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RESEARCH ARTICLE

A COMPARATIVE STUDY TO ANALYSE THE EFFECT OF STAIR GAIT TRAINING VERSUS VARIED OVER GROUND WALKING TRAINING FOR DYNAMIC BALANCE AND WALKING ABILITY IN STROKE PATIENTS - RCT

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ABSTRACT

Objectives: To study the effect of stair gait training for dynamic balance and walking ability in stroke patients. To study the effect of varied over ground training for dynamic balance and walking ability in stroke patients. To compare the effect of stair gait training vs varied over ground training for dynamic balance and walking ability in stroke patients. **Methods:** Cross Sectional Study design assigned by convenient samplingwith30 Subjects in each group. Outcome Measure: BBS, 5 METER WALK TEST, TUG test LEFS. **Results:** stair gait training for dynamic component in BBS score42.73 – 51.40(8.67mean differences) and in varied over ground training BBS score is 38.35-46.73 (8.37 mean differences) which mean differences shows the both are statistically significant and highly significant in stair gait training as well as in LEFS score. **Conclusion:** Stair gait training and varied over ground training shows significant improvement in dynamic balance, gait speed and lower limb function activity. Dynamic balance and lower limb functional activity shows more improvement in stair gait training. In gait speed for TUG Test, and 5 Meter Walk Test shows equally improvement in both the training group.

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INTRODUCTION

Stroke is a global health problem and is a leading cause of adult disability (Ashrafian, 2010). After stroke, most patients walk at speeds that range from approximately 0.2 m/s to 0.8 m/s, These velocities are significantly lower than the SCWS exhibited by age-matched individuals (1.3 m/s to 1.4 m/s) (Straudi, 2016). In Particular, walking up and down stairs is a basic activity in daily life, but only 5–25% of stroke patients are capable of this activity when they are discharged from a rehabilitation- center (Paolucci, 2008). A Stair gait exercise is among the exercises that strengthen the lower limbs of stroke patients, and it is frequently used for transportation and walking on flat ground. Compared with flat-area walking, stair climbing requires more energy and muscle strength in the lower limbs, as it involves horizontal movement and vertical ascent at the same time, while keeping the body balanced. These days, steppers are widely used for lower limb exercise and rehabilitation, which has benefit of reducing stress on the knee joints (Prado-Medeiros, 2011; Alton, 1998). They are also recommended for use in aerobic exercise similar to stair walking, which builds muscle strength (Nadeau, 2003).

Accordingly, stair gait training in the clinical field is an essential exercise process applied to stroke patients who will be discharged from the hospital. (Eun, 2004) In a review of stair gait-related studies, Eun et al.(2004) stated that much larger extension moments than flexion moments occurred in the lower extremity joints of healthy individuals and that larger extension moments occurred in the knee and hip joints than in the ankle joints. It has been suggested that treatment strategies for stroke patients with poor motor control should focus on isolated and selected joint movement training to break up the mass synergistic pattern and improve walking pattern. Isolated ankle dorsiflexion while hip and knee are in extension is the first sign of selective motor control after stroke (Yavuzer, 2006). In clinical practice, it is now widely accepted that high-intensity and task-specific interventions, such as task-oriented circuit training (TOCT), are pivotal to achieve functional recovery after stroke. TOCT is a relatively new concept in neurorehabilitation and it consists of progressive task-specific therapy provided in a group setting (class) (Straudi, 2016). Task-oriented training includes a wide range of interventions such as treadmill training, walking training on the ground, bicycling programmes, endurance training and circuit training, sit-to-stand exercises, and reaching tasks for improving balance.

In addition, use is made of arm training using functional tasks such as grasping objects, constraint-induced (movement) therapy (CIMT) and mental imagery (Rensink, 2009). In a randomized controlled trial, Yang et al. compared a motor-motor dual-task intervention (walking while manipulating either one or two balls of various size) to a no-intervention control. Compared to 12 patients who did not receive any intervention, the 13 patients who received dual-task training significantly improved their gait speed during both single-task and dual-task (tray carrying) walking (Plummer-D'Amato, 2012). Bayouk et al. argued that exercise using tasks is effective at enhancing balance and mobility. Said et al. reported that obstacle training had a significant impact on walking and balance, stroke patients' and it has also been reported that diverse afferent stimuli and functional activities help to improve the ability to perform daily life activities.(4) Depaul et al. studied varied over ground training versus treadmill training proving both interventions effective in improving gait speed (DePaul, 2015). According the previous study of stair gait training as well as MLWP (varied over ground walking) for stroke patients to improve the balance and gait speed but there is no find out comparative study. In an effort to assess the relative value of motor-learning science as a theoretical framework, the Stair Gait Training was compared with MLWP (varied over ground walking).

