IJIS: Vol.1, Issue1, February 2025, Page: 01-07 ISSN: 3049-3277

International Journal of Integrative Studies (IJIS)

Journal homepage:www.ijis.co.in

Effectiveness of Progressive Resistive Exercises on Gait Performance and Balance in Stroke

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Abstract

Study Design: Pre to post-test design- experimental study

Background: There is a lack of clinical research regarding effectiveness of Progressive Resistive Exercises for improvement of Gait performance and Balance in Stroke. To our knowledge there are no prospective, randomized studies in the literature investigating the Progressive Resistive Exercises in improving Gait performance and Balance in Stroke.

Purpose of the study: To determine the effect of Progressive Resistive Exercises for improvement of Gait performance and Balance in Stroke.

Method: 30 subjects with 30-150 days post stroke having Spasticity 1+ or less than 1+ on modified Ashworth were randomly assigned to either control group or experimental group. Readings were taken for Time and Go Test (TUG) on 1st day and last day of 4th week.

Results: The results of the study suggest that progressive resistive exercises are significantly effective in improving gait performance and balance than active exercises (same exercises without resistance) in stroke patients. There was a significant improvement in TUG score in group B in the end of 4th week ($p<0.002$) compared to that in group A.

Conclusion: The results of the study revealed that low carb diet is more effective in decreasing pain in knee osteoarthritis patients.

Keywords: *Stroke, Cadence, Pain, TUG Test, Walking velocity*

DOI: 10.63856/ejd96466

1. Introduction

Stroke is an acute onset of neurological dysfunction due to an abnormality in cerebral circulation with resultant signs and symptoms that correspond to involvement of focal areas of the brain. As a result, the affected area of the brain is unable to function, leading to inability to move one or more limbs on one side of the body. In the past, stroke was referred to as cerebrovascular accident or CVA. Stroke is rapidly developing clinical symptoms and / or signs of focal, and at times global (applied to patients in deep coma and to those with subarachnoid haemorrhage) loss of cerebral functions, with symptoms lasting more than

24 hours or leading to death, with no apparent cause other than that of vascular origin. The last few decades have seen a rise in the incidence and prevalence of stroke in India, attributable to increasing life span, urbanization, and better survival, and the rates are now matching western figures. Stroke is currently the second leading cause of death in the Western world, ranking after heart disease and before cancer and causes 10% of deaths worldwide. The incidence of stroke increases exponentially from 30 years of age. 95% of strokes occur in people aged 45 and older, and Early physical therapy intervention in gait training is believed to be beneficial for patients after a stroke. Poststroke recovery of the upper extremity is less rapid and complete than poststroke recovery of the lower extremity. Individuals with lower extremity impairments may be more functional and appear less disabled than individuals with upper extremity impairments. Approximately 50% to 80% of patients who survive a stroke will eventually regain some degree of walking ability two-thirds of strokes occur in those over the age of 65.

In past, bobath avoided resistive exercises with post stroke individuals with spasticity suggesting that the use of effort would only increase co-contraction and reduce coordination. Hence, they wanted to test the clinical assumption that resistive exercises lead to loss force production and force modulation in spastic subjects in such a way that spasticity and co-contraction increases and force control is reduced. They found that resistive exercises appeared to have a beneficial effect on the performance of paretic muscle hence resistive exercises is not detrimental to post stroke spastic muscle. It should be considered as a possible remediation for the deficits of muscle weakness & decreased function in post-stroke individuals. Progressive resistance training (PRT) generally refers to training with progressively increasing resistive loads beginning at a minimum of 40 percent of that load that can be lifted once (one repetition maximum [1-RM]). The 1-RM is regularly tested at least every 2 weeks, and the resistive load is progressively increased to maintain a sufficiently intense training stimulus. This study is to compare two groups of same protocol, one with resistance and other without resistance.

Need of study:

In previous studies, progressive resistive exercises have been found to be effective intervention to improve muscle strength in stroke patients. But a study is needed to clarify the effects of progressive resistive exercises on gait performance and balance.

Objectives:

To evaluate the effects of progressive resistive exercises on changes in gait performance and balance in stroke patients.

2. Methodology

Number and Source:

The study was conducted on 30 patients.

Design of study was pre test and post test experimental design.

