IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Effect Of Vestibular Rehabilitation On Post Stroke Fatigue And Quality Of Life In Stroke Patients

SHERYL LOUIS CORREIA

A Project Submitted Towards Partial Fulfillment Of

Internship Program - 2023-2024

MIRAJ MEDICAL CENTER'S COLLEGE OF PHYSIOTHERAPY, WANLESS HOSPITAL, MIRAJ.

MAHARASHTRA UNIVERSITY OF HEALTH SCIENCES, NASHIK MARCH 2024

ABSTRACT

- **Background:** Stroke is the second largest cause of death in middle-to-high-income nations and the main cause of acquired physical disability in people globally. It is a significant global health problem and a major cause of mortality and morbidity in developed countries, and increasingly in low-middle income countries. Many stroke survivors experience the incapacitating feeling of fatigue, which is a predictor of death following stroke start. Post stroke fatigue is one of the common complications, with prevalence of 16-74%. Post stroke fatigue is multidimensional motor-perceptive, emotional and cognitive experience that effects the activities of daily living. It presents itself as lack of energy, helplessness and excessive burn out. It may be the reason for depression. It is different from the normal fatigue which ameliorates on rest. This type of fatigue persists even after neurological recovery in stroke patients. The PSF is associated with functional deficits and participation restrictions in the activities of daily living (ADL) and leads to a lower quality of life.

- **Purpose:** To study the effect of vestibular rehabilitation on post stroke fatigue and quality of life.

- **Methodology:** Participants were briefed about the nature of the study and the intervention. Their informed written consent was taken. 30 participants were selected based on the selection criteria. Prior and after the treatment the outcome measures that is Fatigue severity scale and Stroke specific quality of life scale were taken. Intervention protocol was given for 1 hour, 3times a week for 8 weeks.

- **Result:** The p-value after paired t tests in both groups is **less than 0.05** which indicates the strong evidence that there is a significant difference between the pre-test and post-test scores of fatigue and quality of life in stroke patients after vestibular rehabilitation.

- **Conclusion:** The present study concluded that there is significant improvement in post stroke fatigue and quality of life in stroke patients after vestibular rehabilitation

- **Key words:** Stroke, post stroke fatigue, quality of life, vestibular rehabilitation.

INTRODUCTION

Acute, focused neurological dysfunction caused by a vascular damage (infarction, hemorrhage) to the central nervous system is known as a stroke. This condition is clinically defined. Stroke is the second largest cause of death in middle-to-high-income nations and the main cause of acquired physical disability in people globally. Additionally, low-income nations account for 87% of stroke-related disability-adjusted life years and 85% of all stroke fatalities worldwide. [1].

It is a significant global health problem and a major cause of mortality and morbidity in developed countries, and increasingly in low-middle income countries (LMICs).

Seventy percent of strokes occur in LMICs, and the subsequent disease burden is greater than that of high-income countries, Life expectancy in India has recently increased to over 60 years of age leading to an increase in age-related, non-communicable diseases including stroke; making stroke India's fourth leading cause of death and fifth leading cause of disability. The incidence of stroke in India was estimated to be between 105 and 152/100,000 people per year.[2]

Neurological handicaps and loss of functional independence are common after stroke, and are often associated with depression and a poor quality of life [3-4]. At some time after the onset of stroke one third of all those afflicted experience significant depressive symptoms [5]. Stroke patients can also be expected to suffer from a variety of general symptoms related to their perceived health. Patients' self-rated health is known to be an important indicator of their quality of life and it has also been shown to be a good predictor of their future health [6-11.] Several studies have shown a strong association between self-rated health and mortality [12-14]. When planning for rehabilitation and continued care after stroke, it is therefore important to recognize and deal with many factors in addition to the patient's functional status and neurological sequelae.

Fatigue is a disabling and persistent symptom affecting many stroke survivors and is a predictor for death after stroke onset.[16]

Post stroke fatigue is one of the common complications, with prevalence of 16-74%. Post stroke fatigue is multidimensional motor-perceptive, emotional and cognitive experience that effects the activities of daily living. It presents itself as lack of energy, helplessness and excessive burn out. It may be the reason for depression. It is different from the normal fatigue which ameliorates on rest. [17]

The PSF is associated with functional deficits and participation restrictions in the activities of daily living (ADL) and leads to a lower quality of life.[17] Studies on the sensory integration theory in patients with stroke have shown deficits in sensory registration and modulation leading to restricting their activities of daily living. [18,19,20]

Disruption of the central sensory-motor integration such as visual, somatosensory, and vestibular systems leads to an unbalanced use of these senses by patients with stroke. [21]. This lack of integrated use can lead to inefficient postural control that may be due to fatigue.[19].