MATERIALS AND METHODOLOGY

Study Design: Pre and Post quasi-experimental study.

Study Setting: Department of Physiotherapy, Shree B.G.Patel, college of physiotherapy, Anand.

Sampling Method: Random sampling.

Sample Size: 15 Subjects in each group (total 30).

Subjects: Male and Female diagnosed with stroke.

Inclusion Criteria

- were 40 years or above,
- <3 months since onset of ischemic or hemorrhagic stroke
- were able to 30 m walk without assistance (gait aid allowed)
- were able to maintain independent standing posture for 30s or longer
- able to follow a 2 step verbal command

Exclusion Criteria

- were unable to follow commands properly,
- had an Abbreviated Mental Test score below 6
- were medically unstable,
- severe visual impairment

Materials used in study

Assessment form, Measure tape, Chair, Cones, Stopwatch, Pencil, Paper.

Apparatus Required for the Study

Slope, Parallel bar, Curb, Steps tool.

STANDRAD STAIR CASE - LENGTH -- 28 cm

WIDTH -- 0.8 m

HEIGHT -- 7inch (around 10 to 12 cm)

Outcome Measures

1. BBS
2. METER WALK TEST
3. TUG test
4. LEFS

Procedure

30 subjects of age 45-85 years of age referred by Neurophysician were recruited in study. Subjects were selected on basis of inclusion and exclusion criteria. Informed consent in written form were obtained from all the patients. Demographic data in form of age, onset time, duration, affection side and dominant side were collected and pre intervention test was assessed by BBS, TUG test and 5 Meter walk test.

Protocol

Stair Gait Training group: Group will practice 10 step activity at every session:

- Forward stepping with affected leg / non affected leg
- Step down with affected leg / non-affected leg
- Heal-off with affected leg and non affected leg on step / non-affected and affected leg on step
- With affected leg on step, non-affected leg through step up-up and down- down / non affected leg on step, affected leg trough step up-up and down-down
- Affected leg on 1st step them with non affected leg direct step up to next step and direct step down to the ground / Non-Affected leg on 1st step them with affected leg direct step up to next step and direct step down to the ground

This step task do 12 repetation per session. This step task completed then do 1fight of stair (12 stair) climbing ascending and descending and after that 4step on stair as much as fast Each subject in this group stand in front of the stair walking training apparatus and the therapist then assisted the patient during stair climbing by fixing the ischium on the patients paretic side, helping popliteal flexion, and supporting the ankle if the ankle joint was unstable. During stair descent, patient with left hemiplegia maintained stability by supporting the lower limb above the knee joint with his/her left hand while the physical therapist held the waist of the patient with his/her hand. When the patient's foot came into contact with the stairs, the forefoot was placed first to assist weight bearing by the knee. To prevent falls, the patient was permitted to hold the safety bar on the stairs if nesessary.

Varied Overground Walking group: Group will practice 7 core walking activities at every session:

- Short walks;
- Longer distance (≥50 m);
- Steps, curbs, and slopes;
- Obstacle avoidance;

- Transitions (e.g., sit to stand and walk);
- Changes in centre of gravity (e.g., pick up an object off floor); and
- Changes in direction

This task do 12 repetation per session. When any patient complained of pain or showed abnormalities of breathing, feelings of fatigue, or vertigo after the beginning walking training the walking training was immediately stopped. Duration of the study: Each group received the intervention five times per week, for four weeks.

STATISTICAL ANALYSIS

Paired and unpaired T test was used at end of the study. Null hypothesis will be rejected if $P< 0.05$. All the statistical analysis was conducted with the help of version 16.0 of the SPSS.

Data Analysis: Total 30 patients were included in the study depending on which following distribution is observed. Mean ± SD of age for the study population was Mean ± SD of age for stair gait training group was 50.1 ± 8.238797 Mean ± SD of age for varied over ground training group was 51.8 ± 6.425643

RESULTS

In this study stair gait training for dynamic component in BBS score 42.73 – 51.40(8.67mean differences) and in varied over ground training BBS score is 38.35- 46.73 (8.37 mean differences) which mean differences shows the both are statistically significant and highly significant in stair gait training. In this study In this study stair gait training for dynamic balance and gait speed component in TUG Test is26 sec-17.20 sec (8.8 sec mean differences) and in varied over ground training TUG Test 25.07sec- 18.00 sec mean differences) which mean differences shows the both are statistically significant But both the training have equally effect. In this study stair gait training for gait speed component in 5 meter walk Test is 0.55 m/ sec –0.87 m/sec (o.32 m/sec mean differences) and in varied over ground training 5 meter walk Test 0.54 m/sec- 0.80 m/sec (0.26 m/sec mean differences) which mean differences shows the both are statistically significant But both the training have equally effect. In this study stair gait training for functional activity in that LEFS score gait speed component is 44.73- 66.47(21.74 mean differences) and in varied over ground training LEFS score 46.20- 57,60 (11.4 mean differences) which mean differences shows the both are statistically significant But highly significant in stair gait training.

