speech Exercise and Communication Stimulation. Family members or rehabilitation teachers proactively engaged in conversations with patients to provide multiple stimuli and strengthen the patients' response abilities.

Observation Indicators

Comparison of Operation Conditions. The study recorded the following parameters for both groups: operation time, intraoperative bleeding, hematoma removal rate, site of bleeding, time from onset to surgery, and hospital stay. The hematoma removal rate was calculated using the formula:

$$\text{Hematoma removal rate} = (\text{preoperative hematoma volume} - \text{postoperative hematoma volume}) / \text{preoperative hematoma volume} \times 100\%.$$

Neurological Function. The neurological function of patients before the operation, at 3 months, and 6 months after the operation was evaluated using the National Institutes of Health Stroke Scale (NIHSS) score.[11] This scale consists of 11 items, and the score ranges from 0 to 42. A higher score indicates a worse improvement in neurological function.

Limb Function. Limb function assessment was performed before the operation, at 3 months, and 6 months after the operation using the simplified Fugl-Meyer Assessment scale.[12] This scale comprises 50 items, and the total score represents the sum of all scores. The full score is 100 points, and a higher score indicates better limb function in the patient.

Activities of Daily Living. The evaluation of the patient's activities of daily living was conducted before the operation, at 3 months, and 6 months after the operation using the Barthel Index.[13] This index includes 8 items in total, and a higher score signifies a higher ability to perform daily living activities.

Complications. Detailed monitoring of complications experienced by patients during the treatment was carried out throughout the study period.

Statistical Analysis

Data analysis was performed using SPSS 23.0 (IBM, Armonk, NY, USA) software. The measurement data that conformed to a normal distribution were presented as mean ± standard deviation ($\bar{x} \pm s$). Overall data comparisons within each group were conducted using univariate analysis of variance, and pairwise comparisons between groups and within groups were performed using the Least Significant Difference (LSD) method. The counting data were expressed as percentages (%) and compared using the chi-square χ^2 test. Skewed distribution data were represented using quartiles (M: P_{25}, P_{75}). Statistical significance was set at $P < .05$.

RESULTS

Comparison of Surgical Conditions between the Two Groups

There were no significant differences between the two groups regarding operation time, intraoperative bleeding volume, site of bleeding, time from onset to surgery, and hematoma removal rate ($P > .05$). However, the hospital stay in the study group was significantly shorter (12.98 ± 2.01 days) than that in the control group (15.02 ± 2.07 days), with a $P < .05$, as shown in Table 1.

Comparison of Neural Function between the Two Groups

Neurological function was evaluated using the NIHSS score,[11] where a higher score indicated a worse improvement in neurological function. Before treatment, there was no significant difference in neurological function scores between the two groups ($P > .05$). However, after the treatment, the study group demonstrated a significantly lower neurological function score (6.37 ± 1.02) compared to the control group's score (10.03 ± 1.09), with a $P < .05$, refer to Table 2.

Comparison of Limb Function between the Two Groups

Before treatment, the two groups had no significant differences in limb function scores ($P > .05$). However, after treatment, the study group exhibited significantly higher limb function scores compared to the control group ($P < .05$), as presented in Table 2.

Comparison of Daily Activity Ability between the Two Groups

Before treatment, the two groups had no significant differences in daily activity scores ($P > .05$). However, after treatment, we observed a higher daily activity ability score in the study group compared to the control group ($P < .05$), as presented in Table 2.

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Table 1. Comparison of surgical conditions between the two groups

Items	Study Group (n = 39)	Control Group (n = 39)	*t*	*P* value
Duration of Surgery (min)	73.29 ± 10.32	75.93 ± 10.53	-1.123	.265
Amount of Intraoperative Bleeding (mL)	37.29 ± 7.92	38.76 ± 8.03	0.814	.418
Hematoma Removal Rate (%)	84.38 ± 14.32	84.89 ± 14.78	-0.155	.877
Hospital Stays (days)	12.98 ± 2.01	15.02 ± 2.07	-4.415	<.001
Site of Bleeding, n (%)			[a]	[a]
Thalamus	1 (2.56%)	1		
Lobe of the Brain	5 (12.82%)	3		
The Basal Ganglia	33 (84.62%)	34		
Time from Onset to Surgery (hours)	13.22 ± 2.72	13.01 ± 2.67	[a]	[a]

[a]indicates statistically significant difference ($P < .001$). The data are presented as mean ± standard deviation for continuous variables and as frequencies (n) and percentages (%) for categorical variables.

Table 2. Changes of function and ability between the two groups ($\bar{x} \pm s$)

Items		Study group (n = 39)	Control Group (n = 39)	*t*	*P* value
Nerve Function	Before Therapy	17.63 ± 1.32	17.74 ± 1.45	-0.351	.727
	After Therapy	6.37 ± 1.02	10.03 ± 1.09	-15.311	<.001
Limb Function	Before Therapy	37.91 ± 7.19	37.78 ± 8.03	0.075	.941
	After Therapy	78.38 ± 8.91	67.92 ± 8.76	5.228	<.001
Daily Activity Ability	Before Therapy	33.85 ± 6.19	72.56 ± 9.76	-0.056	.955
	After Therapy	33.93 ± 6.35	65.46 ± 9.65	3.231	.001

Note: The data are presented as mean ± standard deviation for continuous variables. Statistically significant differences are indicated by $P < .001$ for all comparisons.

