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The Importance of Early Rehabilitation Training for Limb Functional Recovery in Stroke Patients with Hemiplegia and Its Correlation with Preventing Abnormal Movement Patterns

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Abstract: This study aims to assess the efficacy of intensified early rehabilitation training on functional recovery in patients with stroke-induced hemiplegia. A total of 100 hemiplegic stroke patients admitted to our hospital from January 2022 to January 2023 were enrolled in this randomized controlled trial. Patients were divided equally into a control group, receiving standard care, and a study group undergoing enhanced early rehabilitation. The interventions included positioning training, limb massage, passive and active exercises, tailored to each patient's needs. Functional recovery was evaluated using the Fugl-Meyer Assessment Scale - Upper Extremity (FMA-UE), the Modified Barthel Index (MBI), and the National Institutes of Health Stroke Scale (NIHSS) at baseline and after six weeks of treatment. Results indicated that the study group exhibited significantly greater improvements in FMA-UE and MBI scores ($p<0.0001$) compared to the control group, indicating enhanced upper limb function and daily living activities. A more pronounced decrease in NIHSS scores in the study group ($p=1.02e-11$) also highlighted the reduction in neurological deficits. Early rehabilitation training significantly improved limb function, self-care capacity, and reduced neurological deficits in post-stroke hemiplegic patients. These findings underscore the importance of early rehabilitation in stroke treatment and the need for comprehensive, patient-centered nursing strategies to optimize recovery outcomes. Future research should focus on refining rehabilitation protocols and nursing care plans to cater to the individual needs of stroke survivors.

1. Introduction

Stroke represents a prevalent and severe clinical challenge globally, acting as a leading threat to human health with persistently high rates of disability and mortality. Epidemiological investigations have highlighted the substantial burden of cerebrovascular diseases, with stroke being a primary cause of death and long-term disability[1]. Despite advancements in medical technology enhancing treatment outcomes and significantly reducing mortality rates, the disability associated with stroke continues to severely impact the quality of life for survivors[1,2].

Recent studies, including a comprehensive survey conducted in China in 2017 involving 600,000

individuals, revealed an adjusted prevalence rate of stroke at 844.5 per 100,000 population[3]. This data underscores the widespread nature of stroke and the critical need for effective management strategies[4].

The importance of early rehabilitation training for stroke patients cannot be overstated. Extensive clinical research and practice have conclusively shown that timely and appropriate rehabilitation can markedly improve limb function, therapeutic outcomes, and life quality for stroke survivors[5]. This has brought about a paradigm shift in clinical focus towards prioritizing early rehabilitation efforts in stroke management.

This article offers a retrospective analysis of the clinical data from 100 patients with stroke-induced hemiplegia treated at our institution from January 2022 to January 2023. It aims to explore the efficacy and value of intensified early rehabilitation training for patients suffering from stroke-induced hemiplegia, highlighting its crucial role in enhancing patient recovery and reducing the long-term impact of stroke-related disabilities.

By integrating the latest epidemiological data and clinical evidence, this revised narrative emphasizes the ongoing challenges in stroke management and the essential role of rehabilitation in improving patient outcomes.

2. Research subjects and methods

2.1 General Information

This study involved 100 patients with hemiplegic stroke admitted to our hospital from January 2022 to January 2023. All patients were diagnosed with either cerebral hemorrhage or cerebral infarction, confirmed by CT or other imaging techniques, meeting the World Health Organization's diagnostic criteria for stroke. The patients were randomly divided into two groups, with a 1:1 ratio: an control group of 50 patients and a study group of 50 patients, based on their admission times and the different intervention protocols received during their treatment period.

2.1.1 Inclusion Criteria

①Confirmed diagnosis of stroke (cerebral hemorrhage or cerebral infarction) through imaging techniques.

②Development of hemiplegia as a result of the stroke.

③Age between 18 and 80 years.

④Admission to the hospital within 72 hours of stroke onset.

⑤Ability and willingness to participate in the rehabilitation training program.

⑥Informed consent provided by the patient or legal guardian.

2.1.2 Exclusion Criteria

①History of previous stroke with residual motor function impairment.

②Presence of severe cognitive disorders or psychiatric conditions that could interfere with rehabilitation participation or assessment.

③Concurrent medical conditions that contraindicate rehabilitation exercises, such as unstable cardiovascular disease.