The source of patients was Vimhans hospital, Nehru nagar, New Delhi,

Inclusion Criteria

- 30-150 days post stroke
- Age between 40 to 70 years
- Spasticity 1+ or less than 1+ on modified Ashworth scale.
- MMSE score of minimum 24
- Able to walk 10 meters independently with or without an assistive device.
- No medication, physical, cognitive or mental dysfunction that could impact upon gait performance.

- A concurrent progressive neurological disorder
- Lower limb fracture
- Lower limb amputation
- Uncontrolled hypertension
- Pain on weight bearing
- History of spinal fracture due to osteoporosis or any condition that would prevent a patient from performing strengthening exercises

Sampling: Convenience sampling

Instruments and Tools used

- Ankle exerciser
- Weight cuffs
- Chair
- Stop watch
- 10 m long chart paper
- Measuring tape

Procedure

Samples of convenience of 30 subjects who met the inclusion and exclusion criteria were recruited to participate in the study. The purpose of this study was explained to the subjects. Then they were asked to sign the informed consent form. Baseline measurements (TUG, cadence, walking velocity) were taken in all 30 subjects. Subjects were then divided into 2 groups, Group A and Group B.

Group A – experimental group-15 subjects: progressive resistive exercises for lower limb on affected side (appendix F)

Group B – control group-15 subjects: active exercises (same exercises without resistance) for lower limb on affected side (appendix F). 1-RM : Patient was asked to perform the exercises as given in appendix F for hip abductors, hip flexors, hip extensors, quadriceps, hamstring, ankle dorsiflexors, ankle plantarflexors, invertors and evertors with the weight patient could lift easily through full range of motion. The number of repetitions was counted and applied in the following equation: 1-RM=load/(1.0278- 0.0278*reps). Then the 50% of this weight was calculated and was used as starting position. This was progressed to 80% by second week and patient was reassessed after second week for 1-RM. In third week, protocol was carried out with new RM and was progressed on similar lines. Two sets of 10 repetitions of each exercise were performed with 1-to-2-minute rest period between each exercise. Patients were assessed on outcome measures (TUG, cadence, walking velocity) as under:

Timed up and go test (TUG): Subjects were instructed to sit with their back against a chair and on the word "go", stand up, walk at a comfortable speed past a 3m mark, turn around, walk back and sit down in the chair. The TUG was carried out twice, with 1min interval between each trial, and the mean time (in sec) of these 2 trials was recorded.

Walking velocity: Each subject was instructed to walk at a comfortable, normal pace for 10 m. Only the middle 6 m, however, was timed to eliminate the effects of acceleration and deceleration. From these data, the speed was calculated by dividing the middle 6 m by the time (in seconds) required to walk the 6 m. **Cadence:** The number of steps per unit time. It was reported as steps per minute. Cadence was calculated in steps per minute using the formula: Steps/seconds×60seconds/1minute. Treatment was given thrice

weekly for 4weeks. It took about 30-45 minutes to administer the exercises to the affected lower limb. This was followed by conventional exercises to the upper limb.

Post treatment assessment was assessed and compared with the control group.

Outcome measures

- Timed up and go test
- cadence
- walking velocity

3. Results

The analysis was done by using SPSS statistical software having 12.0 version. In comparison between the groups (progressive resistive exercises and active exercises) independent t- test was used. While, comparison within the groups was done by using paired t-test. The level of significance used to analyze the results was fixed at $p < 0.05$.

Comparison of characteristics (Age, MMSE) of patients between the groups.

Variable	Group A Mean ± S.D	Group B Mean ± S.D
Age (yrs)	54.66 ± 7.08	52.13 ± 8.50
MMSE	29.20±1.01	29.60± 0.73

Intragroup comparison of variables of Group A

Variable	Pre training	Post training	t value	p value	Mean Difference (%)
	Mean±SD	Mean±SD			
TUG	26.22±6.40	19.8±5.14	7.47	.000*	-24.48
Cadence	49.56± 6.80	70±10.29	15.56	.000*	41.24
Walking velocity	0.31± 0.04	0.41±0.06	13.90	.000*	32.25