Given that there are multiple contributing factors to fatigue after a stroke, a variety of interventions might be beneficial. These interventions can be used in combination or individually and include pharmacological options (like antidepressants and stimulants), psychological approaches (such as cognitive behavioral therapy and counseling), or physical strategies, including structured exercise programs.[16].Although, vestibular

rehabilitation contributes to sensory integration through modulating self-awareness, body, space, and spatial navigation and reflex generation for oculomotor and posture control by adaptation compensatory mechanisms through repeating tasks.[4] Gait function, balance, and self-perceived health have all improved in recent research on stroke patients getting vestibular rehabilitation [17].

In stroke patients, this conclusion is also validated, demonstrating that the vestibular cortical network is memory, attention, social cognition, and mental imagery are all closely tied to the remaining sensory and motor impulses [28-30].

A number of measures, including the Fatigue Assessment Scale, Fatigue Impact Scale, Fatigue Severity Scale, and Visual Analogue Scale, are available to quantify fatigue.[25] The 9-item Fatigue Severity Scale (FSS), which is scored on a 7-point Likert Scale, assesses the effects of weariness.[24] It is a standard tool for measuring pathological tiredness in stroke and is straightforward to use, understand, and comprehend. [27]. A evaluation of the health-related quality of life (HRQOL) unique to stroke patients is provided by the Stroke Specific Quality Of Life scale (SS-QOL), a patient-centered outcome measure.

MATERIALS AND METHODOLOGY

The present study was conducted in Sangli district in the year 2023-24. The study protocol was reviewed and approved by the ethical committee of Miraj Medical centre's College of Physiotherapy, Wanless Hospital. 30 participants participated in this study. All participants gave their written, informed consent.

The outcome measures are:

1. Fatigue severity scale .
2. Stroke specific quality of life scale.

MATERIALS

- Ball
- Trampoline
- Plinth
- Tilt board

INCLUSION CRITERIA

- Stroke with unilateral hemiplegia diagnosed by physician.
- Both male and female patients will be included.
- Patients having stroke in the past 3 months till 36 months.
- Able to walk 10METER with no need to assistive device.
- Functional Ambulation Classification score ≥ 3.
- Fatigue severity scale score >36.

EXCLUSION CRITERIA

- Cognitive problems that might affect one's ability to comprehend instructions (Mini Mental State Examination score < 24).
- Severe aphasia, severe unilateral spatial neglect.
- Neurological and Orthopedic comorbidities like significant osteoarthritis, particularly in the lower limbs.

PROCEDURE

The study commenced with the screening of participants based on predefined inclusion and exclusion criteria. Subsequently, participants were evaluated for post-stroke fatigue using the Fatigue Severity Scale and for quality of life using the Stroke Specific Quality of Life Scale. After selection, the intervention was thoroughly explained to the participants, and written consent was obtained. The participants were then divided into two groups: Group A and Group B. Group A received vestibular rehabilitation for 8 weeks, with each session lasting 60 minutes and conducted three times per week, in addition to conventional therapy. Group B received only conventional therapy for 8 weeks, with each session also lasting 60 minutes and conducted three times per week. Upon completion of the intervention, participants were reassessed using the same scales to determine the effectiveness of the treatments.

INTERVENTION

GROUP A (Experimental group)

VESTIBULAR REHABILITATION PROTOCOL [4]

1. Static Position: Standing and Half Kneeling

(i) Firm surface

(ii) Foam surface

(iii) Trampoline

(iv) Tilt board

Each item was performed with open and closed eyes and head rotations to each side as well as throwing and catching a ball.

2. Dynamic Position: Walking

(i) Tandem gait forward and backward

(ii) Walking with a ball in hand and turning side to side as well as tracking the ball.

(iii) Stop and start walking, rotating 180 degrees in the direction as well as standing on one leg while it was ordered.

3. Oculomotor Training

(i) Saccade: rapid eye movement between 2 objects in 4 directions (horizontal, vertical, and 2 diagonal directions)

(ii) Smooth pursuit: tracking an object in 4 directions, while the head is stable

(iii) Vestibuloocular movements: rotating the head side to side, up, and down, while gazing at a subject.

CONVENTIONAL THERAPY SAME AS GROUP B

GROUP B (Control group)

CONVENTIONAL THERAPY

Conventional Physical therapy- 3 sessions of 60 min per week for 8 consecutive weeks.

- Bed mobility
- Sitting balance –LE uncrossed to crossed, sitting on a mat to sitting on a therapy ball, sitting eyes open to eyes closed on a therapy ball

UE- UE extended to UE folded across chest, single UE raises, bilateral UE raises, reaching movements with emphasis on affected side, picking objects off table, stool or floor.