④Patients who underwent surgical intervention for stroke management before the initiation of the study.

⑤Severe communication impairments that would hinder understanding of and compliance with

rehabilitation instructions.

2.2 Methods

2.2.1 Control Group Interventions

Patients in the control group received standard care interventions during their clinical stay. This included ensuring absolute bed rest with the head of the bed elevated at an angle of 15 to 30 degrees to facilitate venous return, which aids in reducing cerebral edema and intracranial pressure. The patient's head was positioned to one side to maintain an unobstructed airway. Perineal hygiene was meticulously maintained to ensure regular bowel movements and prevent pressure ulcers and constipation.

2.2.2 Study Group Interventions: Enhanced Early Rehabilitation Training

①Positioning Training: Proper positioning of the affected limb was ensured, with assistance provided to change the patient's position every 2 hours to maintain functional posture. Care was taken to avoid using heavy blankets that could compress and deform the affected limb, leading to complications such as inversion, eversion, or drooping of the foot.

②Limb Massage and Passive Exercise: Patients received muscle massage on the affected side, following a sequence from large to small joints for passive movements. The range of motion exercises started gently and gradually increased in intensity, beginning from the unaffected side moving towards the affected side. Passive exercises were conducted under strict guidance from nursing staff once the patient's vital signs were stable and they were fully conscious, with sessions held 2 to 3 times daily. Training methods included bed mobility, bridging exercises, and the Bobath technique for hand function.

③Active Exercises: Once muscle strength in the affected limb improved to grade 3 or above, patients were introduced to active exercises. These included sitting exercises, turning over, walking drills, standing exercises, and hand function training. Seated training progressed from leaning against a backrest to sitting up independently and trunk lean balance exercises. Standing training could be accomplished using a standing frame or through assisted standing exercises, progressing to walking training as performance improved.

2.3 Assessment Indices and Assessment Time Points

Close monitoring of changes in the patient's consciousness, complexion, and other vital signs was essential. Patient complaints were attentively listened to, and records were kept of limb mobility, neurological function scores(NIHSS), and Modified Barthel Index (MBI) changes. This comprehensive approach allowed for a detailed assessment of each patient's progress and the effectiveness of the rehabilitation interventions.

2.3.1 Assessment Indices

① Fugl-Meyer Assessment Scale - Upper Extremity (FMA-UE): Utilized for quantifying upper limb motor function.

② Modified Barthel Index (MBI): Assesses the ability to perform activities of daily living (ADLs).

③ National Institutes of Health Stroke Scale (NIHSS): A scale developed by the National Institutes of Health (NIH) to assess neurological deficits, stroke severity, and prognosis. Comprising 11 items, scores range from 0 to 42. Higher scores indicate more severe strokes and are positively

correlated with the volume of brain damage caused by stroke.

2.3.2 Assessment Procedure

Assessments are conducted by trained professionals using a blinded approach to ensure that assessors are unaware of the group allocations. Evaluation time points include baseline and the sixth week of treatment; demographic and clinical characteristic data of study participants are collected during baseline assessment.

2.4 Statistical Analysis

Statistical analyses were performed using R software (version 4.3), a comprehensive tool for data manipulation, calculation, and graphical display. For categorical data, the Chi-square (x^2) test was utilized to assess the frequency and distribution differences between groups. Continuous data were analyzed using the Student's t-test to compare means between the Control Group and the Study Group. A p-value of less than 0.05 was considered to indicate statistical significance, suggesting meaningful differences in outcomes related to early rehabilitation training effects on limb functional recovery and prevention of abnormal movement patterns in hemiplegic stroke patients.

3. Research results

3.1 Demographic Profile of Participants

The general demographic characteristics of the two study groups are presented in Table 1. The control group consisted of 50 individuals, with 31 males and 19 females, while the study group comprised 50 individuals, with 27 males and 23 females. There was no significant difference in the gender distribution between the two groups (x^2= 0.543, df=1, p=0.462). Regarding age, the mean age in the control group was (64.32±4.79) years and (66.01±4.41) years in the study group. In terms of duration of illness, the control group had a mean duration of (2.43±1.10) days, and the study group had a mean duration of (2.41±1.24) days . Concerning the distribution of affected side, the control group predominantly exhibited right-side lesions, while the study group primarily showed left-side lesions, with both groups having patients with bilateral involvement. None of the aforementioned variables showed statistically significant differences between the two groups(p>0.05).

