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EFFECTIVENESS OF STASTIONARY CYCLING EXERCISE ON PLANTAR FLEXOR SPASTICITY AND DYNAMIC BALANCE IN CHRONIC STROKE PATIENTS.

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ABSTRACT

INTRODUCTION:

STROKE is the most common cause of death and disability in **India.** Stroke patients are known to be more likely to have increased **spasticity** and shortended gastronomies which reduced the range of motion of ankle dorsiflexionon the paretic side. This may induce incorrect transmission of somatesthesia from the joint or the muscle receptors or motor response, accompanied by in appropriate ankle strategy, causing difficulty in balance control. All the movements in the ankles including dorsiflexioncontrols the interactions between the feet and the ground, which acting as an essential factor in balance and gait. Post stroke patients with gait problem are more common and it affects functional ambulation. **Cycling** can improve functional mobility and acts as a pseudo walking task-oriented exercise.

AIM: To find out the effectiveness of stationary cycling exercise on plantar flexor spasticity and dynamic balance in chronic stroke patients.

OBJECTIVES: To evaluate the effectiveness of stationary cycling exercise on plantar flexor spasticity by using Modified Ashworth Scale. To evaluate the effectiveness of stationary cycling exercise on dynamic balance by using Dynamic gait index.

METHODOLOGY: 30 chronic stroke patients were taken and divided into two groups, experimental group (n=15) received stationary cycling exercise along with conventional therapy and control group (n=15) received conventional therapy (cryo-stretches and electrical stimulations) for 5 days in a week for 6 weeks.

Research design: Randomised control trial

Sampling method: Simple random sampling.

RESULTS: After six weeks of treatment period, the experimental group were compared with control group. Results shown that there was a significant improvement at 0.05 level.

CONCLUSION: Stationary cycling exercise was shown significant effect on spasticity and dynamic balance in chronic stroke patients.

KEYWORDS: CEREBRO VASCULAR ACCIDENTS, STATIONARY CYCLING, SPASTICITY AND DYNAMIC BALANCE.

INTRODUCTION

STROKE is defined as the "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin.[28]

In India stroke is one of the leading cause of death and disability. The prevalence rate of stroke range 334-424/1,00,000 in urban areas and 84-262/1,00,000 in rural areas. Bases on the 2013 studytheincidence rateof stroke ranges 119-145/100,000.[1] In India, mostly patients with first ever stroke was occurred at the age group of 40 years or lesser. Mean age of stroke patients in Trivandrum and Mumbai was 67 and 66years respectively. In the Bangalore study the mean age was54years. Male incidence rate was higher than females. Most common and high risk factors of stroke in India are hypertension (54%), hyper cholesterolemia (15%) and tobacco smoking (12%). [1]

In upper motor neuron syndromes, **spasticity** is one of the common impairment and it affects their functional performance and rehabilitation interventions.[25]Recent studies showed that spasticity occurs in 20% to 30% of all stroke patients, and another study has reported contracture development in 50% of the cases 6 months after stroke.[24]

Traditional treatment modalities for spasticity include use of an ankle-foot orthotics, physical therapy, systemic medications, tendon surgeries, and focal alcohol neurolysis. More recent treatment options are neuromuscular electric stimulation (NMES). Stroke patients are known to be more likely to have increased **spasticity** and shortening of gastrocnemius which reduced the range of motion of ankle dorsiflexionon the paretic

side.[4]Such changes leads to incorrect transmission of somatesthesia from the receptors or joint, accompanied by in appropriate ankle strategy, causing difficulty in balance control. All the movements in the ankle including dorsiflexion controls the interactions between the feet and the ground, acting as an essential factor in balance and gait.[4] Reduction of plantar flexorspasticity can decrease the risk for falls in daily life and social activities of patients with stroke.[25]

Post stroke patients with gait problem are more common and it affects functional ambulation. It is caused by a complex interplay of motor, sensory, and cognitive impairments. Repetitive motor training can alter brain activities and is mainly used for managing the motor function recovery in stroke patients. Hemiplegia is one of the most common impairment after stroke which reducesthe gaitfunctions. Gait recovery is a major goal in the rehabilitation program for stroke patients. Therefore, for many decades, hemiplegic gait has been the object of study for the development of methods for gait analysis and rehabilitation.[22]