- Standing- single leg support, stepping forward and backward, sideways, step-ups, marching in place, foot on ball, moving a ball with LE.
- Trunk movements – head and trunk rotations, looking up at ceiling and down to floor
- Stretching

3 sets of 10 reps each with 10 seconds hold each

- Functional activities- sit to stand, sit down, turning arounds, floor to standing, lunges, walking activities – forward, backward, sideward, cross-step walking and obstacle stepping.

STATISTICAL ANALYSIS AND RESULTS

- Normality test using Shapiro wilk test between FSS scores and SSQOL scores was done As the p-value for one variable (SSQOL for post in the Experimental group) is less than 0.05, it indicates that the data for this variable is not normally distributed.
- Within group Paired T-Test was done between pre and post results of control group and experimental group.
- Comparison was done within group pre and post-test using Wilcoxon signed ranked test.
- Comparison was done between groups independent test. It was done by using independent samples t test. It was done for FSS scores.
- Between groups independent test using Mann Whitney u test was done to compare the scores of SSQOL.

RESULTS

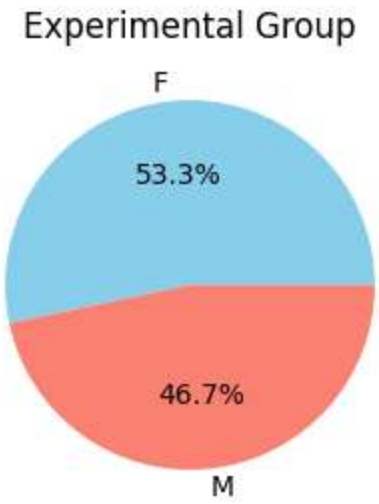
Descriptive Statistics:

Table No:1 -Variable - Gender

Gender	Group		Total
	Experimental	Control	
Male	7	8	15
Female	8	7	15
Total	15	15	30

Graphs representing Gender Distribution:

Graph No:1



Graph No:2

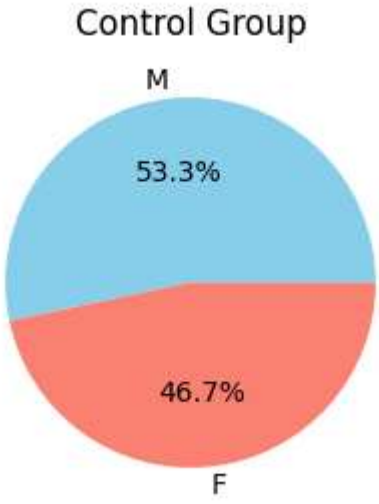
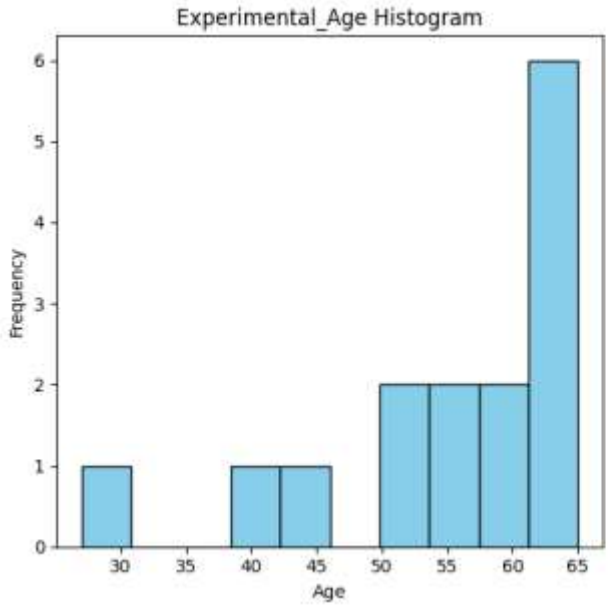


Table No:2-Variable - Age

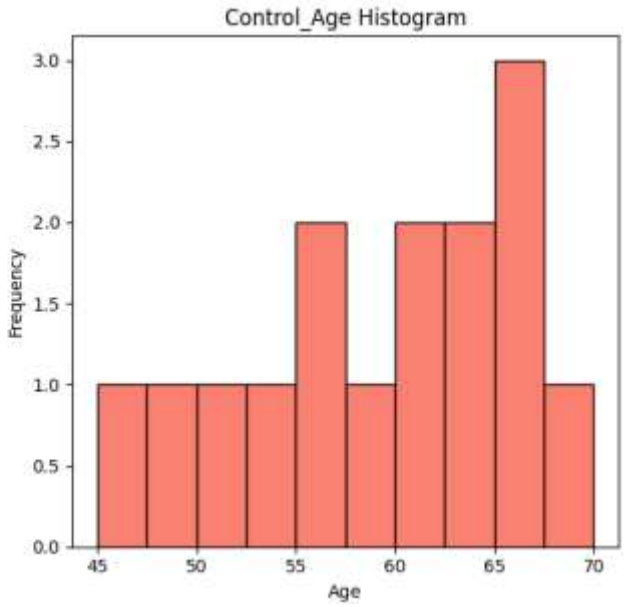
	Group	Mean	SD	Min	Median	Max
Age	Experimental	55.2	10.66503	27	59	65
	Control	58.8	7.222979	45	60	70

