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THE EFFECT OF TASK ORIENTED CIRCUIT TRAINING ON AEROBIC CAPACITY DURING STAIRCLIMBING IN PATIENTS WITH STROKE.

Physiotherapy

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ABSTRACT

Objective: The aim of the study was to evaluate the effectiveness of task oriented circuit training on aerobic capacity during stairclimbing in patients with stroke. **Methods:** 30 Subjects with stroke were screened and recruited based on the inclusion criteria. An informed consent was taken and treated with task oriented circuit training. Intervention will be carried out for 4 days/week for 4 weeks, total 16 sessions. The outcome measures, Aerobic capacity(VO_2Max),Timed Up and Go(TUG) , Timed Up and Down Stair test (TUDS) and Stroke Impact Scale (SIS) were used for pre intervention and post intervention assessment. **Results:** Following the statistical analysis Aerobic capacity(VO_2max) showed mean change of 33.63±4.8 in pre-test and 37.47±4.56 in post- test, difference with p-value < 0.001, and t value -18.801, showing significant improvement in VO_2max the treatment where TUG showed a mean change of in 21.57±3.55 pre-test and 16.87±2.16 in post- test with p value <0.001, and t value 14.276 showing significant improvement in TUG after the treatment. TUDS showed mean change of in 73.7±9.45 pre-test and in 69.8±9.13 post-test with p value <0.001 and t value 13.681 showing significant improvement in TUDS after the treatment and SIS showed mean change of in 64.27±14.4 pre-test and 75.77±10.16 in post-test with p value <0.001 and t value 10.521 showing the significant improvement in SIS after the treatment. **Conclusion:** Task oriented circuit training improves the aerobic capacity and in turn enables them with better balance, transfers, gait and gait related activities such as stair.

KEYWORDS

Stroke, Stair climbing, Task Oriented Circuit Training, Aerobic Capacity, Timed Up And Go, Timed Up And Down Stair Test, Stroke impact scale.

INTRODUCTION

Stroke is a neurological disorder characterized by blockage of blood vessels. Clots form in the brain and interrupt blood flow, clogging arteries and causing blood vessels to break, leading to bleeding. Rupture of the arteries leading to the brain during stroke results in the sudden death of brain cells owing to a lack of oxygen. Stroke can also lead to depression and dementia.[1]

The two types of stroke are ischemic and hemorrhagic. Approximately 87% of all strokes are caused by ischemia, and 13% are caused by hemorrhage. Hemorrhagic stroke accounts for 30% of all stroke deaths. Ischemia is a condition of hypoxia or decreased oxygenation to tissue and results from blood supply. Ischemic stroke can be subdivided into two major categories: those that results from thrombosis and those that results from an embolus. The hemorrhagic stroke can be intracerebral or intracranial accident. An intracerebral haemorrhage is a stoke where blood is leaking directly into the brain tissue. An intracranial haemorrhage is the buildup of blood anywhere within the skull, typically somewhere between the skull and the meninges surrounding the brain and spinal cord.[2]

Clinical features as per vascular territory are as follows: In anterior cerebral artery infarct paresis or weakness of legs more than arm with sparing of hands, urinary incontinence, gait apraxia, akinetic mutism are seen. In middle cerebral artery infarct homonymous hemianopia, aphasia (Broca's and Wernicke's), inattention, gaze paralysis, paresis of face-arm-leg are seen. In vertebrobasilar artery infarct if occipital lobe is involved then symptoms like homonymous hemianopia, cortical blindness and other cortical visual deficits are seen. If cerebellum is involved then ataxia, nystagmus is seen. If brainstem is involved then cranial nerve palsies with diplopia, vertigo, dysphagia, dysphonia is seen. If spinal tract is involved hemiparesis and hemisensory loss are seen. In lacunar stroke syndromes (due to occlusion of deep perforating small arteries) symptoms like pure motor hemiparesis, pure sensory stroke, sensorimotor stroke, ataxic hemiparesis is seen.[3]

Stair climbing is of particular interest in the field of biomechanics and motor control. Since stair climbing is a common activity of daily living, the ability to do it efficiently is important to an individual's quality of life. More demanding than level walking, stair ambulation is performed with ease by healthy individuals; however, it is more difficult to perform for those with decrements in motor function, balance problems, or reduced lower-limb function.[4]

