Effects of Leg Ergometer on Balance and Functional Mobility in Chronic Stroke Patients

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Abstract: ***Under this study, the stroke is the most common form of acquired brain injury and is one of the leading causes of death and disability worldwide most stroke survivors will regain some ability to walk, 40% will require assistance with walking and those of independent, 60% will be limited in community ambulation and having continuing problem with mobility. In this study the primary objective is to find out the effects of leg ergometer on balance and functional mobility in chronic stroke patients. The statistical method has been implemented to analyze the results. These are statistical methods which have been implemented are regression, descriptive statistics, ANOVA, etc. In results, there is a positive effects of leg ergometer on balance and functional mobility in chronic stroke patients.***

Keywords: Leg Ergometer, Functional, Mobility, Stroke, Brain Injury

1. Introduction

Stroke is an "acute neurologic dysfunction of vascular origin with symptoms and signs corresponding to the involvement of focal areas of brain" (WHO). Stroke results in upper motor neuron dysfunction that produce hemiplegia or paralysis of the one side of the body, including limbs and trunk and sometimes the face and oral structures that are the contra lateral to the brain lesion hemisphere that has lesion.

Stroke is the most common form of acquired brain injury and is one of the leading causes of death and disability worldwide (Murray CJ et al 1997). Balance deficits are among the most persistent impairments and common concerns of stroke survivors, as balance is fundamental to optimal mobility and performance of many activities of daily living (Tyson et al., 2006). Factors such as the severity of neurologic deficits, poor motor control and lower limb muscle weakness negatively affect the performance of tasks involving functional balance and mobility (Flansbjer et al., 2006;).

While majority of stroke survivors will regain some ability to walk, 40% will require assistance with walking and those of independent, 60% will be limited in community ambulation and having continuing problem with mobility (Jorgensen HS et al 1995). This reduced level of community ambulation and community participation results in decreased satisfaction with levels of outdoor mobility, community reintegration, and perceived difficulty in outdoor locomotion (Shelton FD et al 2001).

The major cause of balance disturbances after stroke is the CNS lesion which affects the muscle recruitment and synergies. Following stroke, patients lose functions of the motor, sensory and higher brain cognitive faculties to various degrees which leads to diminished balance. It has been documented that hemiplegic or hemiparetic stroke patients presented with more posture sway, asymmetric weight distribution, impaired weight-shifting ability and decreased stability capability (Shumway Cook A et al 1988 and Goldie PA et al 1996).

Balance is a somewhat ambiguous term used to describe the ability to maintain or move within a weight-bearing posture without falling. Balance can further be broken down into three aspects: steadiness, symmetry, and dynamic stability. Steadiness refers to the ability to maintain a given posture with minimal extraneous movement (sway). The term symmetry is used to describe equal weight distribution between the weight-bearing components (e.g., the feet in a standing position, the buttocks in a sitting position), and dynamic stability is the ability to move within a given posture without loss of balance. All of these components of balance (steadiness, symmetry, and dynamic stability) have been found to be disturbed following stroke.

Hemiplegic people show asymmetrical body alignment because of different muscle tone between the affected and unaffected sides. These changes may result in gait deterioration (Nyberg L et al 1995). Generally, longer stance phase duration and shorter swing phase duration during gait on the affected side are shown, and the step length, gait cycle and velocity are changed (Wagennar RC et al 1992). As stroke patients have decreased balance ability, they show inefficient gait pattern through consumption of more energy (Granat MH et al 1996).

Impairment in muscle strength is thought to be an important limiting factor in determining walking speed after stroke. There is a positive correlation between muscle strength and maximum gait speed. Specific muscle groups that demonstrate the strongest relationship with walking speed vary greatly among studies, depending on the number of muscles investigated, the parameter used to quantify strength (ie, hand dynamometer force, isometric or isokinetic torques), and the method of documenting gait speed (eg, self selected or fast speeds, distance walked, with or without assistive devices or orthoses) (Kim CM et al 2003, Richards CL et al 1996). Studies that have compared multiple muscle groups most frequently have identified strength in the hip flexors and ankle plantar flexors as the strongest predictor of walking speed after stroke, although strength in the knee extensors, hip extensors, and ankle dorsiflexors was identified as being significantly related to gait speed. The contribution of the hip flexors and ankle plantar flexors to maximizing walking speed has been related to their large bursts of power generation late in the stance phase of the gait cycle (Nadeau S et al 1999, Bohannon RW et al 1989, Suzuki K et al 1999 and Olney SJ et al 1991).

Various approaches used in the treatment of hemiplegia include approaches like Bobath, Roods, Neurodevelopmental technique, Brunnstrom's movement therapy and Proprioceptive neuromuscular facilitation (PNF) has been applied in stroke rehabilitation. They ar based on the theories that sensory input is a pre-requisite for motor control in normal movements resulting from the cerebral and cerebellar control over spinal level reflex. Other treatment such as Motor relearning program, Convential gait training through parallel bars and ambulating aids such as walker, biofeedback, electrical stimulation, knee straping and AFO are given to improve lower limb function and for gait training.

