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Original Research Article

Effect of Task Oriented Circuit Training Versus Trunk Rehabilitation on Balance, Trunk Control and Functional Ambulation in Chronic Stroke Patients: A Comparative Study

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ABSTRACT

Introduction: Stroke is the second or third most common cause of death, one of the main causes of adult disability worldwide and is global health problem. Stroke leads to impairments in balance, trunk control and ambulation leading to increased disability. It is observed in few studies that task oriented circuit training and trunk rehabilitation training both are effective to improve balance, trunk control and ambulation in stroke patients. There are hardly any literatures that have been done to compare the effectiveness of task oriented circuit training and trunk rehabilitation on balance, trunk control and functional ambulation in chronic stroke patients.
Method: In this study total 30 patients were selected and were allocated in two groups. Group A received task oriented circuit training and Group B received trunk rehabilitation for 4 weeks. Pre and post treatment balance, trunk control and functional ambulation were assessed using berg balance scale, trunk impairment scale and functional ambulatory category respectively.
Results: Balance, trunk control and functional ambulation significantly improved (p <0.001. Comparison between groups showed that Task oriented circuit training was more effective in improving balance, trunk rehabilitation was more effective in improving trunk control and both were equally effective in improving functional ambulation in chronic stroke patients.
Conclusion: Task oriented circuit training is more effective in improving balance, trunk rehabilitation is more effective in improving trunk control and both are equally effective in improving functional ambulation in chronic stroke patients.

Key words: stroke, balance, trunk control, ambulation, circuit training, trunk rehabilitation

INTRODUCTION

Stroke is an acute onset of neurological dysfunction because of an abnormality in cerebral circulation with resultant signs and symptoms which corresponds to the involvement of focal areas of the brain.[1] Stroke is the generic term describing the abrupt and sudden nature of onset and refers to a group of disorders that include cerebral infarction, cerebral hemorrhage, and subarachnoid hemorrhage. In literature stroke is reported as one of the common global problems and a major concern of long term neurological disability in adults. It is also a major cause of death seen in worldwide population.[2] The cumulative incidence of stroke ranged from 105 to 152/100,000 persons per year during the past two decades in different parts of the country.[3] Stroke patients face challenges such a motor, sensory and communication deficits, and in areas such as cognition, quality of life, and mental and physical health.[4] Stroke is more disabling than lethal with at least 30% of stoke survivors making an incomplete recovery and a further 20% of them requiring assistance for ADLs.[5]

Hemiparesis or hemiplegia are the most typical symptom of stroke.[1] In addition to limb muscles, trunk muscles are also impaired in stroke patients.[1] Ability of the trunk muscles to allow the body to remain upright, adjust weight shift, and perform selective movement of the trunk that maintains the center of mass within the base of support during static and dynamic postural adjustments is called as the trunk stability.[4] Poor recovery of trunk muscle performance leads to severe disability and reduction in activities of daily living.[5] A study stated that the central nervous system initiates a feed forward recruitment pattern of core musculature which provides a more stable neuromuscular foundation for muscular movements and which can contribute to more precise limb control during locomotion.[6] The altered trunk movements makes it a challenge for the maintenance of the body equilibrium, and to get back normal movements of the trunk and of the pelvis in patients with stroke.[1]

Balance impairment is another challenge faced by post-stroke patients which has been identified recurrently in many studies as a risk factor for falls and fear of falling. These fall-related injuries are expected to occur which further increasing the rate of mortality among stroke survivors.[7] There is a vicious cycle of balance disability and functional immobility resulting in delay of the recovery process of stroke rehabilitation. The ability to analyze, compare, and to select the appropriate sensory information are impaired following stroke which results in problems with sensory reweighting and integration. The inability in selecting reliable visual, vestibular and somatosensory information in order to produce proper motor action necessary to maintain postural stability and balance results in the decreased ability to maintain static and dynamic balance in stroke.[8]