DISCUSSION

In stair gait training and varied over ground training directly shows effect in some BBS component like stepping reaction time, one leg standing, alternate stepping and functional reach task so the major dynamic components as well as static component also improve but stair gait training shows more improvement. Kim reported that a step exercise could facilitate a patient's walking pattern when conducting a stepping motion and it could increase walking speed, as found with the stair gait exercise (Kim, 2013).

Kim *et al.* (2006) examined the contact force applied to knee joints during flat surface gaits and during slope-way or stair gaits. They reported that the contact force was greater during stair gaits, approximately 4.25 times that of the body weight.

As Christina and Savannah (Christina, 2002) mentioned, physical ability is required more during stair gait than during ground gait training, because balance ability of the trunk and muscle strength of the lower limbs are needed. A study on stair gait conducted with 30 adult hemiplegic patients to determine changes in balance and muscle activity after gait training with different stair heights reported that the 10 cm-high stair gait training group showed the most significant difference in balance abilities, as well as larger changes in muscle activities than stair gait groups with other heights (Horstman, 2008). Stair gait training shows in some other effect like improvement in gait cycle, muscle strength, and functional reach test also.

Yong-kyu choi *et al.* (2016) Study indicate that stair task training improved walking ability and suggest the applicability of stair task training for clinical rehabilitation. It was conducted on hemiplegic patients for six weeks and provided an approach to improve the mobility functions of stroke patients. The findings showed that the stair task training group had effective results in the swing phase time affected lower extremity, compared with the group that applied weight support on the affected lower extremity and balance training. (Kim, 2013). In the literature, between 37% and 73% of individuals with stroke report at least 1 fall, and 20% to 55% report repeated falls. In our study, both the MLWP and BWSTT groups had a relatively low rate of at least 1 fall (37.7% and 31.3%) and multiple falls (6.6% and 12.5%) over the study period. In addition, in the LEAPS, fall rates were highest in the early BWSTT group compared with the home exercise group. The authors hypothesized that the difference may. Be related to the lack of balance-specific training in the BWSTT intervention compared with the home exercise program (DePaul, 2015). In the clinical field, constant stair gait training can reduce the fall accidents of stroke patients and result in improvements in performing independent activities (Kim, 2006). Varied over ground training meanly effect on gait speed and past evidences also meanly shows result in TUG test, 5 meter walk test, and 10 meter walk test and gait parameter. Those article I have found for varied over ground training in that mainly outcome measures is TUG test, 5 meter walk test, 10 meter walk test, 6 minute walk test, Riverhead Mobility Index and Stroke Rehabilitation Assessment of Movement taken and shows significant changes. In this study varied over ground training has found of effect in berg balance (BBS) also so it's directly suggesting the improvement in static as well as dynamic component. Walking performance likely improves secondary to increased ability to produce muscle forces, to move joints through a greater range of motion, and to deliver more oxygenated blood to the active tissues. The task-oriented focus of the motor learning based approach has the potential to lead to not only an efficient and automatic motor sequence pattern for walking, but also reward-based adaptive changes in the brain which may be sustainable (Brach, 2013). Park showed that a proprioceptive exercise for the ankle increased muscle strength and improved the dynamic balance of the affected patients but that the TUG time fell from 20.47 seconds to 15.27 seconds (5.02 sec mean differences) after six weeks of exercise (Park, 2013).

Table No.1. Shows the demographic data

Gender		Side of hemiplegia		Causeof stroke	
Male	Female	Right	Left	ischemic	hemorrhagic
21	9	12	18	22	8

Table No.2. Comparison of Pre and Post Value in Stair Gait training Group And over ground waliking group

Parameter	Group	Pretest	Post test	Df	P value	T value
		Mean ± sd	Mean ± sd			
Bbs	Stair gait trainiing	42.73± 2.91	51.40 ± 2.20	14	<0.0001	12.35
	Obstacle walking	38.33± 4.48	46.73± 3.56	14	<0.0001	6.315
Tug(sec)	Stair gait trainiing	26.00± 7.86	17.20 ± 4.39	14	<0.0001	8.15
	Obstacle walking	25.07± 4.85	18.00± 4.47	14	<0.0001	7.926
5 meterwalk test(m/s)	Stair gait trainiing	0.55±0.16	0.87 ± 0.13	14	<0.0001	28.28
	Obstacle walking	0.54± 0.15	0.80± 0.12	14	<0.0001	7.460
Lefs	Stair gait trainiing	44.73± 6.94	66.47 ± 8.59	14	<0.0001	16.14
	Obstacle walking	46.20±7.32	57.60±8.36	14	<0.0001	12.92