Aerobic Requirements During Stair Ascent and Descent there is reduced cardiorespiratory fitness in chronic stroke contributes to reductions in gait performance and the elevated energy cost of walking. Factors such as muscle weakness, motor control, balance impairment, and spasticity could influence the speed and distance walked. The aerobic cost was markedly higher in stroke, contributing in part to an elevated physiologic burden of stair ambulation.[5]

It is common that individuals with acute stroke have low peak V02, indicating that these individuals are unfit before they have the stroke. Indeed, poor aerobic fitness is an important risk factor for stroke.[6]

Circuit Class Therapy is a form of Task Specific Training that involves the practice of structuring tasks in a circuit or series of workstations. It satisfies the three key characteristics of an effective and efficient skill training programme including:

- Using different workstations that allow people to practice intensively in a meaningful and progressive way to suit their respective needs.
- Efficient utilization of therapists'/trainees' time.
- It encompasses group dynamics such as peer support and social support.[7]

Circuit Class Therapy is effective in improving balance, transfers, gait, gait-related activities (such as climbing stairs) and upper limb functions in stroke survivors, especially when applied within the first six months after stroke and even later.[8]

METHODOLOGY

The aim of the study is to investigate the effect of task oriented circuit training on aerobic capacity during stair climbing in patients with stroke.

This study was an interventional study with purposive sampling method. 30 subjects were taken according to the inclusion and exclusion criteria. Ethical clearance was taken from the institutional ethical committee. In the present study the inclusion criteria was patients with Ischemic Stroke diagnosed with a CT scan, Stroke within 45 days, Above 18 years of age,A score of 26 points or higher on the montreal cognitive assessment(MoCA),Independent stair climbers (with or without handrail). Subjects with history of orthopaedic, vestibular and degenerative disease affecting balance in standing posture and ability to walk were excluded from the study. The subjects included will be explained about the intervention in the language understood by subject family members.A signed informed consent will be obtained in subjects own understandable language.

INTERVENTION

After the evaluations are done on day 1 subjects are explained about intervention in the workstation in circuit training and the procedure of staircase climbing.

- Workstations were divided into 2 SETS, SET-1 and SET-2.
- In Set-1 there is workstations number 1,2,3 and 4 will be carried out during the first day of the week and on the alternate day and Set-2 there are workstations number 5,6,7 and 8 will be carried out during the second day of the week and again repeated on the alternate day.
- Each task in each in the workstation was done for 5-10 reps x 3 sets.
- There will be a rest break for 2 mins when the patient shifts from one workstation to another.
- The activities will be carried out for 4 days/week for 4 weeks.

OUTCOME MEASURE

The Montreal Cognitive Assessment (MoCA) was developed to detect mild cognitive impairment with higher sensitivity and includes executive and attentional tasks, which are often affected in stroke patients. The MoCA was divided into 7 cognitive domains visuospatial, naming, attention, language, abstraction, recall and orientation. This assessment has demonstrated high test-retest reliability good internal consistency, and strength in detecting executive functions.[8]

The Timed Up and Go Test (TUG) is a widely used performance test for the evaluation of functional mobility or basic mobility skills in elderly people. The TUG is easy to administer compared with other performance measures and provides information on the abilities that facilitate living safely at home. The TUG requires participants to stand up from a chair, walk 3 meters, turn around, return to the chair, and sit down again. The time required to complete the test is recorded in seconds using a stopwatch.[9]

Gait is frequently impaired with balance difficulties and also a reduced capacity to ascend and descend stairs.[10]

Timed Up and Down Stairs was developed as a functional mobility outcome measure that would potentially reflect improvements in the musculoskeletal and neuromuscular systems that contribute to the control of posture. Timed Up and Down Stairs involves the subject ascending one flight of stairs, turning around, and descending to the starting point. One can hypothesize that performance on the Timed Up and Down Stairs requires a certain amount of strength of the lower extremities and trunk, range of motion in the lower extremities, coordination for fast reciprocal movements, and anticipatory and reactive postural control.[11]

The SIS 3.0 is a 59-item self-report assessment of stroke outcome used to assess health-related quality of life. The SIS has eight domains: strength, hand function, mobility, physical and instrumental activities of daily living, memory and thinking, communication, emotion, and social participation. Scores for each domain range from 0 to 100, and higher scores indicate a better quality of life.[12]The SIS 3.0 is designed for repeated administration to track the impact of a stroke on survivors' health and life status over time. It can also be used in clinical and research applications.[13] The SIS has demonstrated validity and reliability for assessing health related quality of life in stroke survivors.[14]

DATAANALYSIS

Table 1: Age In Years -frequency Distribution Of Subjects.