One of the most serious consequences of stroke is gait dysfunction. Propulsion, upright stability, shock absorption and energy conservation are required during normal gait.[4] Perry et al. found that stroke patient had reduced shock absorption at heel strike, poor control of momentum during stance, inability to generate force for push off to maintain forward propulsion and inadequate excursion of the paretic limb during swing phase in hemiplegic gait.[4] Although majority of patients with stroke walk independently, they are not able to walk efficiently. One of the main aim of the rehabilitative process it to help patients achieve high level of functional independence as possible within the limits of their particular impairments.[9] Mobility affected patients are prone to inactivity and often have a sedentary lifestyle, which may result in a variety of problems which includes deteriorating gait, social isolation, feelings of depression and fatigue, ultimately affecting their quality of life.[10]

Task related training (TRT) is a rehabilitation strategy which involves the practice of goal-directed, functional movements in a natural environment and to help patients derive optimal control strategies for alleviating movement disorders. In a TRT program, the patient is required to work in a task-specific or goal-driven or self-driven activity.[9] Task-specific training is based on the dynamic systems theory, in which the focus of rehabilitation is to enhance the function across all performance domains by emphasizing function, participation, and quality of life.[11]

Stroke can lead to impairments in trunk muscle strength, activation patterns and proprioception. These problems and their subsequent trunk performance deficits have been found to be related to imbalance and limited functional recovery. Following this line of thinking, trunk exercises could thus possibly improve balance and functional recovery.[12] Trunk movement impairment and muscle weakness in stroke patients can have a negative impact on the control of position and independent daily living activities.

Therefore, recovering the ability of trunk control should be preceded by the training to restore other functions.[6]

There are studies which prove that task oriented circuit training and trunk rehabilitation training both are effective to improve balance, trunk control and gait in stroke patients. There are few literatures that have been done to compare the effectiveness of task oriented circuit training and trunk rehabilitation on balance, trunk control and functional ambulation in patients with chronic stroke. Hence, this study was conducted.

MATERIALS AND METHODOLOGY

Experimental study was done for 4 weeks (5days/ week) on 30 patients (15/ group). Study was approved by the ethical committee. Patients were selected using simple random sampling and were divided in 2 groups using chit method. The nature of study was explained and written consent was obtained from patients prior to the study.

Inclusion criteria: [1, 6, 13, 14]

- Age 30-65 years
- Both male and female
- First onset of unilateral stroke resulting in hemiplegia
- Post stroke duration of at least 6 months
- Ability to understand simple verbal commands (MMSE score >/=24)
- Able to do sit to stand with or without support
- Scoring <21 on Trunk impairment scale
- Scoring of at least 30/56 on Berg balance scale
- Able to walk independently 10 meters with or without walking aid
- Currently not receiving any other type of intervention

Exclusion criteria:

- Diagnosis of stroke with any other neurological disorder affecting balance (e.g. MS, vestibular disorder, Parkinson, impaired vision)
- H/O diagnosed musculoskeletal disorder affecting motor performance e.g. fracture, OA, ligament injury
- Patients with any deformities

Task oriented circuit training protocol: [7, 14]

It incorporated workstations involving task oriented activities

At all stations patients practiced for 3 minutes, and this session was followed by 1 minute transfer to the next station.

Protocol was given for 45-50 minutes per day.

The core practice activities included:

1. Sit to stand
2. Stepping forward
3. Stepping backwards
4. Tandem Standing
5. One Leg Standing
6. Reaching forward at shoulder height

Walking practice included:

1. Obstacle crossover
2. Reaching forward at shoulder height
3. Slope
4. Stairs

Progress was assessed as required, such that the level of difficulty, complexity and dosage (no. of repetitions) matched the ability of each individual.