Age Distribution:

Graph no:3



Graph no :4



Normality test using Shapiro wilk test

H0: Data is normally distributed(p-value>0.05)i.e alpha=5%
H1: Data is not normally distributed

Table No:3- Shows z-value and P-value of outcome measures

		Experimental		Control	
		Z-value	P-Value	Z-value	P-value
FSS	Pre	0.9523	0.5616	0.9841	0.9900
	Post	0.9281	0.2559	0.9304	0.2768
SSQOL	Pre	0.9109	0.1400	0.9759	0.9344
	Post	0.8302	0.0092	0.9502	0.5287

Result: As the p-value for one variable (SSQOL for post in the Experimental group) is less than 0.05, it indicates that the data for this variable is not normally distributed. Due to this deviation from normality, parametric tests are not appropriate for SSQOL. Therefore, we will opt for a non-parametric test for SSQOL and para-metric test for FSS variable, specifically the Wilcoxon signed-rank test for SSQOL, which is suitable for analyzing non-normally distributed data and Paired T-test for FSS, which is suitable for analyzing normally distributed data.

Within group pre and post- test using Paired T -test:

Hypothesis:

H0: There is no significant difference between pre-test and post test score using Fatigue severity scale

H1: There is significant difference between pre-test and post test score using Fatigue severity scale

Table No:4-Comparison of pre-test and post-test scores of FSS in two Groups by paired sample t test

Groups	Times	Mean	SD	Mean Diff.	SD Diff.	t-value	p-value
Group EXP	Pre	42.466	4.085	-8.533	-1.098	12.026	9.096×10^{-09}
	Post	33.933	2.987				
Group CTR	Pre	40	2.236	-0.16	-0.139	4.1246	0.001
	Post	38.4	2.097				

In both groups, the mean difference between the pre-test and post -test is positive, indicating a substantial decrease in post-stroke fatigue post-intervention. The smaller mean diff. in EXP group suggest greater reduction in post-stroke fatigue compared to the CTR group. The negative SD indicates the reduction in variability from the pre-test to post-test, implying a more consistent response to the intervention among participants.

The t -value indicates that there is a large difference between the pre-test and the post test scores. Also, the p-value in both groups is less than 0.05 which indicates the strong evidence to reject H0 and suggest that there is a significant difference between the pre-test and post-test scores.

Comparatively, both the Experimental and Control groups exhibit significant differences between pre-test and post-test scores, with the Experimental group showing a more pronounced effect. This observation is further supported by the lower p-value in the Experimental group, suggesting its greater significance compared to the Control group.

Within group Pre and post test using Wilcoxon signed ranked test:

Hypothesis:
H0: There is no significant difference between pre-test and post test score using Stroke Specific Quality of life scale

H1: There is significant difference between pre-test and post test score using Stroke Specific Quality of life scale

Table No:5-Comparison of pre-test and post-test scores of SSQOL in two Groups by wilcoxon signed rank test

Groups	Times	Mean	SD	Mean Diff.	SD Diff.	W	p-value
Group EXP	Pre	141.46	10.96	26.94	4.88	17	7.972×10^{-05}
	Post	168.4	15.84				
Group CTR	Pre	137.13	5.097	4.6	-0.105	57	0.02225
	Post	141.73	4.992				

In both groups, the mean difference between the pre-test and post-test is positive, indicating a substantial increase in quality of life post-intervention. The smaller mean diff. in CTR group suggest smaller improvement in scores compared to the EXP group. For EXP group, the positive SD suggests an increase in the spread of scores from pre-test to post-test, possibly indicating greater variability in individual responses to the intervention. While the negative SD in CTR group suggests slight decrease in variability.

A lower Wilcoxon-value and smaller p-value indicates stronger evidence against the null hypothesis. In the EXP group, the Wilcoxon-value is 17 and the p-value is 7.972×10^{-05}, reflecting strong evidence to reject the null hypothesis. Similarly, in the CTR group, the Wilcoxon-value is 57 and p-value is 0.02225, indicating significant evidence against the null hypothesis but to a lesser extent compared to the EXP group.

