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Original research article

Study of the improved effect of step up exercise program for improving gait of stroke patient in udaipur region.

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Abstract

Background: Walking impairment is extremely common in stroke survivors. Human walking is a commonplace phenomenon, yet it is regulated by complex cerebral regulatory mechanisms. Stroke damages motor cortices and their descending corticospinal pathways, resulting in muscle weakness. On the other hand, brainstem descending pathways and the intraspinal motor descending pathways as well as the intraspinal motor network, become uninhibited and hyper excitable. In order to fix the dysfunction of gait some physical exercise are suggested by physiotherapist. These workouts helps patient to overcome gait disability and back to a normal life.

Objective: To compare the impact of task specific step-up exercise program over conventional exercise program on stride length and maximum velocity of stroke patients.

Methodology: 30 post-stroke hemiplegic patients were selected for study. Further these 30 individuals randomly divided into two groups. Which were named as control group and experimental group with 15 patients in each group for conventional and step-up therapy. Duration of study was 4 months.

Result: While, comparing records of the two groups before the therapy, shows no diverge in the pre-test, considerably (p>.05), i.e., discovered to be statistically equivalent. In contrast, post therapy outcome shows significant change between the control and experiment group because p value for step length, natural velocity and cadence were <0.05.

Conclusion: The study's findings indicate that step-up exercises are more effective than traditional exercises in improving stroke patients' outcomes. Because the experimental group outperformed the control group in terms of stride length and maximum velocity, the improvement in gait and balance is considerably greater.

Keywords: Step up exercise, post stroke therapy and gait dysfunction

Introduction

Walking impairment is extremely common in stroke survivors. Human walking is a commonplace phenomenon, yet it is regulated by complex cerebral regulatory mechanisms. The brainstem descending pathways (RST and VST) and the intraspinal locomotor network are part of the automated process. Leg muscles are known to be organized into modules that provide subtasks for body support, posture, and locomotion. There are several major kinematic methods known to reduce the center of gravity (COG) displacement. Stroke damages motor cortices and their descending corticospinal pathways, resulting in muscle weakness. On the other hand, brainstem descending pathways and the intraspinal motor descending pathways as well as the intraspinal motor network, become uninhibited and hyper excitable [1].

In order to fix the dysfunction of gait some physical exercise are suggested by physiotherapist. These workouts helps patient to overcome gait disability and back to a normal life.

Traditional gait training aims to enhance walking biomechanics and aesthetics. Parallel bars and ambulation aids are given to assist in early gait stability and safety. However prolonged use of these devices can be problematic for a patient who has potential to walk without the device. With chronic use, the patient fails to acquire proper balance mechanisms due to weight shift towards the less afflicted area, resulting in disrupted locomotor rhythm. Slow walking and step-ups should be encouraged to overcome this difficulty and maintain the natural rhythm of the locomotor system [2].

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Walking on ramps, cubes, over and around barriers, and those with coincident timing requirements (e.g. crossing the street, stepping on and off elevators or escalators, walking through automatic doors) should be practiced in the community activity. Initially, your speed of gait will be slow and deliberate. As control improves, the patient is advised to increase gait speed while being safe. As control improves, dual-task and balancing activities can be introduced into the training regimen.
A key goal of training is for the patient to be able to assess his or her own performance and recognize and initiate corrective actions. The patient should be able to modify his or her walking speed and direction while walking, as well as negotiate changes in the support surface and environment. Functional practice in real-life settings will help the patient gain the confidence needed to meet the rigours of community reentry [3].

Objective

1. To compare the impact of task specific step-up exercise program over conventional exercise program on stride length of stroke patients.
2. To compare the impact of task specific step-up exercise program over conventional exercise program on maximum velocity of stroke patients.

Material and methods

Sample size: 30 post-stroke hemiplegic patients were selected for study. All patients were informed about the study. A duly filled consent form with sign collected from them for record purpose. Further these 30 individuals randomly divided into two groups. Which were named as control group and experimental group with 15 patients in each group. Duration of study was 4 months.

Inclusive criteria

Sample size included both male and female chronic hemiparetic patients aged 45-65 years with symptoms lasting more than 6 months, beginning rehabilitation within 6 months of the emergence of the first episode of single stroke, being able to walk 10 meters singly without a mechanical aids, being above Stage 3 of Brunnstrom's stages in the affected lower limb, being oriented and communicating independently, and being able to step up a 6" high step stool in forward, backward, and later directions.