Table 3. Comparison of Post Value in Stair Gait training Group And over ground waliking group

PARAMETER	GROUP	POST TEST MEAN ± SD	DF	P VALUE	T VALUE
BBS	Stair Gait Trainiing	51.40 ± 2.20	28	0.0002	4.325
	Obstacle Walking	46.73± 3.56			
TUG(sec)	Stair Gait Trainiing	17.20 ± 4.39	28	0.6251	0.4942
	Obstacle Walking	18.00± 4.47			
5 METERWALK	Stair gait Trainiing	0.87 ± 0.13	28	0.1595	1.445
TEST(m/s)	Obstacle Walking	0.80± 0.12			
LEFS	Stair Gait Trainiing	66.47 ± 8.59	28	0.0078	2.864
	Obstacle walking	57.60±8.36			

According this study result in TUG test for stair gait training and varied over ground training means differences is 8.8 sec and 7.07 sec and other study result in TUG test mean differences 5.02 sec so in this study shows more significant result in TUG test. Geiger et al. divided chronic hemiplegic patients into a proprioceptive group and a control group and observed the TUG test result decreased from 23.08s to 14.62s (8.46 mean differences) in the proprioceptive group. Kyo CS, Kim HA.et all in this study comparison of TUG for measuring dynamic balance ability was showed statistically significant decrease in both two groups (p>.05) and significant decrease in experimental group more than control group (p>.001) (Kyo, 2013). Rebecca A. States et all systemic review result for over ground training in that Timed Up and Go test improved by 1.81 seconds (95% CI, -2.29 to -1.33) based on three studies (n -118),and our study varied over ground training tug test improvement shows in 1.77sec - 7.07 sec which shows more significant (Rebecca, 2009). Kyo CS, Kim HA.et all this study has investigated that that the gait velocity at after stair gait training on stroke patients was showed significant differences with 0.44.- 08m/s at before -training and 0.75.-18m/s at after-training (p>.05) (Kim, 2013). According this study result in 5 meter walk test for stair gait training and varied over ground training means differences is 0.32 m/sec sec and 0.26m/sec and other study result in 5 meter walk test mean differences 0.31 m/sec sec so in this study shows significant. DePaul et al. showed that despite a lack of between-group differences in the primary outcome, it is important to note that both interventions resulted in a clinically meaningful change (0.14 m/s) in comfortable gait speed (Horstman, 2006). Vincent *et al.* In this tidy there was meaningful change of gait speed 0.12 m/s and 0.11m/s in varied over ground training and limited progressive treadmill training group which was statistically significant in within group comparison but also was clinically beneficial And with our study correlation shows more significant change in gait speed in 5 meter walk test 0.26 m/sec.

Rebecca States *et al.* systemic review result for over ground training in that Walking speed increased by 0.07 m/sec [95% confidence interval (CI), 0.05– 0.10] based on seven studies (n _ 396), and our study varied over ground training 5 meter walk test improvement shows in 0.26 m/sec which shows more significant (Rebecca, 2009). The literature suggests that an average walking velocity of 1.1 to 1.5 m/s is probably fast enough to be functional as pedestrian in different environmental and social contexts (eg, crossing a street safely) (Pohl, 2002).

In past research for stair gait training and varied over ground training I have not found as in functional activity assessment so in this study interpretation of functional activity manly for lower limb in that outcome measure taken as Lower extremity functional scale (LEFS). In this study stair gait training and varied over ground training both are showing improvement in lower extremity functional scale so stabilize the functional outcome. Based on motor learning science, the MLWP was specifically designed to encourage cognitive effort and problem solving during training. Practice tasks were random or serial in order and feedback and guidance was delayed or limited in frequency to allow self-evaluation and correction of errors. Although these strategies have been associated with improved outcomes after stroke, there is evidence that the degree of benefit is influenced by the complexity of the skill being learned and the experience of the learner (DePaul, 2015)

Conclusion

Stair gait training and varied over ground training shows significant improvement in dynamic balance, gait speed and lower limb function activity. Dynamic balance and lower limb functional activity shows more improvement in stair gait training. In gait speed for TUG Test, and 5 Meter Walk Test shows equally improvement in both the training group

Limitation of the study

- The sample size was too small.
- Long term follow was not there to check the consistency & long term effect of the treatment.

Future Research

- Multicenter trials with long-term follow-up can be carried out to check the carry over effect.
- Outcome measure to evaluate quality of life can be considered.
- There is no compression study for stair gait training and varied over ground training so study done with larger population then result are more valid.

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