Trunk rehabilitation protocol: [1, 6, 13]

Exercises were carried out 45-50 minutes per day with 1-2 minutes break during each exercise. The exercise program consisted of 4 supine exercises and 7 sitting exercises

Supine exercises included:

1. Bridging
2. Unilateral bridging
3. Rotation of upper trunk (by bringing clasped hands on either side)
4. Rotation of lower trunk (by moving knees on either side)

Sitting exercises (patient seated with hips and knees at 90 degree flexion and feet kept flat on floor) included:

1. Selective flexion extension of lower trunk
2. Upper trunk lateral flexion (by initiating movement from shoulder girdle so as to bring the elbows towards the plinth)

3. Lower trunk lateral flexion (by initiating movement from pelvis girdle so as to lift the pelvis off the plinth)
4. Upper trunk rotation and Lower trunk rotation (by moving both shoulders and knees forwards and backwards respectively)
5. Forward reach (by asking the patient to reach forward at shoulder height by forward flexing the trunk at hips)
6. Lateral reach at shoulder height (by giving reach out for a fixed point at shoulder height so as to elongate the trunk on weight bearing side and shorten it on non-weight bearing side)

The number of repetitions and intensity of the exercises were determined based on patient's performance.

The intensity was increased by introducing one or several of the following changes:

1. Reducing the base of support
2. Increasing lever arm
3. Advancing the balance limits
4. Increasing the hold time

Both the groups received conventional treatment which included:

1. Knee to chest
2. Abdominal crunches
3. Mini squats
4. Lifting heels
5. Upper limb training

DATA ANALYSIS AND RESULTS

The present study aimed at finding the effects of task oriented circuit training versus trunk rehabilitation on balance, trunk control and functional ambulation in chronic stroke patients after 4 weeks protocol.

The data was analyzed with the help of R-software. Total 30 patients, both male (47%) and female (53%) with mean age of 48.4 [Group A (task oriented circuit training)] and 52.4 [Group B (trunk rehabilitation)] were selected using random sampling method and were allocated into two groups (15 patients in each group) using chit method. Various statistical measures such as mean, standard deviation (SD) and test of significance were utilized to analyze the data. 95% confidence interval was taken into consideration. The results were concluded to be statistically significant if, p value was <0.05. Data was analyzed using unpaired t test for Inter group analysis and by using Paired t test for Intra group analysis.

The pre and post intervention data in group A (task oriented circuit training) and group B (trunk rehabilitation) was analyzed using Paired t-test. There was significant difference ($p < 0.0001$) in pre (38.33±5.052) and post (46.93± 4.992) mean berg balance scale score, pre (16.93 ± 2.915) and post (19.86 ± 2.722) mean trunk impairment scale score and pre (3.53± 0.915) and post (4.46± 0.743) mean functional ambulatory category within group A. There was significant difference ($p < 0.0001$) in pre (33.87± 5.097) and post (38.33± 6.293) mean berg balance scale score, in pre (12.4± 4.564) and post (18.73 ± 2.764) mean trunk impairment scale score and in pre (1.6± 01.121) and post (2.26± 0.961) mean functional ambulatory category within group B. Thus, task oriented circuit training and trunk rehabilitation both are effective in improving balance, trunk control and functional ambulation at the end of 4 weeks.

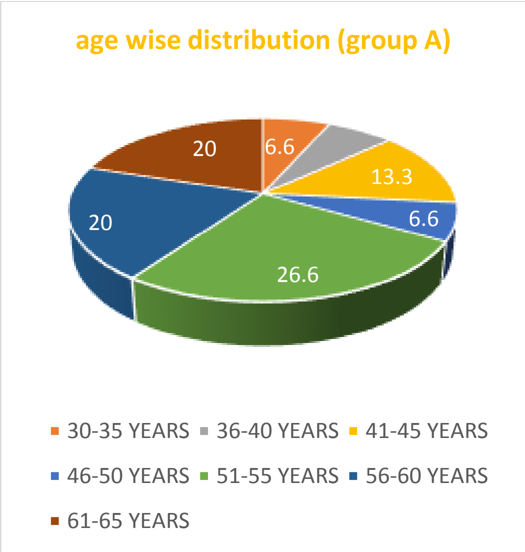
Comparison of Inter group scores was done using unpaired t test. There was significant difference with p value 0.001, when the comparison of pre and post berg balance scale score between group A (8.6 ± 3.043) and group B (4.46 ± 2.232) and pre and post trunk impairment scale score between group A (2.93 ± 1.534) and group B (6.33 ± 2.63) were done. There was no significant difference with p value 0.13, when the comparison between pre and post functional ambulatory category between group A (0.933 ± 0.457) and group B (0.669 ± 0.488) was done.