The muscle activity pattern during pedaling is known to be very similar to other forms of locomotion, including gait and is assumed to be generated by a similar central network (Rassch CC et al 1999, Christensen LOD et al 2000). Features of muscle co-ordination during pedaling include relatively low co-activation of one-joint and two-joint antagonists (Rosecrence JC et al 1991, Ericson MO et al 1985). Pedaling is a functional, safe and accessible mode of exercise for patients with a wide range of ambulatory capability.

Objectives of the Study
To find out the effects of leg ergometer on balance and functional mobility in chronic stroke patients.

2. Research Methodology

Study Design:
Experimental pre and post test design.

Subjects:
Both male and female were taken.
Both right and left hemiplegics were taken.

Setting:
Study was conducted in the department of occupational therapy, JOTC

Participants:
30 stroke patients were included in the study.

Inclusion Criteria:
1) Clinical diagnosis of first stroke.
2) Age: 25-65.
3) Able to follow simple instructions.
4) Able to walk with or without an assistive device, for 10 metres.
5) No cognitive deficits (more than 25 in MMSE)

Exclusion Criteria:
1) Hemiplegic due to other causes other than CVA e.g. TBI
2) Previous injury to lower extremity.

Independent Variable:
Leg ergo meter training.

Dependent Variable:
Improved balance and functional mobility.

3. Data Analysis

Table 1: Demographic Characteristics

NO.	Baseline Characteristics	Control Group	Experimental Group
1	No. of subjects	15	15
2	Age (Range)	40-56	40-58
3	Mean age (SD)	47.73±5.24	49.21±5.18
4	Gender (Male/Female)	14:1	12:3

Table 2: Comparison of Pre & Post Test score of BBS in Control and Experimental Group

BBS	Z (2-tailed)	P (2-tailed)
Control	-3.162	0.002
Experimental	-3.427	0.001

Table 3: Comparison of Pre & Post Test score of TUG in Control and Experimental Group

TUG Test	MEAN(SD)	t		df	P
PRE			POST		
Control	24.80±3.858	24.27±3.973	4.000	14	0.001
Experimental	25.87±4.94	18.73±5.29	10.913	14	0.000

Table 4: Between Group Comparison of TUG

TUG	MEAN(SD)	t	df	P
Control	24.27±3.973	-3.236	28	0.003
Experimental		18.73±5.29		

4. Discussion

As balance and mobility is impaired after stroke, it can lead to avoidance of physical activities and social participation, falls and loss of independence. Hence intervention that can improve balance and mobility is important part of rehabilitation. The present study was designed to examine the effect of leg ergometer on balance and functional mobility in chronic stroke patients.

The findings of the study suggest that both control group and experimental group shows statistically significant improvement in balance and mobility and there is statistically significant difference between the group as shown by scores.

Our results indicate that although both the control group (p=0.002) and experimental group (p=0.001) exhibited improvement in the BBS (1st outcome measure) on within group analysis yet the BBS shows significant difference between the control and experimental group in the final measurement (p=0.011) on between group analysis. Similarly in TUG (2nd outcome measure) both control group (p=0.001) and experimental group (p=0.000) exhibited improvement on within group analysis yet the TUG shows significant difference between the control and experimental group in the final measurement (p=0.003).

5. Control Experimental

Post 4 Weeks
The reason for improvement in balance and mobility may be due to biomechanical functions executed during pedalling by

the muscle groups. Specifically, the phasing of two pairs with respect to limb extension and flexion and the transitions between extension and flexion do not change with pedaling direction. One pair of groups (uniarticular hip and knee extensors alternating with their anatomic antagonists) generates the energy required for limb and crank propulsion during limb extension and flexion, respectively. In the second pair, the ankle planter flexors transfer the energy from the limb inertia to the crank during the latter part of limb extension and the subsequent limb extension to flexion transition. The dorsiflexors alternate with the plantarflexors. The phasing of the third pair (the biarticular thigh muscles) reverses with pedaling direction. In forward pedaling, the hamstring is excited during the extension to flexin transition and in backward pedaling during the opposite transition. In both cases hamstring propel the crank posteriorly through the transition. Rectus femoris alternates with hamstrings and propels the crank anteriorly through the transitions. With three control signals, one for each pair of groups, different cadences (or power outputs) can be achieved by adjusting the overall excitatory drive to the pattern generating elements, and different pedaling goals (e.g., smooth, or energy-efficient pedaling; 1or 2 legged pedaling) by adjusting the relative excitation levels among muscle groups. These six muscle groups are suggested to be elements of a general strategy for pedaling control, which may be applicable to other human locomotor tasks (Rassch et al 1999).

6. Conclusion

The study showed that relatively short training programme on leg ergometer lead to relevant improvement on balance and functional mobility in chronic stroke patients. These result suggest Leg ergometer can be included along with conventional occupational therapy to improve balance and functional mobility in chronic stroke patients.

7. Limitations

- Sample size was small.
- There was no control over the extraneous factors such as natural recovery.
- Follow-up could not be done on the subjects in both the groups.
- The study duration was also short.
- Sample was dominated by male subjects.

8. Recommendation For Further Studies

- Further study with a large sample with long duration.
- Long term follow up study can be conducted to understand the sustained effects of leg ergometer.

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