The significant mean differences, standard deviation differences, Wilcoxon-values, and p-values in both the EXP and CTR groups suggest that there is a significant difference between pre-test and post-test scores using the Stroke Specific Quality of Life (SSQOL) scale. Therefore, we reject the null hypothesis (H0) and conclude that there is a significant improvement in SSQOL scores post-intervention in both groups.

Between groups independent test using independent samples t test

Hypothesis:

H0:There is no significant difference between Experimental group and Control group using Fatigue severity scale

H1:There is significant difference between Experimental group and Control group using Fatigue severity scale

Table No:6- Shows mean SD and p value of FSS pre and post intervention

Variable	Time	Group	Mean	SD	Mean Diff.	SD Diff.	t-value	p-value
FSS	Pre	EXP	42.466	4.085	-2.466	-1.849	2.0510	0.04972
		CTR	40	2.236				
	Post	EXP	33.933	2.987	4.467	-0.89	-4.7393	5.6560×10^{-05}
		CTR	38.4	2.097				

The independent t-test comparing the pre-test scores of the Experimental (EXP) and Control (CTR) groups reveals a significant difference. The mean difference (Mean Diff.) of -2.466 suggests that, on average, participants in the EXP group had lower fatigue severity scores compared to those in the CTR group before any intervention. This negative mean difference indicates that the EXP group reported less fatigue severity at baseline compared to the CTR group. Additionally, the standard deviation difference (SD Diff.) of -1.849 indicates greater variability in pre-test scores within the EXP group compared to the CTR group. The t-value of 2.0510 and the p-value of 0.04972 further support these findings, indicating a significant difference between the pre-test scores of the EXP and CTR groups. Thus, we reject the null hypothesis (H0) and conclude that there is a significant difference in fatigue severity between the two groups before any intervention.

The independent t-test comparing the post-test scores of the Experimental (EXP) and Control (CTR) groups also reveals a significant difference. The mean difference (Mean Diff.) of 4.467 indicates that, on average, participants in the CTR group had higher fatigue severity scores compared to those in the EXP group after the intervention. This positive mean difference suggests that the CTR group experienced increased fatigue severity levels post-intervention compared to the EXP group. The standard deviation difference (SD Diff.) of -0.89 indicates a smaller decrease in variability in post-test scores within the CTR group compared to the EXP group. The t-value of -4.7393 and the p-value of 5.6560e-05 further support these findings, indicating a significant difference between the post-test scores of the EXP and CTR groups. Thus, we reject the null hypothesis (H0) and conclude that there is a significant difference in fatigue severity between the two groups after the intervention.

In summary, the independent t-test comparing both pre-test and post-test scores of the Experimental and Control groups demonstrates significant differences. These findings support the alternative hypothesis (H1), suggesting a significant difference in fatigue severity between the Experimental and Control groups, both before and after the intervention.

Between groups independent test using Mann Whitney u test

Hypothesis:

H0: There is no significant difference between Experimental group and Control group using Stroke Specific Quality of life scale

H1: There is significant difference between Experimental group and Control group using Stroke Specific Quality of life scale

Table No:7- Shows mean SD and p value of SSQOL pre and post intervention

Variable	Time	Group	Mean	SD	Mean Diff.	SD Diff.	w	p-value
SSQOL	Pre	EXP	141.46	10.96	-4.33	-5.863	125.5	0.6036
		CTR	137.13	5.097				
	Post	EXP	168.4	15.84	-26.67	-10.84	225	3.3328×10^{-06}
		CTR	141.73	4.992				

The Mann-Whitney U test comparing the pre-test scores of the Experimental (EXP) and Control (CTR) groups does not reveal a significant difference. The mean difference (Mean Diff.) of -4.33 suggests that, on average, participants in the EXP group had slightly lower scores compared to those in the CTR group before any intervention. Similarly, the standard deviation difference (SD Diff.) of -5.863 indicates greater variability in pre-test scores within the EXP group compared to the CTR group. However, the Mann-Whitney U-value of 125.5 and

the associated p-value of 0.6036 indicate insufficient evidence to reject the null hypothesis (H0), suggesting no significant difference between the pre-test scores of the EXP and CTR groups.

The Mann-Whitney U test comparing the post-test scores of the Experimental and Control groups does reveal a significant difference. The mean difference (Mean Diff.) of -26.67 indicates that, on average, participants in the CTR group had significantly lower scores compared to those in the EXP group after the intervention. The standard deviation difference (SD Diff.) of -10.84 suggests a decrease in variability in post-test scores within the CTR group compared to the EXP group. The Mann-Whitney U-value of 225 and the associated p-value of 3.3328×10^{-06} indicate strong evidence to reject the null hypothesis (H0), suggesting a significant difference between the post-test scores of the EXP and CTR groups.