Hence the results show that task oriented circuit training was more effective in improving balance, trunk rehabilitation was more effective in improving trunk control and both were equally effective in improving functional ambulation in chronic stroke patients.

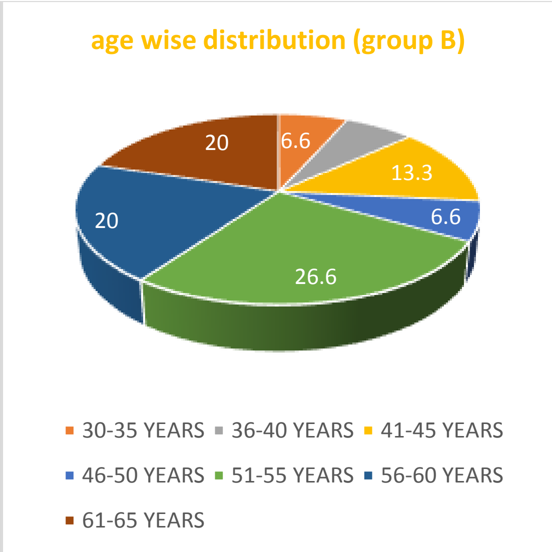
1. Statistical analysis of descriptive data of study population

Table 1: Age wise distribution of patients

	Group A		Group B	
Age	**No. of patients**	**Percentage**	**No. of patients**	**Percentage**
30-35 years	2	13.3 %	1	6.6 %
36-40 years	3	20 %	1	6.6 %
41-45 years	1	6.6 %	2	13.3 %
46-50 years	2	13.3 %	1	6.6 %
51-55 years	4	26.6 %	4	26.6 %
56-60 years	1	6.6 %	3	20 %
61-65 years	2	13.3 %	3	20 %



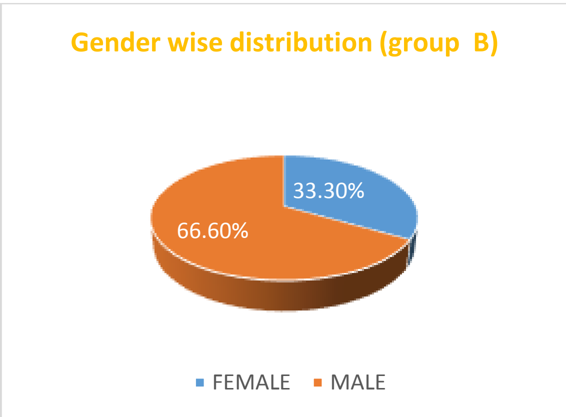
Graph 1: Age wise distribution of patients in percentage in group A



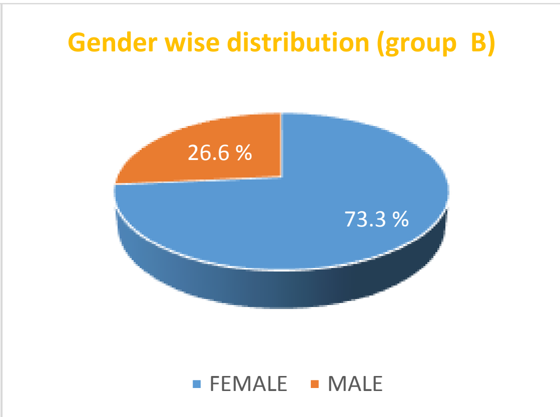
Graph 2: Age wise distribution of patients in percentage in group B

Table 2: gender-wise patient distribution

	Group A		Group B	
Gender	**Samples**	**Percentage**	**Samples**	**Percentage**
Female	5	33.3 %	11	73.3 %
Male	10	66.6 %	4	26.6 %