The different physical therapies all aim to improve gait functions mostlyusing over ground gait training. Beside the specific technique used all approaches require specifically designed exercises, physical therapist's direct observation and manipulation of the lower limbs position during gait on a regular surface, followed by assisted walking practice over ground. According to the theoretical principles of reference that have been the object of a Cochrane review in 2007, neurological gait rehabilitation techniques can be classified in two main categories: neurophysiological and motor learning. Some other advancedtechniques like robot technique and functional electrical stimulation techniques also used in gait rehabilitation.

Apart from these techniques, some skilled activity like cycling is essential in brain changes and recovery, that might lead to improvements in functional activities such as gait. Cycling have locomotor patterns of reciprocal flexion and extension movements and alternating muscle activation of antagonists.[3]walking also similar with cycling pattern**. Cycling**can improve gait functionand acts as a pseudo walking task-oriented exercise. Cycling improves the muscle strength and also facilitate muscle control of the lower limbs, which may allow putting more weight on the affected leg while standing. Hsin-Chang Lo studied on cycling with assistance of functional electrical stimulation. However the pure effect of cycling exercise on spasticity is unknown. Therefore, this study investigates the effectiveness of stationary cycling exercise on plantar flexor spasticityand dynamic balance in chronic stroke patients.

NEED OF THE STUDY:

Stroke can results in neurological impairments like spasticity. The prevalence of post stroke spasticity is nearly 43%. In lower limbs, plantar flexor spasticity is more common. It results in balance and gait dysfunction. During the gait cycle, stroke patients have difficulty in clear the foot due to weak ankle dorsiflexors and spasticity of plantar flexors.

Number of studies suggested that spasticity had treated with stretching exercises and electrical stimulation. Previously Suk- Min Lee studied the effects of stationary cycling exercise on the balance and gait abilities in chronic patients.[3]Hsin- Chang Lo et al. studied the FES assisted leg cycling in wheel chair had shown on reduction in spasticity.[25] Evidence showed limited literature on the effects of cycling over the spasticity in stroke patients.So, more studies are required to know the effect of cycling exercise on spasticity and gait. So, I want to investigate the effectiveness of stationary cycling exercises on plantar flexor spasticityand dynamic balance in chronic stroke patients.

AIM:

To find out the effectiveness of stationary cycling exercise on plantar flexor spasticity and dynamic balance in chronic stroke patients.

OBJECTIVES:

- To evaluate the effectiveness of stationary cycling exercise on plantar flexor spasticity by using Modified Ashworth scale.
- To evaluate the effectiveness of stationary cycling exercise on dynamic balance by using Dynamic gait index.

MATERIALS AND METHODOLOGY

MATERIALS: Couch, Stationary cycle (STAY FIT DB-12), Electrical stimulator, Ice pack, box, 2 obstacles (cones) and sand bag.

METHODOLOGY:

30 chronic stroke patients were selected randomly to be the subjects of this study, after they had received an explanation of the contents and purpose of this experiment and given their consent to participation. Patients were selected from college of physiotherapy SVIMS and S.V.AYURVEDIC hospital, Tirupati.

STUDY DESIGN: Randomised control trial

TYPE OF SAMPLING: simple random sampling, the subjects were selected by lottery method.

Study duration: 5days in a week for 6 weeks

INCLUSIVE CRITERIA:

- Patients with more than 6 months of attack with stroke.
- Included both Ischemic & hemorrhagic stroke subjects.
- Stroke patients with age group of 40-65 years.
- Gender: both male and female stroke subjects.
- Stroke patients with plantar flexor spasticity of

MAS score 2or <2.

- Stroke patients with voluntary control grading 3.
- Stroke patients with MMSE score >24 were included.
- Stroke patients with Trunk control test >50.
- Stroke patients who were capable of walking 10m independently with or without any aids.