In summary, the Mann-Whitney U test comparing both pre-test and post-test scores of the Experimental and Control groups reveals significant differences only in post-test scores. Before the intervention, no significant difference was observed between the groups in terms of Stroke Specific Quality of Life scores. However, after the intervention, the Control group exhibited significantly lower scores compared to the Experimental group. These findings support the null hypothesis (H0) for pre-test scores and reject it for post-test scores, suggesting a significant difference between the Experimental and Control groups in terms of Stroke Specific Quality of Life scores after the intervention.

DISCUSSION

We looked at how vestibular rehabilitation exercises affected stroke patients' levels of independence and weariness when performing instrumental and daily tasks. The study's main variables were changes in fatigue and quality of life, which were found to be better in the experimental group relative to the control group in terms of FSS and SSQOL, respectively. The study involved a total of 30 participants who were randomly assigned to two groups: the experimental group and the control group, each comprising 15 individuals. The Fatigue Severity Scale (FSS) was utilized to evaluate post-stroke fatigue, while the Stroke-Specific Quality of Life Scale (SSQOL) was employed to assess the quality of life. Participants in the experimental group received vestibular rehabilitation in addition to conventional therapy over a period of 8 weeks, with 3 sessions each week, each lasting 60 minutes. The control group was provided with only conventional therapy for the same duration and frequency.

First variable of the study was post stroke fatigue which was measured using fatigue severity scale. Post stroke fatigue has shown significant improvement after vestibular rehabilitation. A study was undertaken by Ghaffari A, Asadi B, and Zareian A in 2022 to investigate the impact of vestibular rehabilitation on fatigue following a stroke. This study looked at how vestibular rehabilitation affected post-stroke fatigue patients' BADLs (basic activities of daily living), depression, and Lawton IADLs (instrumental activities of daily living). Random assignments were made to the experimental and control groups of individuals. The experimental group participated in a vestibular rehabilitation treatment for 24 sessions. The typical therapy, which consists of three sessions per week lasting roughly 60 minutes each, was given to the control group. The fatigue Impact Scale (FIS) and the Fatigue Assessment Scale (FAS) were employed to quantify fatigue Result: Vestibular rehabilitation was beneficial for fatigue, depression, and ADL in patient.[4] Vestibular rehabilitation was found to be beneficial in reducing fatigue in people with Parkinson's disease and multiple sclerosis (MS), according to studies by Abasi.et.al and Hebertetal. If more than one neuronal adaptation exists When the central nervous system is damaged, a process known as sensory adaptation takes place, which leads to a pattern of sensory dependency [35,36]. Exercises for the vestibular system appear to enhance the central nervous system's adaptability and lessen the pattern of sensory dependence. As a result, patients may utilize the vestibular system more effectively and rely less on their ocular and somatosensory systems. Resensory integration therefore strikes a balance between the brain's capacities, resulting in less exhaustion and less energy used for daily tasks.

Electroneurophysiological studies revealed that stroke patients have aberrant connection between the pri mary motor cortex (M1) and the supplementary motor region (SMA)[32]. The findings suggest that we may be able to reorganize SMA-to M1 connectivity patterns and generate a sensory motor gain by stimulating the supplementary motor area (SMA) with vestibular training in dynamic conditions without visual differences. This will help to improve anticipatory postural adjustment (APA) and achieve a higher performance in carrying out daily

activities.[33] These findings align with those of Tramontano et al. and Mitsutake et al., who demonstrated the beneficial benefits of vestibular therapy on stroke patients' postural control and walking balance. It's likely that vestibular therapy reduces the energy needed to maintain balance, which helps lessen physical tiredness following a stroke.[37,38].

The second variable of the study was quality of lifeWai **K. Tang, MD, Jin Y. Lu.(2010)**conducted a study which stated that Poststroke fatigue is associated with poorer HRQOL in chronic stroke. It was an independent predictor of HRQOL in 190 young stroke survivors 6 years after stroke. HRQOL was assessed with the Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) at 3 months after the subjects' index stroke. Fatigue was evaluated by using the Fatigue Severity The correlation between the FSS and SF-36 scores was examined and adjusted for potential confounders, including age, sex, marital status, previous stroke, social support, global cognitive functions, neurologic deficits, and depressive symptom. Conclusion: The findings suggested that fatigue has an impact on short-term HRQOL in stroke patients.[27]

According to Hansson et al., stroke patients experienced improvements in their self-rated health following vestibular rehabilitation, including self-care, mobility, engagement in routine activities, pain and discomfort, and depression anxiety as assessed by the EuroQol-5D (EQ5D)[34]

CONCLUSION

This study concluded that vestibular rehabilitation has a significant effect on reducing post-stroke fatigue severity and improving quality of life in stroke patients.