Graph 3: Gender wise distribution of patients in percentage in group A



Graph 4: Gender wise distribution of patients in percentage in group B

Intra-group comparison data analysis

Table 3: Comparison of pre post score of parameters within group A (task oriented circuit training)

Parameters	**pre**		**Post**		**t value**	**p value**	**Result**
Berg balance scale score	Mean	SD	mean	SD	10.94	<0.0001	Highly significant
	38.33	5.02	46.93	4.992			
Trunk impairment scale score	Mean	SD	mean	SD	7.407	<0.0001	Highly significant
	16.93	2.915	19.87	2.72			
Functional ambulatory category	Mean	SD	mean	SD	7.89	<0.0001	Highly significant
	3.53	0.915	4.46	0.743			

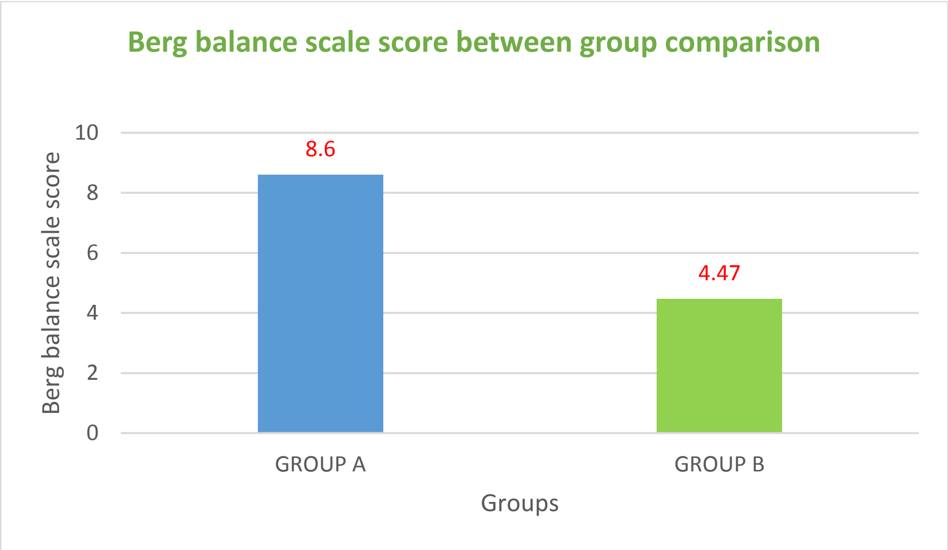
Table 4: Comparison of pre post score of parameters within group B (trunk rehabilitation)

Parameters	pre		Post		t value	p value	Result
Berg balance scale score	Mean	SD	mean	SD	7.75	<0.0001	Highly significant
	33.87	5.097	38.33	6.293			
Trunk impairment scale score	Mean	SD	mean	SD	9.302	<0.0001	Highly significant
	12.4	4.564	18.73	2.764			
Functional ambulatory category	Mean	SD	mean	SD	5.2	<0.0001	Highly significant
	1.6	1.121	2.26	0.961			

Inter-group comparison data analysis

Table 5: Comparison of pre post berg balance scale scores between group A and group B

Group	Difference (mean)	t value	p value	Result
Group A	8.6± 3.043	4.2425	0.0001	highly significant
Group B	4.46± 2.232			



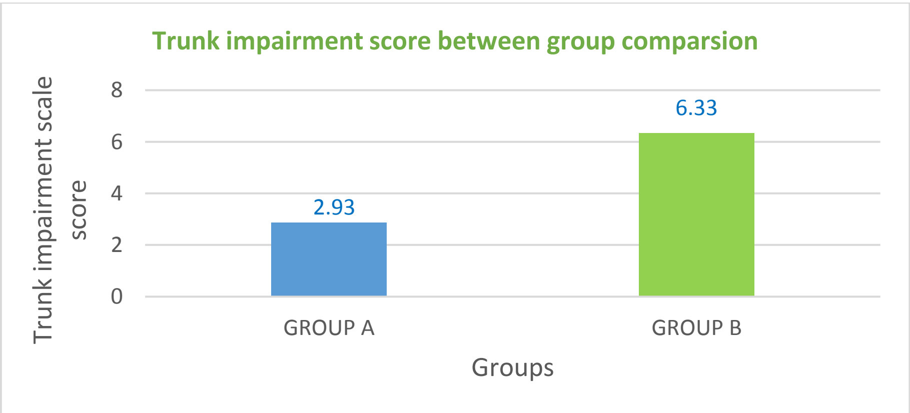
Graph 5: Comparison of pre post berg balance scale scores between group A and group B