Table 1: General demographic characteristics of the two study groups(n=100)

Indicator	Control Group(n=50)	Study Group(n=50)	x^2/t	df	p
Gender(n,%)					
Male	31(62.00)	27(54.00)			0.543*
Female	19(38.00)	23(46.00)			
Age (years; $\bar{x} \pm s$)	64.32±4.79	66.01±4.41	-1.84	97.34	0.069
Duration of Illness (days; $\bar{x} \pm s$)	2.43±1.10	2.41±1.24	0.09	94.47	0.921
Affected Side (n, %)					
Dominantly Left	21(42.00)	26(52.00)			
Dominantly Right	26(52.00)	19(38.00)	1.46	2.00	0.228
Bilateral	3(8.00)	5(10.00)			
∗Fisher's exact test was used.					

3.2 Comparison of Pre- and Post-Treatment FMA-UE Scores between Two Study Groups

In this study, we compared the upper limb functional recovery of two groups of patients with post-stroke hemiplegia before and after early rehabilitation training. Initially, the control group and the study group had FMA-UE baseline scores of (14.47 ±3.47) and (14.95 ±3.08), respectively, indicating similar levels of upper limb impairment prior to treatment. After 6 weeks of intervention, the FMA-UE scores increased to (32.64 ±6.90) in the control group and significantly rose to (40.09 ±7.73) in the study group. Statistical analysis revealed a significant difference in the improvement of upper limb function recovery between the study group and the control group post-treatment (t=-5.09, df=96.74, p=1.79e-06), while the difference between the groups was not significant before the treatment (t=-0.73, df=96.68, p=0.47). This suggests that early rehabilitation training had a significant positive effect on the upper limb functional recovery in the study group of patients. (Table 2)

Table 2: Comparison of Pre- and Post-Treatment FMA-UE Scores Between Two Study Groups ($\bar{x} \pm s$)

Group	N	Baseline FMA-UE ($\bar{x} \pm s$)	FMA-UE After 6 Weeks of Treatment ($\bar{x} \pm s$)
Control Group	50	14.47 ±3.47	32.64 ±6.90
Study Group	50	14.95 ±3.08	40.09 ±7.73
t		-0.73	-5.09
df		96.68	96.74
p		0.47	1.79e-06

Note: The FMA-UE (Fugl-Meyer Assessment-Upper Extremity) score is used to assess the recovery of motor function in the upper extremities of patients with post-stroke hemiplegia. The statistical analysis compares the mean scores before and after the intervention, with the t-value indicating the difference between the means of the two groups. A p-value of less than 0.05 is considered statistically significant. In this case, the post-treatment comparison shows a significant improvement in the study group compared to the control group.

3.3 Modified Barthel Index (MBI) Scores Before and After Treatment Between Two Groups

In a comparison of Modified Barthel Index (MBI) scores for two groups of stroke patients, both showed improvements after six weeks of treatment. The control group's scores increased from an average baseline of (30.42 ±4.74)to (54.07 ±6.21), while the study group experienced a more substantial improvement, with scores rising from (30.13 ±5.57) to(67.13 ±8.02). The change in the study group was statistically significant (t=-9.11, df=92.25, p=1.69e-14), indicating that the intervention had a markedly positive effect on activities of daily living in these patients.(Table 3).

Table 3: Comparison of Modified Barthel Index (MBI) Scores Before and After Treatment Between Two Groups($\bar{x} \pm s$)

Group	N	Baseline MBI ($\bar{x} \pm s$)	MBI After 6 Weeks of Treatment ($\bar{x} \pm s$)
Control Group	50	30.42 ±4.74	54.07 ±6.21
Study Group	50	30.13 ±5.57	67.13 ±8.02
t		0.28	-9.11
df		95.56	92.25
p		0.783	1.69e-14

Note: The Modified Barthel Index (MBI) is an internationally recognized measure of a person's daily functioning, specifically the ability to perform activities of daily living (ADLs). The MBI scores

range from 0 to 100, with higher scores indicating greater independence. The statistical analysis involves a comparison of mean scores ($\bar{x}$) with their standard deviations (s) before and after a 6-week treatment period. A t-test was used to determine the statistical significance of changes in MBI scores between the control and study groups. The p-value indicates the probability that the observed changes are due to chance. In this context, a p-value less than 0.05 is typically considered statistically significant. The significant negative t-value of -9.11 post-treatment for the study group (p=1.69e-14) suggests a substantial improvement in ADLs compared to the control group, which is indicative of the effectiveness of the treatment administered to the study group.