Exclusive criteria

Selection criteria excluded perceptual and cognitive disabilities, significant sensory impairments in the lower limbs, serious orthopedic or rheumatologic conditions trying to meddle with gait, any linked medical issue or any high-risk cardiovascular disorders, as well as any auditory and severe vision problems.

Clinical examination

Before and after therapy, each study group completed a standardized evaluation of balance, functional mobility and sensorimotor dysfunction with a physical therapist (>10 years of experience) using standardized instructions.

Gait analysis

Before beginning a new program, gait parameters were measured on a 10-meter walkway with a standard sheet of paper on its base using the ink foot-print record approach. Patients were instructed to walk and step on a paper roll and an ink pad. The soles of the patients' feet created tracks on the paper as they travelled from one end of the walkway to the other.

Procedure

Control group were assigned with conventional therapy and experimental group assigned with step up exercise. Data of gait analysis collected both time pre and post therapy for comparison purpose.

Step up exercise

These exercises promote better foot clearance and step length through increased hip flexor strength, quadriceps and glute strength through increased force generation and walking speed, and pelvic stability and standing balance through weight shifting. It contains three main actions Forward step, Backward step and Lateral step.

Program for conventional exercise

The pre-test score of Gait Parameters was taken before giving the exercises to record Independent Variable. The patients were instructed to do weight bearing on both legs, weight transfer between both legs, single leg stance, and standing with both legs with their eyes closed. Each exercise was performed three times in the presence of a physiotherapist. All gait metrics were scored again after the intervention.

Data analysis and statistics

The shift in score between pre-and post-treatment gait variables (Step length, natural velocity, and Cadence) of two groups (Control and Experimental) and continuous demographic variables (Age, Height, Weight, and BMI) of two groups (Control and Experimental) was evaluated by comparing using an independent t-test. The mean difference+ SD were used to represent the whole data. The paired t-test was performed to analyze the group's pre- and post-differences.

Results

Demographic characteristics: Table No.-1 elucidates all general data like age, sex, duration of a stroke, height, weight and paretic side. P-Value of all recorded data is >0.05, it shows that it is statistically insignificant and has no intergroup difference.

Table 1: Demographic characteristics of participants

S. No.	Characteristics	Experimental group (n=15)	Control group (n=15)	p value
1.	Gender: male/female (No.)	8/7	7/8	0.723
2.	Age (yrs)	56.40±6.25	55.53±6.73	0.552
3.	Height (cm)	163.52±5.43	165±6.92	0.889
4.	Weight (kg)	64.5±4.15	65.12±5.43	0.743
5.	Duration of stroke (months)	5.47±1.45	4.98±2.13	0.501
6.	Paretic side (right/left)	9/6	10/5	0.462

*Values are expressed as mean ±Sd. Where, Sd is standard deviation.
*P value >0.05.

Gait variables: Tabular form shows comparison between two groups and within the group data. Statistics shows no baseline difference between two groups.

While, comparing the stride lengths, as well as the maximum velocities of the two groups before the therapy, shows no diverge in the pre-test, considerably (>.05), i.e. discovered to be statistically equivalent. In contrast, post therapy outcome shows significant change between the control and experiment group.

Table 2: Comparison of gait variables between two groups, pre and post therapy

S. No.	Outcome measures		Time		p value	Chancre Change		
		Groups	**Pre-therapy**	**Post-therapy**		**Mean**	**0/0**	**Fold**
1.	Stride length	Control	88.45+18.42	97.15+18.22	<0.001	8.75+6.75	8.56	2.01
		Experiment	78.75+25.22	97.74+23.45	<0.001	19.11+5.88	17.12	
		p value[b]	0.282	<0.001				
2.	Maximum velocity	Control	1.001+0.26	1.06+0.28	<0.001	0.60±0.02	4.87	2.69
		Experiment	0.798+0.29	1.02+0.32	<0.001	0.17+0.07	13.12	
		p value[b]	0.19	<0.001				

*Values are expressed as mean ±Sd. Where, Sd is standard deviation.
*p value[a] shows within the group difference and p value[b] shows difference between two groups pre and post therapy.
*p<0.05 deemed as statistically significant value.

1. **Stride length:** In control group stride length was 88.45±18.42 and in experiment group 78.75±25.22. While after therapy stride length increased in both group. It was 97.15±18.22 for control group and 97.74±23.45 for experiment group. On comparison experiment group shows 17.12% change in stride length. It was 2.01 fold from control group.