Table 5: Comparison of pre post trunk impairment scale scores between group A and group B

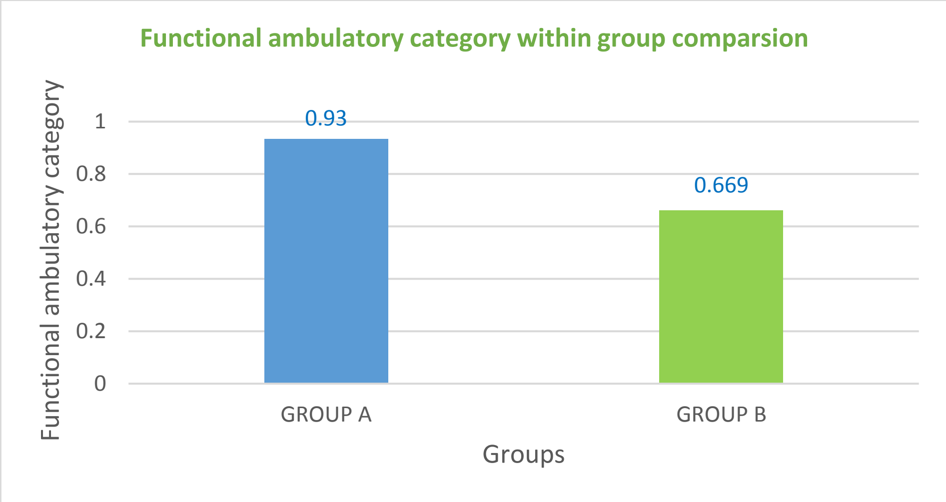
Group	Difference (mean)	t value	p value	Result
Group A	2.93 ± 1.534	4.321	0.0001	highly significant
Group B	6.33 ± 2.63			

Table 6: Comparison of pre post functional ambulatory category between group A and group B

Group	Difference (mean)	t value	p value	Result
Group A	0.933 ± 0.457	1.5	0.13 (>0.05)	not significant
Group B	0.669 ± 0.488			



Graph 6: Comparison of pre post trunk impairment scale scores between group A and group B



Graph 7: Comparison of pre post functional ambulatory category between group A and group B

DISCUSSION

Stroke patients may suffer from a number of the physical impairments such as muscular weakness, loss of motor functions or motor insufficiencies, limited Range of movements, and complete dependency on others even for basic activities. Many patients have to face long lasting disabilities and are unable to make full progress towards their movements and functions ever.[15]

Trunk stability is often overlooked as an essential core component for balance and coordinated extremity use for daily activities. An appropriate sensorimotor ability of the trunk is required for trunk control to provide a stable foundation for balance functions in patients with stroke.[4] The altered trunk movements are a challenge for the maintenance of the body equilibrium and restoration of normal movements of the pelvis and of trunk in patients with stroke.[1]

Balance impairment is another challenge faced by post-stroke patient. Fall related injuries are expected to occur, further increasing the rate of mortality among stroke survivors.[7] The decreased ability to maintain static and dynamic balance in stroke has also been related to the inability in selecting reliable visual, vestibular and somatosensory information in order to produce proper motor action necessary to maintain postural stability and balance.[8]

Stroke patients shows muscle weakness, abnormal muscle tone, and disorder in balance and posture control, which results in difficulty in locomotion.[4] Although majority of patients with stroke walk independently, they are not able to walk efficiently.[4] Speed, depression, level of ADLs, use of a walking aid, and the strength of ankle dorsiflexion, knee flexion, knee extension were all found to be significant factors influencing balance in patients with stroke.[7]