RFRENCES

1) Murphy SJ, Werring DJ. Stroke: causes and clinical features. Medicine. 2020 Sep 1;48(9):561-6.
2) Jones SP, Baqai K, Clegg A, Georgiou R, Harris C, Holland EJ, Kalkonde Y, Lightbody CE, Maulik PK, Srivastava PM, Pandian JD. Stroke in India: A systematic review of the incidence, prevalence, and case fatality. International Journal of Stroke. 2022 Feb;17(2):132-40.
3) Suenkeler IH, Nowak M, Misselwitz B, Kugler C, Schreiber W, Oertel WH, Back T: Timecourse of health-related quality of life as determined 3, 6 and 12 months after stroke. Relationship to neurological deficit, disability and depression. J Neurol. 2002, 249 (9): 1160-1167. 10.1007/s00415-002-0792-3.
4) Herrmann N, Black SE, Lawrence J, Szekely C, Szalai JP: The Sunnybrook Stroke Study: a prospective study of depressive symptoms and functional outcome. Stroke. 1998, 29 (3): 618-624.
5) Hackett ML, Yapa C, Parag V, Anderson CS: Frequency of depression after stroke: a systematic review of observational studies. Stroke. 2005, 36: 1330-1340. 10.1161/01.STR.0000165928.19135.35.
6) King RB: Quality of life after stroke. Stroke. 1996, 27 (9): 1467-1472.
7) Tibblin G, Cato K, Svardsudd K: Goteborg quality of life study of men born in 1913 and 1923 - age, sex, job satisfaction and cardiovascular diseases. Scand J Prim Health Care Suppl. 1990, 1: 39-45.
8) Shadbolt B, Barresi J, Craft P: Self-rated health as a predictor of survival among patients with advanced cancer. J Clin Oncol. 2002, 20 (10): 2514-2519. 10.1200/JCO.2002.08.060.
9) Muters S, Lampert T, Maschewsky-Schneider U: Subjective health as predictor for mortality. (Article in German). Gesundheitswesen. 2005, 67 (2): 129-136. 10.1055/s-2005-857886.
10) Hillen T, Davies S, Rudd AG, Kieselbach T, Wolfe CD: Self ratings of health predict functional outcome and recurrence free survival after stroke. J Epidemiol Community Health. 2003, 57: 960-966. 10.1136/jech.57.12.960.

11) Bjorner JB, Söndergaard-Kristensen T, Orth-Gomér K, Tibblin G, Sullivan M, Westerholm P: Self-rated Health, A Useful Concept in Research, Prevention and Clinical Medicine. 1996, Swedish Council for Planning and Cordination of Research.

12) Sundquist J, Johansson SE: Self reported poor health and low education levelpredictors for mortality: a population based follow up study of 39,156 people in Sweden. J Epidemiol Community Health. 1997, 51 (1): 35-40Self rated healthStroke.

13) Mossey JM, Shapiro E: Self-rated health: a predictor of mortality among the elderly. Am J Public Health. 1982, 72 (8): 800-808.

14) Idler EL, Benyamini Y: Self-rated health and mortality: a review of twenty-seven community studies. J Health Soc Behav. 1997, 38 (1): 21-37. 10.2307/2955359.

15) Hoeymans N, Feskens EJ, Kromhout D, van den Bos GA: The contribution of chronic conditions and disabilities to poor self-rated health in elderly men. J Gerontol A Biol Sci Med Sci. 1999, 54 (10): 501-506.

16) Bogousslavsky J, Paciaroni M. Post-Stroke Fatigue: Epidemiology, Clinical Characteristics and Treatment. European Neurology. 2014 Nov 1;72.

17) Ghaffari A, Asadi B, Zareian A, Akbarfahimi M, Raissi GR, Fathali Lavasani F. The Effects of Vestibular Rehabilitation on Poststroke Fatigue: A Randomized Controlled Trial Study. Stroke Research and Treatment. 2022 Aug 31;2022.

18) Oliveira CB, Medeiros ÍR, Greters MG, Frota NA, Lucato LT, Scaff M, Conforto AB. Abnormal sensory integration affects balance control in hemiparetic patients within the first year after stroke. Clinics. 2011;66:2043-8

19) Jang SH, Lee JH. Impact of sensory integration training on balance among stroke patients: Sensory integration training on balance among stroke patients. Open Medicine. 2016 Jan 1;11(1):330-5.

20) Sharony AF, Engel-Yeger B. Sensory modulation and participation in daily occupations in stroke survivors. Canadian Journal of Occupational Therapy. 2021 Dec;88(4):375-83.