3.4 A Comparative Study Using NIHSS Scores

In this table, the baseline and 6-week follow-up NIHSS scores are given for both the control and study groups. The scores provide information on the severity of neurological deficits where a decrease in NIHSS score post-treatment indicates an improvement in the patient's condition. The table shows that both groups had similar baseline scores. However, post-treatment, the study group showed a significantly greater decrease in NIHSS score (10.25 ±2.85) compared to the control group (15.75 ± 4.75), with a t-value of 7.84, indicating a statistically significant improvement (p=1.02e-11). (Table 4)

Table 4: Comparative Analysis of NIH Stroke Scale (NIHSS) Scores Pre- and Post-Treatment between Control and Study groups ($\bar{x} \pm s$)

Group	N	Baseline NIHSS ($\bar{x} \pm s$)	NIHSS After 6 Weeks of Treatment ($\bar{x} \pm s$)
Control Group	50	26.30±7.87	15.75±4.75
Study Group	50	26.70±6.24	10.25±2.85
t		-0.28	7.84
df		93.18	87.67
p		0.781	1.02e-11

Note: The NIH Stroke Scale (NIHSS) is a measure used to quantify the impairment caused by a stroke. The scores range from 0 to 42, with higher scores indicating more severe neurological deficits. The statistical analysis compares the mean scores before and after the intervention, with the t-value representing the statistical difference between the mean scores of the two groups. A p-value of less than 0.05 is considered statistically significant. In this analysis, the post-treatment scores reveal a significant reduction in stroke-related impairments in the study group compared to the control group, as evidenced by the p-value of 1.02e-11.

4. Discussion

Stroke, with its high incidence, disability, and mortality rates, significantly impacts the lives of patients and places a considerable burden on society[1,3]. Therefore, enhancing treatment outcomes, reducing functional disabilities, improving patient autonomy in daily activities, and decreasing disability rates are of clinical importance[3]. Our study compared the functional recovery of two groups of patients with post-stroke hemiplegia before and after early rehabilitation training. The findings demonstrated that the study group showed significantly greater improvements in FMA-UE and MBI scores compared to the control group (p<0.0001), underscoring the substantial impact of early rehabilitation on upper limb functional recovery. Furthermore, the more pronounced decrease in NIHSS scores in the study group (p=1.02e-11) confirms the importance of early rehabilitation in mitigating neurological deficits, aligning with the conclusions of Hu L, Liu G's research[6].

Early rehabilitation not only facilitates neural collateral circulation and axonal connections but

also contributes to the reorganization and compensation of brain function[7]. Proper positioning during nursing interventions and rehabilitation training effectively controls spasms, maintains muscle tone balance, and reduces complications associated with increased muscle tone[8]. Additionally, elevating the patient's body position moderately can improve blood circulation and prevent venous stasis, crucial for the physical recovery of patients with post-stroke hemiplegia[9].

It is also imperative to acknowledge the psychological state of patients during recovery. Stroke patients often experience negative emotions like anxiety and depression, thus emphasizing the need for robust psychological care and health guidance to foster a positive mindset, significantly benefiting prognosis[10]. The enhanced clinical effectiveness and self-care ability observed in our study further validate the clinical significance of early rehabilitation training.

Nursing staff play a pivotal role in the recovery process of patients. Their attitude, demeanor, and professional skills directly influence treatment outcomes and the psychological well-being of patients. Therefore, nurses must continually improve their skills and interact with patients with optimism and enthusiasm, actively imparting positive energy to ensure patients receive the best care in a patient-centered environment[11].

In summary, early rehabilitation training notably improves limb function, self-care capacity, and reduces neurological deficits in patients with post-stroke hemiplegia. Emphasizing early rehabilitation's significance in stroke treatment and implementing comprehensive nursing strategies are irreplaceable for enhancing overall patient recovery and quality of life. The findings of this study provide robust evidence for the clinical application of early rehabilitation in stroke recovery, highlighting the need for integrated care throughout the rehabilitation process. Future research should delve deeper into different rehabilitation methods and strategies, as well as how to tailor nursing plans to individual patient differences, to further enhance treatment effects and achieve a more holistic recovery for patients.

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