EXCLUSIVE CRITERIA:

- Stroke subjects with cognitive and perceptual deficits.
- Stroke subjects with other neurological disorders.
- Psychologically disturbed stroke subjects.
- Stroke subjects with sensory deficits.
- Stroke subjects with global aphasia.
- Stroke subjects with cardiovascular diseases.
- Stroke subjects with head injuries, fractures of lower limbs and recent surgeries of lower limbs.

METHODOLOGY

All subjects who were selected on the basis of inclusion criteria were divided into two groups: control group, experimental group with 15 subjects in each group by lottery method and voluntary participation of the subjects was done after signing the consent form. The purpose of the study was clearly explained to all subjects.

Evaluation of spasticity: All the 30 subjects underwent spasticity assessment through the Modified Ashworth Scale for plantar flexors. The modified Ashworth scale is a 6-pont rating scale it is easy to test. It does not require any equipment. Subjects were positioned in supine lying on the treatment couch. Instruct the subjects to be in relaxed position. By doing passive ankle dorsiflexion therapist felt resistance offered by the spastic muscles which was graded by modified Ashworth scale.[24]

Evaluation of dynamic balance: All the 30 subjects underwent dynamic balance assessment through the DYNAMIC GAIT INDEX. This test requires shoe box, two obstacles (cones), stairs (with a handrail) and 20 (6.1 meters) foot pathway. It consists of total eight components with score 24.[13]

- Gait level surface: Ask the patient to walk on a 6 meters surface with their normal speed and scoring given according to the level of performance.
- Change in gait speed: Start walking with normal speed, when I tell the patient to go or slow. They have to change their walking speed with respectively.
- Gait with horizontal and vertical head turns: Start walking with normal speed in the surface. Instruct the patient to walk in straight way with changing the directions of the head to right / left and up/ down.
- Pivot turns: start walking in the path. When I instruct to turn and stop, patient has to turn quickly and stop.
- Step over the obstacle: A box was kept in the middle of the walking surface and patient has try to step over the box.
- Step around the obstacles: Two cones are place in the middle of the path and instruct the patient to walk in s-shape manner).
- Steps: Instruct to climb the stairs as they would at home.

Scores are ranging from 0-3. 0-indicates the lowest level and 3- indicates the highest level of function.

INTERVENTIONS:

CYCLING EXERCISE PROCEDURE:

In this study, STAY FIT DB-12 model stationary cycle was used. Before cycling exercise, patient sits on the seat of the cycle and holds the both hands over the handles. Place the foot on the pedals and strap was secured around it. Start cycling exercise by moving the legs repetitively in circular manner.

Treatment parameters:

50-60 rpm with resistance was set at 1-4.

Treatment time[27]: 30 minutes cycling with rest intervals.

No of sets: 3 sets of exercises

One set- Cycling time: 10 minutes

Rest time: 2 minutes.

Treatment duration: 5 days per week for 6 days.

Intervention group includes cycling exercise, cryo-stretches and electrical stimulations.

CONTROL GROUP:

CRYO-STRETCHES: It contains 20 minutes of cooling the muscles, static stretching, and contract relax technique. The patient was positioned in supine lying. The ice pack put under the belly of plantar flexors for 20 min. Following this 5-6 repetitions of 65 sec stretches are applied with a 20 sec rest between the sets. Each period of 65 sec consists mainly of static stretching with three 5 sec isometric contractions interspersed throughout the stretch.

ELECTRICAL STIMULATIONS:[30]

Patient was positioned in supine lying on a low couch. Ankle was kept in neutral with sand bag support.

Group of muscles: Ankle dorsiflexors.

Type of current: Surged faradic currents.

Parameters:

Pulse duration: o.1ms.