21) Bernard-Espina J, Beraneck M, Maier MA, Tagliabue M. Multisensory integration in stroke patients: a theoretical approach to reinterpret upper-limb proprioceptive deficits and visual compensation. Frontiers in neuroscience. 2021 Apr 7;15:646698.

22) Han BI, Song HS, Kim JS. Vestibular rehabilitation therapy: review of indications, mechanisms, and key exercises. Journal of Clinical Neurology. 2011 Dec 1;7(4):184-96

23) Caplan B, DeLuca J, Kreutzer JS. Encyclopedia of clinical neuropsychology. Springer; 2010.

24) Nadarajah M, Mazlan M, Abdul-Latif L, Goh HT. Test-retest reliability, internal consistency and concurrent validity of Fatigue Severity Scale in measuring post-stroke fatigue. European journal of physical and rehabilitation medicine. 2016 Oct 21;53(5):703-9.

25) Carod-Artal FJ. Specific scales for rating quality of life after stroke. Revista de Neurologia. 2004 Dec 1;39(11):1052-62.

26) Alotaibi SM, Alotaibi HM, Alolyani AM, Dali FA, Alshammari AK, Alhwiesh AA, Gari DM, Khuda IK, Vallabadoss CA. Assessment of the stroke-specific quality-of-life scale in KFHU, Khobar: A prospective cross-sectional study. Neurosciences Journal. 2021 Apr 1;26(2):171-8

27) Tang WK, Lu JY, Chen YK, Mok VC, Ungvari GS, Wong KS. Is fatigue associated with short-term health-related quality of life in stroke? .Archives of physical medicine and rehabilitation. 2010 Oct 1;91(10):1511-5.

28) Lopez C. The vestibular system: balancing more than just the body. Current opinion in neurology. 2016 Feb 1;29(1):74-83.

29) Angelaki DE, Cullen KE. Vestibular system: the many facets of a multimodal sense. Annu. Rev. Neurosci.. 2008 Jul21;31: 125-50.

30) Sarvghadi P, Ghaffari A, Rostami HR. The effects of neurofeedback training on short-term memory and quality of life in women with breast cancer. International Journal of Therapy and Rehabilitation. 2019 Nov 2;26(11):1-8.

31) Skånér Y, Nilsson GH, Sundquist K, Hassler E, Krakau I. Self-rated health, symptoms of depression and general symptoms at 3 and 12 months after a first-ever stroke: a municipality-based study in Sweden. BMC Family Practice. 2007 Dec;8(1):1-9.

32) J. L. Amengual, T. F. Münte, J. Marco-Pallarés et al., "Overactivation of the supplementary motor area in chronic stroke patients," Journal of Neurophysiology, vol. 112, no. 9, pp. 2251–2263, 2014.

33) N. G. Galligan, D. Hevey, R. F. Coen, and J. A. Harbison, "Clarifying the associations between anxiety, depression and fatigue following stroke," Journal of Health Psychology, vol. 21, no. 12, pp. 2863–2871, 2016.

34) E. Ekvall Hansson, H. Pessah-Rasmussen, A. Bring, B. Vahlberg, and L. Persson, "Vestibular rehabilitation for per sons with stroke and concomitant dizziness—a pilot study," Pilot and feasibility studies, vol. 6, no. 1, pp. 1–7, 2020.

35) A. Abasi, P. Raji, J. H. Friedman et al., "Effects of vestibular rehabilitation on fatigue and activities of daily living in people with Parkinson's disease: a pilot randomized controlled trial study," Parkinson's Disease, vol. 2020, Article ID 8624986, 7 pages, 2020.

36) J. R. Hebert, J. R. Corboy, M. M. Manago, and M. Schenkman, "Effects of vestibular rehabilitation on multiple sclerosis related fatigue and upright postural control: a randomized controlled trial," Physical Therapy, vol. 91, no. 8, pp. 1166 1183, 2011.

37) M. Tramontano, E. Bergamini, M. Iosa, V. Belluscio, G. Vannozzi, and G. Morone, "Vestibular rehabilitation training in patients with subacute stroke: a preliminary randomized controlled trial," NeuroRehabilitation, vol. 43, no. 2, pp. 247 254, 2018.

38) T. Mitsutake, M. Sakamoto, K. Ueta, S. Oka, and E. Horikawa, "Effects of vestibular rehabilitation on gait performance in poststroke patients: a pilot randomized controlled trial," International Journal of Rehabilitation Research, vol. 40, no. 3, pp. 240–245, 2017.

39) Cruz-Cruz C, Martinez-Nuñez JM, Perez ME, Kravzov-Jinich J, Ríos-Castañeda C, Altagracia-Martinez M. Evaluation of the stroke-specific quality-of-life (SSQOL) scale in Mexico: a preliminary approach. Value in health regional issues. 2013 Dec 1;2(3):392-7.