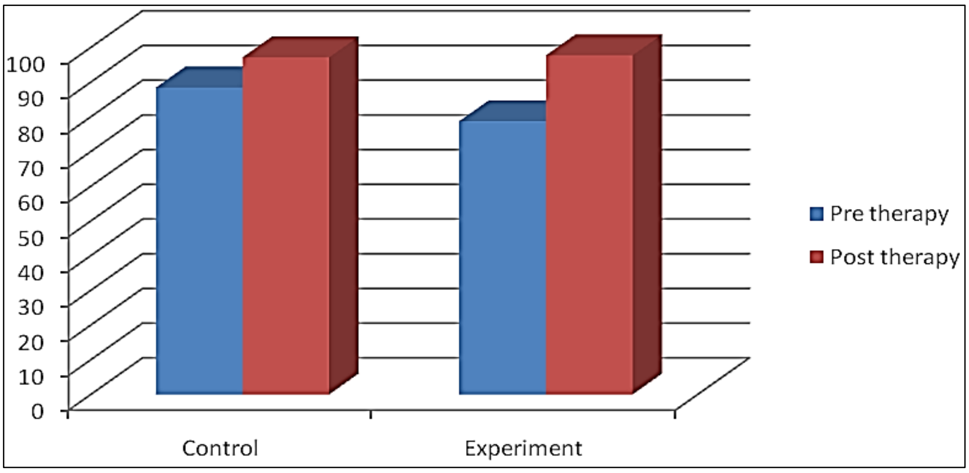

Fig 1: Stride length (mean value) comparison of two group pre and post therapy

2. **Maximum velocity:** Mean value of maximum velocity pre-therapy was 1.001±0.26 and 0.798±0.29 for control and experiment group respectively. Post therapy it shows mean change 0.60±0.02 and 0.17±0.07 for control and experimental group. 2.69 fold increases was observed after comparing value of experiment group and control group.

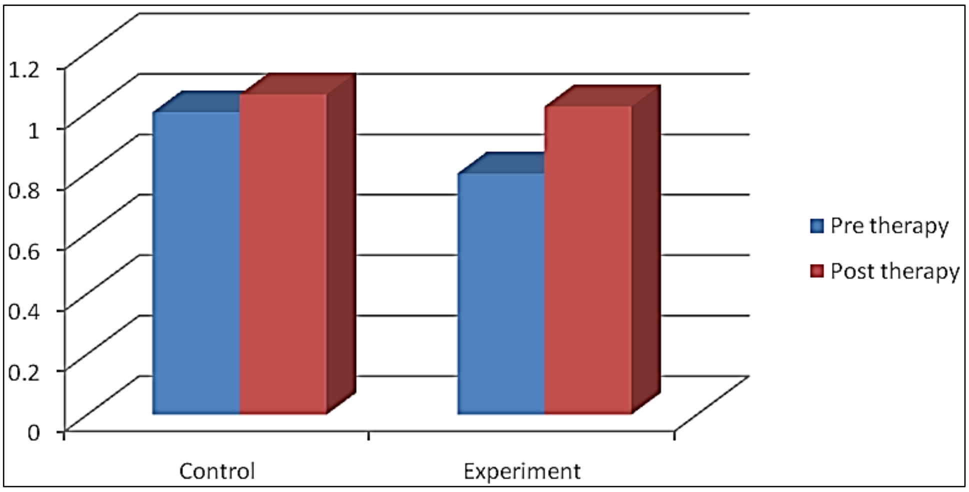

Fig 2: Maximum velocity comparison of two group pre and post therapy

Discussion

The purpose of this study was to determine whether step-up training improves the walking capacity of chronic stroke patients and, if so, which technique is more effective in boosting stroke patients' walking ability. Step-up training enhanced the walking capacity of chronic stroke patients, increasing maximum velocity by 0.17 and stride length by 19.17. These data suggest that step-up training can provide the same benefits as stair walking and functional training.

All gait measures improved in both therapy groups, which may be attributable to the learning and practise effects of the interventions in both groups. The step-up training regimen, on the other hand, improved the afflicted leg's balance, strength, and loading, which could explain the findings of the experimental group [4, 5, 6, 7, 8, 9]. Ernst E may also indicate the progress of the control group in a review where traditional physiotherapy for gait training is universally considered to be beneficial in stroke patients [10].