Age in Years	No. of Patients	%
<40	7	23.3
40-50	9	30.0
51-60	8	26.7
>60	6	20.0
Total	30	100.0

Mean ± SD: 50.63±16.04

Table 1- Shows the age distribution of the subjects who had participated in this study, 7(23.3%) subjects were between age group less than 40 years of age,9 (30%) subjects were between age group 40-50 years of age,8(26.7%) subjects were between age group 51-60 years of age,6(20%) subjects were between age group more than 60 years of age.

Table 2: Aerobic Capacity(VO_2 max)- Frequency Distribution Of Subjects.

VO_2 max	Pre Test (ml/kg/min)	Post Test (ml/kg/min)	% Difference
1-10	0(0%)	0(0%)	0.0%
11-20	0(0%)	0(0%)	0.0%
21-30	10(33.3%)	1(3.3%)	-30.0
31-40	20(66.7%)	19(63.3%)	-3.3%
41-50	0(0%)	10(33.3%)	33.3%
Total	30(100%)	30(100%)	-

P=0.0011* Significant, Paired proportion test

Table 2- Shows the pre-test scores and post test scores of Aerobic capacity($V0_2$Max),The pre-test scores, 10 subjects was between 21-30mL/Kg/Min, 20 subjects between 31-40 mL/Kg/Min in the pre-test evaluation. After the intervention the post test scores were , 1 subject between 21-30 mL/Kg/Min, 19 subjects between 31-40 mL/Kg/Min, 10 subjects between 41-50 mL/Kg/Min. The pre and post test scores were evaluated by applying "paired proportional test", where the p value obtained was P<0.001, which proves that the intervention was statistically significant. Improvement of 33.3% at a low score of VO_2Max

Table 3: TUG (SECONDS)- Frequency Distribution Of Subjects.

TUG (SECONDS)	Pre Test	Post Test	% Difference
1-10	0(0%)	0(0%)	0.0%
11-20	13(43.3%)	30(100%)	56.7%
21-30	17(56.7%)	0(0%)	-56.7%
Total	30(100%)	30(100%)	-

P<0.001**, Significant, Paired proportion test

Table 3- Shows the pre-test scores and post test scores of TUG, The pre-test scores, 13 subjects could ambulate between 11-20 sec, 17 subjects between 21-30 secs. After the intervention the post test scores were, 30 subjects between 11-20 secs.

Table 4: TUDS (SECONDS)- Frequency Distribution Of Patients Studied.

TUDS(SECONDS)	Pre Test	Post Test	% Difference
1-20	0(0%)	0(0%)	0.0%
21-40	0(0%)	0(0%)	0.0%
41-60	4(13.3%)	6(20%)	6.7%
61-80	20(66.7%)	19(63.3%)	-3.4%
81-100	6(20%)	5(16.7%)	-3.3%
Total	30(100%)	30(100%)	-

P=0.0607+, Significant, Paired proportion test

Table 4-Shows the pre-test scores and post test scores of TUDS, The pre-test scores were,4 subjects could ambulate the stairs between 41-60 sec, 20 subjects between 61-80 sec and 6 subjects at 81-100 secs. After the intervention the post test scores were, 6 subjects between 41-60 secs, 19 subjects between 61-80 secs and 5 subjects between 81-100 secs.

Table 5: SIS(%)v Frequency Distribution Of Subjects Studied

SIS(%)	Pre Test	Post Test	% Difference
1-20	0(0%)	0(0%)	0.0%
21-40	2(6.7%)	0(0%)	-6.7%
41-60	9(30%)	3(10%)	-20.0%
61-80	17(56.7%)	18(60%)	3.3%
81-100	2(6.7%)	9(30%)	23.3%
Total	30(100%)	30(100%)	-

P=0.0245*, Significant, Paired proportion test

Table 5- Shows the pre-test and post-test scores of SIS, the pre-test score was 2 subjects between 21-40 in the Stroke Impact Scale, 9 subjects between 41-60 in the Stroke Impact Scale, 17 subjects between 61-80 in the Stroke Impact Scale, 2 subjects between 81-100 in the Stroke Impact Scale. After the intervention the post test scores were, 3 subjects between 41-60 in the Stroke Impact Scale, 18 subjects between 61-80 in the Stroke Impact Scale, 9 subjects between 80-100 in the Stroke Impact Scale.