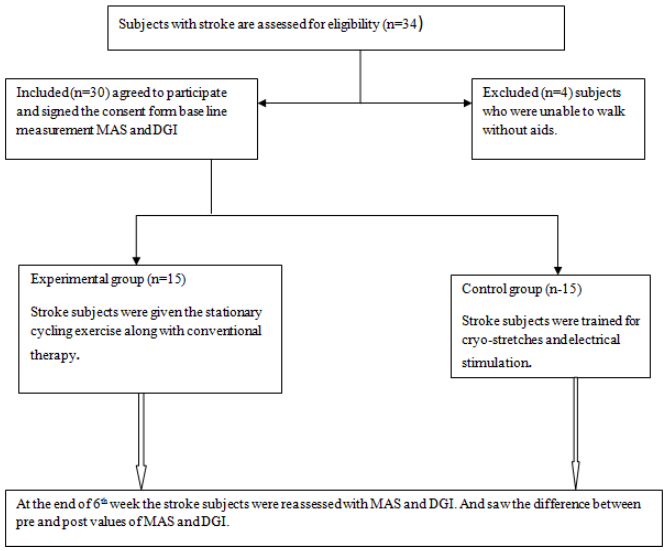
Surge duration: 4sec,Rest: 6 sec.

Treatment duration: 9 minutes.

Placement of electrodes: cathode electrode: Tibialis anterior muscle belly.

Anode electrode: fibula head.

STUDY ALOGORHYTHM



Statistical analysis and results

Statistical analysis was done using the statistics software "SPSS 20.0 version". For this purpose of the data was entered into Microsoft excel spreadsheet, tabulated and subjected to statistical analysis.

All the 30 subjects completed the entire study protocol as defined, by 6 weeks in the training sessions. To observe the treatment impact before and after, within the group and between the groups, analysis is carried out by using paired t-test- outcome measures of plantar flexor spasticity and dynamic balance.

Table 1: Analysis of Comparison within outcome measures of Control between pre and post values of MAS, DGI.

Control		N	Mean	SD	t-value	p-value
MAS	Pre	15	1.67	0.362	-5.292	0.001
	Post	15	1.33	0.362		
DGI	Pre	15	9.73	2.404	11.784	0.012
	Post	15	13.33	2.769		

*Indicates significance at 5% level.

To compare the pre and post values of MAS and DGI in control group, t-test for paired sample observations has been used. It is observed that post values have shown some significant impact on the subjects.

As p< 0.05, there is significant difference between the pre and post within the control group.

Table 2: Analysis of Comparison within outcome measures of experimental between pre and post values of MAS, DGI.

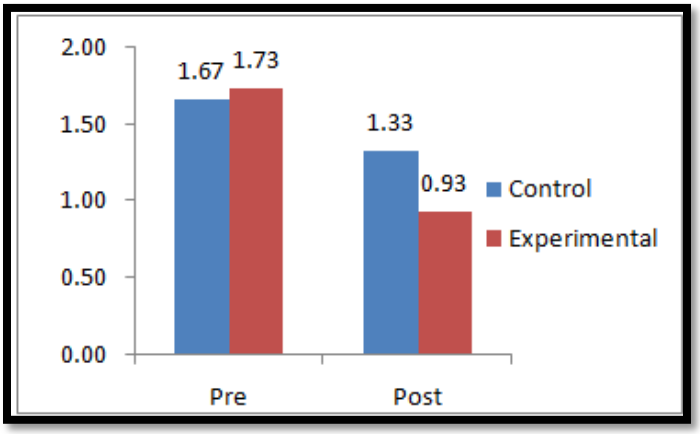
Experimental		N	Mean	SD	t-value	p-value
MAS	Pre	15	1.73	0.372	-12.220	0.000
	Post	15	0.93	0.417		
DGI	Pre	15	8.67	1.676	15.875	0.001
	Post	15	17.13	1.922		

*Indicates significance at 5% level.

To compare the pre and post values of MAS and DGI in experimental group, t-test for paired sample observations has been used. It is observed that post values have shown some significant impact on the subjects.

As p< 0.05, there is significant difference between the pre and post within the experimental group.

Graph 1: Following graphical representation shows the comparison of MAS Means pre and post values in two groups.



Graph: 2 Following graphical representation shows the comparison of DGI Means pre and post values in two groups.