*= significant, p<0.05

Intragroup comparison of variables of Group B

	Pre training	Post training	t value	p value	Mean

Variable	Mean±SD	Mean±SD			Difference (%)
TUG	26.43±5.97	24.65±5.94	5.29	.000*	-6.73
Cadence	49.44±12.51	55.32±13.57	5.77	.000*	11.89
Walking velocity	0.30±0.07	0.33±0.07	5.68	.000*	10

*=significant, p<0.05

Intergroup Pre training comparison of variables of group A and B

VARIABLE	GROUP A	GROUP B	t value	p value
	Mean±SD	Mean±SD		
TUG	26.22±6.40	26.43±5.97	0.094	.92^{NS}
Cadence	49.56± 6.80	49.44±12.51	0.033	.97^{NS}
Walking velocity	0.31± 0.04	0.30±0.07	0.675	.50^{NS}

N.S= not significant, p>0.05

Intergroup Post training comparison of variables of group A and B

	GROUP A	GROUP B	t value	p value
	Mean±SD	Mean±SD		
TUG	19.8±5.14	24.65±5.94	2.35	.02*
Cadence	70.03±10.29	55.32±13.57	3.34	.002*
Walking velocity	0.41± 0.06	0.33±0.07	3.36	.002*

*= significant, p<0.05

Comparison of mean difference between group A and group B

	GROUP A	GROUP B	t value	p value
	Mean±SD	Mean±SD		
TUG	6.34±3.29	1.78±1.30	4.99	.000
Cadence	20.47±5.09	5.88±3.59	8.76	.000
Walking velocity	0.09±.02	.02±.01	8.75	.000

*= significant, $p<0.05$

4. Discussion

This study examined the effectiveness of progressive resistive exercises on gait performance and balance in stroke.

Subacute stroke patients were allocated to experimental and control group. Patients in the experimental group received progressive resistive exercises in the affected lower limb whereas in the control group patients received active exercises (same exercises done without resistance). Results have shown significant effect within the group ($p<0.05$) on time up and go test, walking velocity and cadence. The results were also found significant in case of time up and go test, walking velocity and cadence ($p<0.05$) between the group A and group B.

In analyzing standing balance, Fabio found the antagonist muscle response absent or attenuated when balance was disturbed. Therefore, both the agonists and antagonists may be weak in hemiparetic patients

Thus, in the study, improvement in walking velocity can be attributed to strength gain in hip flexor and ankle plantarflexor and improvement in cadence can be attributed to strength gain in hip adbuctor and knee extensor muscles. Furthermore, improvements in walking velocity and cadence are correlated with gait performance. Olney S. supports this and concludes that increases in hip extension in late stance phase may be functionally important because these changes are associated with moving the trunk forward over the stance foot, thus providing the hip flexors with better mechanical advantage to generate power to pull-off the limb, resulting in a larger contralateral step length and an increase in speed. The magnitude of hip extension in late stance has been positively related to walking speed.

The power of the working muscles are maintained or increased in response to the tension created in them. A high degree of tension and consequent increase in power can be developed by free exercises. During active exercise the capillaries in the working muscles dilate and their permeability is increased. Many capillaries that were closed when the muscle was at rest become open and blood flows through them. In this way the capacity of the muscles to contain blood is markedly increased and the interchange of fuel and waste products between the blood and the tissue fluids is facilitated. Improvement in control group (active exercises) may be due to increase in blood flow and waste products are exchanged between blood and tissue fluids.

Therefore, progressive resistive exercises proved to be more effective in improving gait performance and balance as compared to active exercises i.e. same exercises done without resistance.

Future research

- Future studies need to clarify whether it is the progressive resistance or the movement practice that is responsible for the improvements in function in frail older adults.

- Longer duration study should be done, to result in larger improvements in both groups.
- Comparison of balance training with progressive resistive exercises in stroke patients can be done
- Comparison of gait training with progressive resistive exercises in stroke patients can be done
- More balance parameters can be taken.

5. Conclusion

The results of the present study suggest that progressive resistive exercises are significantly effective in improving gait performance and balance than active exercises (same exercises without resistance) in stroke patients.

Clinical Relevance

The result of present study indicate that Progressive resistive exercise provided an important stimulus for walking speed, cadence and lower extremity strength gains in individual with stroke. It therefore improved balance and gait performance in subacute stroke patients which ultimately leads to increase in quality of life.

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