DISCUSSION

A stroke or Cerebrovascular accident (CVA) is defined as an abrupt

onset of a neurologic deficit that is attributed to a focal vascular cause. Subjects after stroke are less active, experience more fatigue, and perform activities at a slower pace compared with individuals with no impairments. Stroke subjects will have mobility problems such as stairclimbing, balance and gait due to neuromuscular impairments such as reduced motor control, muscle weakness, and spasticity. This can compromise their daily activities participation. An additional reason for poor activities performance might be their reduced aerobic capacity combined with an increased aerobic energy expenditure during daily activities after stroke. Aerobic Requirements during stair ascent and descent there is reduced cardiorespiratory fitness in chronic stroke contributes to reductions in gait performance and the elevated energy cost of walking. The aerobic cost was markedly higher in stroke, contributing in part to an elevated physiologic burden of stair ambulation.

Circuit exercise has been found to improve stroke survivors' functions and quality of life. The benefits of circuit class training in the improvement of cardiovascular fitness, muscle strength, and endurance, post-stroke individuals can improve physical performance by incorporating specific exercises into the circuit class training. Therefore, the present study aimed to evaluate the effect of task-oriented circuit training on aerobic capacity during stair climbing in subjects with stroke**.**

This interventional study was conducted on 30 stroke subjects who met the inclusion criteria and were given the intervention for 4 days a week for 4 weeks. The exercise intervention in co-operated each session consisting of Workstations that were divided into 2 SETS, SET-1 and SET-2. In Set 1 there is workstations number 1, 2, 3 and 4 will be carried out during the first day of the week and on the alternate day and Set 2 there are workstations number 5, 6, 7 and 8 will be carried out during the second day of the week and again repeated on the alternate day . Each task in each in the workstation was done for 5-10 reps for 3 sets. There will be a rest break for 2 mins when the patient shifts from one workstation to another. In set 1, workstation 3, task 3-lunges, 20 subjects were unable to perform due to functional/mobility restriction. Workstation 4, walking on heel toe gait, 25 subjects were unable to do it due to oedema or mobility restriction.

The pre and post interventional data were assessed by the outcome measures such as aerobic capacity (VO_2Max), the maximum volume of oxygen that can be utilized in one minute. Timed Up and Go test (TUG), to assess fall risk and progress of balance and gait. Timed Up and Down Stair Test (TUDS), to assess the ability to ascent and descend the flight of stairs and Stroke Impact Scale 3.0 (SIS 3.0), Self-report questionnaire to evaluate disability and health related quality of life after stroke.

The meta-analysis done by Pang (2011) poor aerobic fitness is an important risk factor for stroke as well as low aerobic fitness has also been related to an increased risk of various forms of cardiovascular disease. low aerobic fitness is a significant determinant of poor bone health (i.e. osteoporosis) in individuals with chronic stroke. Therefore, improving aerobic capacity may be essential in prevention of secondary diseases due to lack of fitness in the stroke population. Prevention of secondary disabling conditions is a major component of health promotion for people with chronic disabilities and is an emerging practice in rehabilitation.

With reference to the above said study, in this current interventional study, the pre-test scores were, between 21-30mL/Kg/Min there were 10 subjects, between 31-40 mL/Kg/Min there were 20 subjects in the pre-test evaluation. After the intervention the post test scores were ,between 21-30 mL/Kg/Min there were 1 subject, between 31-40 mL/Kg/Min there were 19 subjects, between 41-50 mL/Kg/Min there were 10 subjects. The pre and post test scores were evaluated by applying “paired proportional test”, where the p value obtained was $P<0.001$, which proves that the intervention was statistically significant. Improvement of 33.3% at a low score of VO_2Max. This states that there is an improvement of the cardiopulmonary endurance and activities of daily living. Hence, aerobic capacity(VO_2Max) plays an essential role.

A study done by Kelly LP, Devasahayam AJ (2021) suggested that task-oriented circuit training may be an effective strategy to replicate the intensities and outcomes achieved during traditional aerobic exercise training without using ergometers or other specialized equipment. task-oriented circuit training was more effective than usual physiotherapy on gait outcomes in a cohort of stroke survivors who recently completed inpatient rehabilitation.

A descriptive cross-sectional study done by Novak AC, Brouwer B, (2012), to estimate stair ascent and descent in relation to a measured standard of strength and metabolic (aerobic) capacities in persons with chronic stroke compared with healthy adults. The study concluded that the relative aerobic cost of stair ascent and descent was higher in stroke survivors because of their lower aerobic capacity.