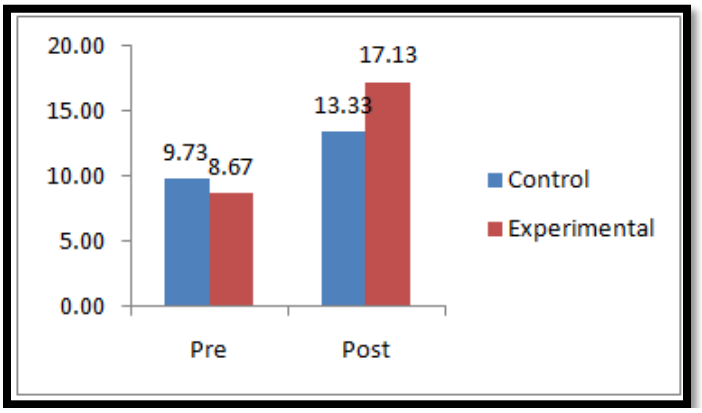


Table 3: Analysis of Comparison between Experimental and Control using difference of pre and post values

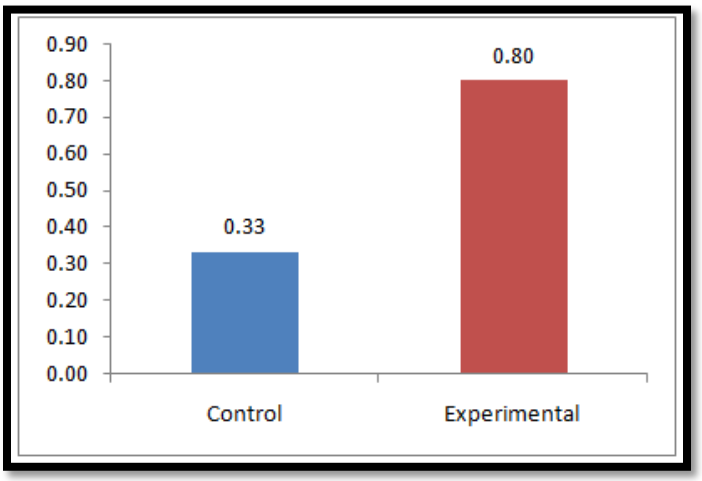
Variable	Group	N	Mean	SD	t-value	p-value
MAS	Control	15	0.33	0.244	-5.137	0.001
	Experimental	15	0.80	0.254		
DGI	Control	15	3.60	1.183	-7.918	0.001
	Experimental	15	8.47	2.066		

*Indicates significance at 5% level.

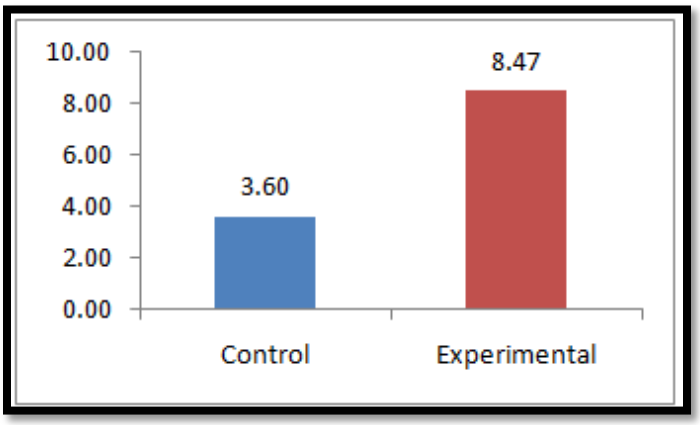
To compare the pre and post values of MAS and DGI between the experimental group and control group for two sample t-test observations has been used. It is observed that experimental group have shown more significant improvements on the subjects.

As $p < 0.05$, there is significant difference between the pre and post between the experimental group and control group.

Graph 3: Following graphical representation shows the comparison of MAS Means of two groups.



Graph 4: Following graphical representation shows the comparison of DGI Means of two groups.



RESULTS:

After a 6 weeks treatment period, the subjects in experimental and control group had shown improvement with outcome measures, on comparing experimental and control group, there is a significant improvement at 0.05 levels with the outcome measures i.e., MAS and DGI.