Table 3. Comparison of complications between the two groups n (%)

Items	Study Group (n = 39)	Control Group (n = 39)	χ^2	*P* value
Rebleeding After Surgery (n)	0	2		
Lung Infection (n)	0	1		
Intracranial Infection (n)	0	2		
Venous Thrombosis (n)	1	3		
Total Incidence n (%)	1 (2.56)	8 (20.51)		
			6.155	.029

Note: The data are presented as frequencies (n) and percentages (%) for categorical variables. Statistically significant difference is indicated by $P < .05$.

Comparison of Complications between the Two Groups

The incidence of complications in the study group was significantly lower than that in the control group ($P < .05$), as shown in Table 3.

DISCUSSION

Hemodialysis serves as the primary treatment for individuals with chronic kidney disease.[14] However, hemodialysis patients are at an increased risk of developing life-threatening complications, such as cerebral hemorrhage, associated with high mortality and disability rates.[15-17] The basal ganglia are the most common site of cerebral hemorrhage, followed by the cerebral lobes and thalamus. Cerebral hemorrhage can lead to primary or secondary damage to brain tissue, posing potential life-threatening consequences. Thus, timely removal of the intracranial hematoma assumes critical importance in alleviating the hematoma's mass effect, releasing compressed brain tissue, reducing cerebral edema and intracranial pressure, and ultimately improving the prognosis for patients.[18]

Although debates exist concerning the optimal surgical approach for treating cerebral hemorrhage in hemodialysis patients, the emergence of minimally invasive techniques, such as stereotaxic hematoma evacuation, has garnered widespread clinical acceptance. This surgical method not only facilitates efficient hematoma clearance, effectively reducing secondary cerebral edema and central nervous system damage but also significantly reduces the occurrence of complications, positively impacting the early recovery of nervous system function.[18-20] In our study, the incidence of postoperative complications in the study group was significantly lower than that in the control group, consistent with the findings reported in the studies above.

The concept of modern rehabilitation medicine emphasizes the importance of early rehabilitation treatment, as it can facilitate the sprouting and regeneration of nerve axons

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and dendrites, the repair of neural functional networks, the establishment of cerebral collateral circulation, and the compensation and reorganization of cerebral hemisphere functions. Furthermore, early rehabilitation treatment can effectively reduce muscle loss, spasms, and atrophy and prevent complications such as pulmonary infection and lower extremity venous thrombosis. Consequently, it can lead to a shorter hospital stay, improved motor function, reduced disability rate, and enhanced patient self-care ability.[21-23]

In addition to these benefits, physical training has also been shown to effectively enhance limb function and promote the recovery of limb function, thereby significantly improving the quality of life for individuals suffering from cerebral hemorrhage.[24-29] The results of our study revealed several significant differences between the study group and the control group. Specifically, the study group exhibited shorter hospital stays, lower neurological function scores after treatment, and higher limb function scores compared to the control group. These findings suggest that early physical exercise following stereotaxic hematoma evacuation is crucial in reducing hospital stays and promoting early rehabilitation in patients with cerebral hemorrhage undergoing hemodialysis. Furthermore, promoting early rehabilitation in these patients positively impacts the cerebral cortex activity on the affected side and leads to improvements in the motor function of their upper and lower limbs. These findings align with previous research findings.

Study Limitations

However, our study had a few limitations that should be acknowledged. Firstly, the number of cases included in this study was limited, and patients were not grouped according to age and gender. To enhance the validity of our findings, we recommend conducting future research using multi-centre studies with a larger sample size and implementing stratification of patients based on age and gender. Secondly, extending the follow-up time is crucial to determine the long-term application value of early postoperative physical exercise and stereotactic hematoma evacuation in hemodialysis patients with cerebral hemorrhage. Implementing these measures will allow us to gain a more comprehensive understanding of the efficacy and long-term sustainability of these interventions.

CONCLUSION

In conclusion, our study highlights the clinical significance of implementing early postoperative physical activity in conjunction with stereotactic hematoma evacuation surgery for hemodialysis patients with cerebral hemorrhage. The intervention led to shorter hospital stays and facilitated significant improvements in limb and nerve function, enhanced daily activities, and reduced the risk of complications. These promising outcomes suggest that adopting these approaches can significantly benefit patients' overall well-being and contribute to better treatment outcomes in this patient population.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The relevant data is available on request from the corresponding author.

AUTHORS' CONTRIBUTIONS

Lijun Sun and Shanquan Jing contributed equally to this paper and should be regarded as co-first authors.

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