As Wade *et al*. noted, the step-up exercise group improved significantly in stride length and cadence, which would have resulted in an improvement in walking speed, which is generally the goal to improve functional relevance [11]. There are two methods for increasing walking speed: increasing stride length and increasing cadence. Individuals often combine both strategies until they get the longest comfortable step length. Any additional gain in speed after that is entirely attributable to higher cadence [12]. The experimental group's significant increase in cadence, step length, and stride length compared to the control group may be attributable to this group's big increase in maximum velocity.

Household ambulation is equivalent to significant gait deficits and a walking speed of 0.4m/s, according to Schmid *et al*. [13] and Perry *et al*. [14] Moderate gait deficits represent limited community ambulation and are equivalent to 0.4 to 0.8 m/s. Full community ambulation denotes minor disability and a walking pace of more than 0.8 meters per second. Gait speed increased significantly in both therapy groups in this trial and continued to limited community ambulation (0.8m/s), but this was clearly improved (2.2 times) in the experimental group compared to the control group. This lack of full community ambulation accomplishment may be attributable to the study's short length.

Taub and Wolf [15] hypothesized that the learnt disuse of the damaged limb could be a cause of slow recovery in some stroke patients. This fact, combined with the widely held belief that people who have had a chronic stroke hit a plateau in their motor recovery after a year and show very little progress in gait performance for the rest of their lives [16]. They stressed the significance of developing innovative treatment options for such individuals.

The stair climbing gait workout is part of a rehabilitation program designed to proficiently restore the ability to walk of stroke patients [17] and earlier studies found that the stair gait exercise and step climbing exercise had similar effects on the strengthening of the lower extremities of stroke patients when changes in muscle activity were examined using electromyography (EMG) [18]. When comparing the muscle strengths of participants between groups, an EMG study revealed an increase in the RF, GCM, and TA muscle strengths in both the step climbing exercise and stair gait exercise groups [18]. Similarly, following eight weeks of training, patients in both groups demonstrated significant increases in muscle strength. An analysis of the groups revealed that the RF strength rose dramatically more in the step climbing exercise program than in the stair gait exercise program, whereas the TA strength improved massively more in the stair gait exercise program than in the step climbing exercise program. MacCulloch observed that dorsiflexion of the ankle joint occurs during stair gait training and that the greatest dorsiflexion occurs during the swing phase [19]. In contrast to the stair gait exercise, which regularly activates the TA, a person participating in the step climbing exercise does not require ankle dorsiflexion to ascend to the next step, hence the TA muscle strength improves significantly less. Damiano noted that in a lower-limb cross-exercise, the short moment arm of the bent knee joint increases with knee extension to support one's weight, putting significant load on the knee extensor to stabilize the knee joint [20].

Following lower limb strengthening exercise, Persch revealed increased muscle strength and improvement in walking-related variables [21]. Suzuki found that five months after a stroke, 54 percent of patients' walking speed was affected by muscular strength in the lower limbs on the stroke-affected side [22]. Park showed that increased step length and walking speed due to greater dorsiflexion helped to reduce foot drop and lower limb stability during the swing phase and that a stable walking pattern could improve both static and dynamic stability by minimizing postural sway [23]. Flansbjer stated that higher knee extensor strength is a major predictor of 6 m walking distance and endurance, as well as enhanced walking speed [24]. Kim showed that a step exercise, when performed with a stepping motion, could facilitate a patient's walking pattern and increase walking speed, as discovered with the stair gait exercise [18].

Conclusion

The study's findings suggest that step-up exercises are more helpful than standard exercises in improving the outcomes of stroke patients.

- Both groups show a significant improvement in gait.
- In terms of outcome measures, the experimental group outperformed the control group.
- Because the experimental group outperformed the control group in terms of stride length and maximum velocity, the improvement in gait and balance is significantly greater.