Discussion:

The aim of this study was to investigate the effectiveness of cycling exercise on the plantar flexor spasticity and dynamic balance in chronic stroke patients.

A total number of 30 subjects participated in the study and randomized into 15 subjects in the experimental group and 15 subjects in the control group. Subjects in the control group receive conventional therapy; cryo-stretches, electrical stimulations, where as experimental group was given static cycling exercise along with conventional therapy.

Based on the statistical analysis, the alternate hypothesis stating that stationary cycling exercises reduces spasticity and improve gait abilities in chronic stroke patients can be accepted and null hypothesis is rejected.

Experimental group and control group both have shown statistically significant difference between pre and post values of MAS and DGI. But the subjects in the experimental group has shown higher significance compared to the control group.

The significant results in the control group was due to effect of cryo-stretches, electrical stimulation. The underlying physiology behind the reduction of spasticity using ice is not totally understood; it may be due to slowing of conduction in both the muscle and motor nerves, a decrease in the sensitivity of the muscle spindle or impaired conduction in the gamma efferent's; which are more susceptible to cooling than alpha efferent's. Electrical stimulation is effective in reducing spasticity stimulation of the weak antagonist. Application to the tibialis anterior muscle or to the common peroneal nerve have been shown to reduce spasticity in the plantar flexor muscles and improve dorsiflexion.[29]

A study by Cinara Stein was done on effect of electrical stimulation in spastic muscles after stroke. He was concluded that NMES combined with other intervention modalities can be considered as a treatment option that provides improvements in spasticity and range of motion in patients after stroke.[24]

A study by **Ki-Suk Park** done on the effects of plantar flexor stretching applied to patients with hemiplegia caused by stroke to improve their range of motion in the ankle joints, balance, and gait ability. The results of that study showed that the experimental group undergoing balance training with plantar flexor stretching increased their PROM in dorsiflexion and experienced a significant improvement in balance ability when compared to the control group undergoing plantar flexor static stretching.[4]

Studies have shown that stretching of plantar flexor muscles increased the ankle dorsiflexion and improve the gait by reduced the ankle joint resistance.[12]

Majority of falls occur during walking (40–90%), so the ability to assess dynamic balance and mobility properly post-stroke is extremely important. One common tool used to assess changes in mobility and fall risk is the dynamic gait index (DGI). The DGI was developed by Shumway-Cook and Woollacott to evaluate functional stability during gait activities and risk of falling in older individuals[13].

Repetitive practice is important for motor learning, as the repetitions helpsthe system to coordinate muscle synergies. Cycling havelocomotor patterns of repetitive reciprocal flexion and extension movements. Hence, stationary cycling exercise, which employs reciprocal movement of the lower limbs and requires coordination of corresponding muscles, effectively decreased the spasticity and increased the dynamic balance.[22,3]

A study by Kuo and Zajak suggested that the muscles that may be particularly important for this purpose are the hamstrings, rectus femoris, gastrocnemius, and tibialis anterior. These were all activated during the cycling task, which requires reciprocal flexion and extension movements of the hip, knee, and ankle[3].

Studies have shown that both assisted leg cycling and non assisted leg cycling exercise was reduced the muscle tone and improve the gait.[25]

Here in this study both control group (table1) and experimental group (cycling exercise)(table2) shows significant effect on the reduction of spasticity and improvement in dynamic balance. But experimental group have showed more significant improvement due to cycling exercise (table3).

CONCLUSION

The present study examined the effect of stationary cycling exercise on plantar flexor spasticity and dynamic balance in chronic stroke patients. Conventional therapy exercises and cycling exercise both are useful for reducing spasticity and improving dynamic balance. Moreover, experimental group (cycling exercise) had more significant effect on reducing spasticity and dynamic balance than control group.

Limitations:

1) Sample size is small.

2) Only one group of muscles were taken.

Recommendations:

1. The study can be done with large sample size.
2. The study can be done with strength and gait.
3. Comparative study can be done.

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