In this current study, the pre- test mean with standard deviation score of (VO_2Max) was 33.63±4.8 was improved to post mean with standard deviation score 37.47±4.56 which was statistically significant (p-value < 0.0001). This finding was in consensus with the previous study suggesting that the relative aerobic capacity of stair ascend and descend was higher in stroke survivors because of their low aerobic capacity. Thus, the result justifies the use of aerobic capacity (VO_2Max) in the study.

In this current study, task-oriented circuit training was given for 4 days per week for 4 weeks. A study done by Dean CM (2000) reported the efficacy of a task-related circuit class in improving locomotor function in chronic stroke which was carried out for 3 times a week for 4 weeks, the intervention showed significant improvement in walking speed and endurance, force production through the affected leg during sit-to-stand, and the number of repetitions of the step test. In relation to the above study, the protocol was tailored in the current study.

In a systematic review and meta-analysis done by Zhen L, Han X.G. et.al, (2017) on improving balance in people after stroke which suggested that evidence supporting the usage of Timed Up and Go Test to assess walking and balance program in stroke who are at a high risk of falling. This result was in accordance with a study by Hafsteinsdottir TB, Renisnk M, et.al, (2016) conducted a systemic review and meta-analysis study on improving balance in chronic stroke which suggested that task-oriented circuit training had a significant improvement in timed up and go scores. This study goes in accordance with the present study with significant differences with the pre scores of timed up and go test with mean and standard deviation was 21.57**±**3.55 to post scores of timed up and go test with mean and standard deviation was 16.87**±**2.16, the result was statistically significant (p-value<0.0001).

Bonnyaud C, Zory R, Pradon D, Vuillerme N, Roche N, (2013). Conducted a study to determine performance on the Timed Up and Down Stairs (TUDS) test was related to clinical variables (maximal gait speed, strength and spasticity) and to biomechanical gait parameters (spatio-temporal, kinematic and kinetic gait parameters) in hemiparetic patients. Rehabilitation programs which aim to improve stair performance and independence in daily life activities should focus on these three parameters. In accordance with this study, the current study showed significant differences within TUDS group pre and post treatment with mean with standard deviation pre TUDS score 73.7±9.45 to mean with standard deviation and post TUDS score 69.8±9.13 which was statistically significant (p-value < 0.0001).

Richardson M et al. (2016) in his study concluded that the SIS is a valid and reliable measure of patient functioning post-stroke, and is a useful tool for evaluating the effectiveness of stroke rehabilitation interventions in the community setting. The current study demonstrated significant improvement in quality of life of stroke patients which was evaluated based on the Stroke impact scale .The mean with standard deviation pre-SIS score was 64.27±14.4 was improved to post mean with standard deviation Stroke Impact Scale score was 75.77±10.16 which was statistically significant (p-value < 0.0001). This result shows that there was improvement in quality of life.

Hence, alternate hypothesis is accepted and null hypothesis is rejected.

LIMITATIONS

1. The study was carried out on small sample size.
2. No long term follow up was carried out to assess the carry over effect of the intervention.
3. The number of sessions were very less i.e, 16 sessions.

RECOMMENDATIONS

1. Long term follow-up with larger population are warranted to see the effectiveness of the intervention and it might reveal higher statistical significance.
2. Similar study can be performed with randomization of samples in different groups**.**
3. Similarly, Anerobic capacity ($VOCO_2$) can be assessed.

CONCLUSION

Subjects with stroke may experience a variety of deficits, including impairment of motor, sensory, cognitive, perceptual and language functions and also have low peak V02 which effects their functional abilities. Task-Oriented Circuit Training is effective in improving balance, transfers, gait, gait-related activities (such as climbing stairs). Stair ambulation is important for independent mobility in Activity of Daily Living. Hence, it is important in stroke rehabilitation to improve their aerobic capacity as well as lower extremity activity essential for gait and stair ambulation to increase their Quality of Life (QOL).

In this current interventional study subjects were treated with task oriented circuit training on aerobic capacity was effective in order to improve stair climbing in patients with stroke. The outcome measures that were used in this study were aerobic capacity(VO_2Max), timed up and go test(TUG), timed up and down stair test(TUDS) and stroke impact scale(SIS). Result of data analysis showed improvement in cardiovascular fitness, balance, transfers, gait and gait related activities such as stairclimbing.

Thus, the results observed in this study concluded that, Task oriented circuit training on aerobic capacity was effective in order to improve stair climbing in patients with stroke.

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