Studies show that trunk impairment and functional performance related to balance and gait are significantly correlated. Thus, any intervention that improves trunk performance will facilitate improvement in balance and gait in stroke patients.[16] A study has shown that treatment of hemiplegic lower limb along with the selective trunk exercise regime may result in a large effect size index for the gait[13] and that selective trunk exercises with NTD show improvements in measures of mobility, balance and trunk control in chronic stroke patients.[6] Furthermore, improved trunk control with trunk rehabilitation could be the reason for change in gait speed. Therefore, when an improved level of proximal trunk control was attained, a better the distal lower limb mobility might be anticipated such as that involved in walking. The analysis of trunk kinematics during walking show that pelvic movements are unstable and asymmetrical in patients with stroke. With trunk rehabilitation, there may be increased time spent in affected limb support stance which may be reason for the gait symmetry improvement.[17]

Improvements observed among patients receiving trunk rehabilitation can be attributed to the anatomical fact that the trunk muscles are bilaterally innervated and the axial muscles are rarely contracted unilaterally even when the arm produces a unilateral movement, to stabilize the trunk, which could enforce the contraction of the muscles on the paretic side by irradiation.[1]
There are studies that have shown that task oriented training program was effective in improving balance in stroke[18] and task-oriented rehabilitation after stroke has proved to be effective and relevant for stroke practice. The mechanism for effectiveness of task related training may be attributable to an enhancement of presynaptic inhibition of the hyperactive stretch reflexes in spastic muscles, decrease in the co-contraction of spastic antagonists, and disinhibition of descending voluntary commands to the motor neurons of paretic muscle.[9] Task-specific training is also seen to be effective in improving the static and dynamic postural control and trunk ranges of motion which favors our findings.[11]
Task-oriented training, focusing on repetitive or circuit training, has shown to positively affect improved functional outcomes after stroke, especially for lower extremity functioning.[19]
Task oriented training provides proper visual input and, substitutes for absent or reduced proprioceptive input from the affected body side which proves that recovery that occur after task oriented training is due to learning as well as cortical plasticity related to acquisition and recovery of function. Brain-functional imaging studies also describe the recovery from hemiplegic stroke to be associated with a marked reorganization of activation patterns of specific brain structures after task oriented training.[18]
The reason for improvement in task related training could be supported by plasticity following brain lesion. Following stroke repetitive exercises and training in real life task may be an important stimulus in the making of new more effective functional connections within remaining brain tissue. Therefore, it could be because of specificity of training with respect to different environmental conditions as practiced in task oriented circuit training might had helped in post training improvement in spatial variables. Improvement in gait in Group A is because as patients achieved skill in walking, tasks were made more complex by increasing stepping over objects, difference in heights of objects, walking without stopping. These complexities were useful in daily life activities. This could be the explanation for post training improvement in temporal variables. This suggests that-with interventions of Task Related Training, long term stroke patients are able to improve walking performances.[9]

CONCLUSION

The study concluded that Task oriented circuit training is more effective in improving balance, trunk rehabilitation is more effective in improving trunk control and both are equally effective in improving functional ambulation in chronic stroke patients.

Clinical implications:

The study findings are of clinical importance since they indicate an improvement in balance, trunk control and gait in stroke patients. Hence, either task oriented circuit training or trunk rehabilitation could be used to improve balance, trunk control and functional ambulation in stroke patients.

Limitations

1. Only patients who had stroke for more than 6 months were included in the study.
2. The patients who participated were recruited from a specific geographical location.
3. The patients could not be followed up in order to ascertain, whether the interventions had long lasting effects and could ensure the retention phases of motor learning

Future scope

1. Future studies need to be done with other outcome measures such as posturography and electromyographic analysis and biofeedback.

2. A larger sample size would allow better stratification of the obtained results in terms of age ranges, stages of recovery, balance, trunk impairment and functional ambulatory scores. Thus, a diverse cohort will be required to apply the finding of the study to the general population.

Declaration by Authors

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