References

1. Li S, Francisco GE, Zhou P. Post-stroke Hemiplegic Gait: New Perspective and Insights. Front Physiol. 2018 Aug;9:10-21.
2. Giladi N, Horak FB, Hausdorff JM. Classification of gait disturbances: distinguishing between continuous and episodic changes. Movement Disorders. 2013;28(11):1469-73.
3. Pirker W, Katzenschlager R. Gait disorders in adults and the elderly: A clinical guide. Wien Klin Wochenschr. 2017;129(3-4):81-95.
4. Hyndman D, Ashburn A, Stack E. Fall events among people with stroke living in the community: circumstances of falls and characteristics of fallers. Archives of Physical Medicine and Rehabilitation. 2002;83:165-170.
5. Laufer Y, Dickstein R, Chefez Y, Marcovitz E. The effect of treadmill training on the ambulation of stroke survivors in the early stages of rehabilitation: a randomized study. Journal of Rehabilitation Research & Development. 2001;38(1):69-78.
6. Hyuk Cheol, Kwon Dong Hoon Jeong, Jin Yong Kong, Oh Yun Kwon. A Study of the Characteristics of Lower Extremity Weight Bearing in Independently Ambulatory Hemiparetic Patients. Journal of Asia Pacific Special Education. 2001;3(1):139-159.
7. Hiroshige Tateuchi, Toshihiko Yoneda, Takahiro Tanaka, Hitoshi Kumada, Masahiro Kadota, Hiroshi Ohno, *et al*. Postural control of Initiation of Lateral step- and step-up motion in young

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adults. Journal of Physical Therapy Science. 2006;18:49-55.

8. Richard W Bohannon, Patricia A Larkin. Lower Extremity Weight Bearing Under Various Standing Conditions in Independently Ambulatory Patients with Hemiparesis. Physical Therapy. 1985;65(9):1323-1325.
9. Yukari Mori, Makoto Ayabe, Takuya Yahiro, Takuro Tobina, Akira Kiyonaga, Munehiro Shindo, *et al*. The Effects of Home-based Bench step exercise on Aerobic Capacity, Lower Extremity Power and Static Balance in Older Adults. International journal of sports and health science. 2006;4:570-576.
10. Ernst EA. Review of stroke rehabilitation and physiotherapy. Stroke, 1990.
11. Wade DT, Wood VA, Heller A, Maggs J, Langton Hewer R. Walking after stroke. Measurement and recovery over the first 3 months. Scandinavian Journal of Rehabilitation Medicine. 1987;19(1):25-30.
12. Donald A Neumann. Kinesiology of the musculoskeletal system; foundations for physical rehabilitation. 2016:ed3:528-529.
13. Arlene Schmid, Pamela W Duncan, Stephanie Studenski, Sue Min Lai, Lorie Richards, Subashan Perera, *et al*. Improvements in Speed Based Gait Classifications Are Meaningful. Stroke. 2007;38:2096-2100.
14. Perry J, Garrett M, Gronley JK, Mulroy SJ. Classification of walking handicap in the stroke population. Stroke. 1995;26:982-989.
15. Taub E, Wolf SL. Constraint Induced Movement Techniques to Facilitate Upper Extremity use in Stroke Patients. Topics in Stroke Rehabilitation. 1997;3(4): 38-61.
16. Clive E Skilbeck, Derick T Wade, Langton Hewer R. Victorine A Wood. Recovery after stroke. Journal of Neurology, Neurosurgery and Psychiatry. 1983;46:5-8.
17. Seo KC, Kim HA. The effects of gait ability in the stroke patients after stair gait exercise and lamp gait exercise. Journal of the Korean Society of Physical Medicine. 2013;8:397-406.
18. Kim CR, Choi SJ, Shin WS. EMG study for muscle activation during variable gait training in stroke patients: stepper climbing, stair-up and level-ground gait. Journal of the Korean Society of Physical Therapy. 2013;25:393-398.
19. MacCulloch PA, Gardner T, Bonner A. Comprehensive fall prevention programs across settings: a review of the literature. Geriatric Nursing. 2007;28:306-311.
20. Damiano DL, Norman T, Stanley CJ, *et al*. Comparison of elliptical training, stationary cycling, treadmill walking and over ground walking. Gait Posture. 2011;34:260-264.
21. Persch LN, Ugrinowitsch C, Pereira G, *et al*. Strength training improves fall-related gait kinematics in the elderly: a randomized controlled trial. Clinical biomechanics (Bristol, Avon). 2009;24:819-825.
22. Suzuki K, Imada G, Iwaya T, *et al*. Determinants and predictors of the maximum walking speed during computer-assisted gait training in hemiparetic stroke patients. Archives of Physical Medicine and Rehabilitation. 1999;80:179-182.
23. Park YH, Kim YM, Lee BH. An ankle proprioceptive control program improves balance, gait ability of chronic stroke patients. Journal of Physical Therapy Science. 2013;25:1321-1324.
24. Flansbjer UB, Downham D, Lexell J. Knee muscle strength, gait performance and perceived participation after stroke. Archives of Physical Medicine and Rehabilitation. 2006;87:974-980.