The Effect of Visual Feedback Assisted Bicycle Ergometry in Improving Functional Activities of Lower Extremity among Post Stroke Patients-Quasi Experimental Study

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Abstract

Objective: The most common and widely recognised impairment caused by stroke is motor impairment. Motor impairments of lower limb limits the patient's ability in standing and walking. The motor recovery of the lower limb can be enhanced by repetitive trainingat the early phase of rehabilitation. The aim of this study is to find out the effect of visual feedback assisted cycle ergometry training in improving the lower extremity function among post hemiparetic stroke patients.

Study Design: Two groups pre test and post test Quasi experimental study design.

Subjects: 30 patients of age group between 40-70 years who had a first stroke were randomly assigned into two groups, experimental cycling (N=10) group and conventional physiotherapy (N=10) group.

Interventions: Patients of two groups received conventional physiotherapy training for 50-60 minutes a day. Additionally experimental group patients received 30 minutes of leg cycling training.

Outcome Measures: The motor function of the lower extremity was assessed by the Fugl-Meyer Assessment. dynamic standing balance was assessed by Step test and the functional ability was assessed by functional ambulation category scale.

Results: In the with in-group comparison, both the cycling group and the conventional therapy group had improved significantly with respect to Fuglmeyer lower extremity score, step test score and functional ambulation category score. In between group comparison, experimental cycling group patients demonstrating better performance in both Fuglmeyer lower extremity score, step test score and functional ambulation category scale than the conventional therapy group patients.

Conclusion: This study shows that there is a significant improvement in lower limb function among the experimental group patients after an early short duration of cycling training.

Keywords: *Stroke, conventional physiotherapy, MOTO-med bicycle ergometry, fuglmeyer motor assessment scale, steptest, functional ambulation category scale.*

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Introduction

Stroke is defined as a rapidly developing clinical signs of focal or global disturbances of cerebral blood function with symptoms lasting for 24 hours or longer or leading to death, with no apparent cause other than vascular origin- WHO.

The incidence of stroke increases dramatically

with age, doubling after every decade after 55. India is witnessing a stroke epidemic silently. By 2020, India will report about 1.9 million cases of stroke per year, at least one-third of whom will be disabled.

Stroke is a major health problem not only because it is the third major cause of death but also because it leaves patients with several residual disabilities like physical dependence, cognitive decline, dementia, depression and seizures. The costs involved in caring for these patients are enormous and it creates adverse social implications[2]

Individuals with hemiparesis following a stroke will often have difficulty in bearing weight or "loading" the paretic lower extremity and transferring weight from one leg to the other. As a result, these individuals commonly shows asymmetry during sitting and standing activities and during walking, with a greater amount of body weight distributed on the unaffected lower extremity than on the affected lower extremity.

The motor recovery after the stroke occurs depending on the severity of the lesion and rehabilitative training. Several studies have revealed that motor experience plays a vital role in the subsequent physiological reorganization occurring in the intact tissues adjacent to the lesion. Clinical studies on central motor neuroplasticity support the role of goal-oriented, active, repetitive movements in the training of the paretic limb to enhance motor relearning and recovery[3].

The recovery of standing and walking ability is considered the most important objective of the lower limb rehabilitation of individuals after stroke[3].

Cycling and walking share a similar kinematic pattern. Both tasks are cyclical, require reciprocal flexion and extension movements of hip, knee and ankle and have an alternating activation of agonist/antagonist muscles in a well-timed and coordinated manner[14,15]. The cycling provides the mechanical coupling between the two legs helps the stroke patients to pedal cyclically so that a steady pattern of excitation emerge in the affected limb[9]. Furthermore, cycling avoids problems of balance and can be safely performed even from a wheelchair, without requiring support from any robotic devices or the constant supervision of a therapist. Though cycling leg exercise is not exactly like walking, the task of maintaining a simplified locomotor pattern and learning to shift weight between affected and unaffected extremities is task oriented. For all these reasons, leg cycling training is a safer and more economic intervention to give functional ambulation training after stroke and it is also becoming an interesting option for home rehabilitation[3].

In this study the cycling leg training is given using MOTO-med bicycle ergometer which is with visual feedback. In MOTO-med the motion given are from passive motion to assistive motion to active training. Irrespective of the mode of motion, the MOTO-med allows a very great number of repetitions. Greater numbers of repetitions are considered to be effective concerning the use of the central nervous system's plasticity[6]. Also the resistance offered by the MOTO-med cycle ergometer may increase the muscle strength. As MOTO-med provides visual feedback about symmetry in weight transfer from one leg to other while pedalling, patient by himself can correct the asymmetry if occurs. This training using visual feedback will reduce the non-use of affected lower extremity and make the patient to use his paretic leg.

Need for the Study: Loss of movement is the common consequence of stroke for which a wide range of interventions has been developed. Recovery of stroke depends highly on the area of brain involved and also the nature of rehabilitation. Recently many studies suggested that earlier rehabilitation will soon recover the patient's functional status. Therefore, much of the focus of stroke rehabilitation and in particular the work of physiotherapists and occupational therapists, is on the recovery of impaired movement and the associated functions. There seems to be a direct relation between motor impairment and function; for example, independence in walking (function) has been correlated with lower-limb strength (impairment). Therefore, the ultimate goal of therapy for lower-limb motor impairment is to improve the function of walking and recovery of movement. In stroke rehabilitation motor activity of lower limb possess an important component of regaining gait and expanding activities of daily living. Recently the duration of hospital stay is getting reduced because of increased medical expense. So it is essential to find out the techniques that will complement the present conventional therapy to enhance the post stroke motor recovery in potential way. An exercise that has been considered suitable for hemiparetic stroke is pedaling on a cycle ergometer with variable limb loading. Short-term changes in muscle coordination in the paretic leg have been demonstrated after a single session of ergometer cycling. In addition, functional improvements have been

reported in balance and walking ability following longer-term cycling exercise. Cycling training will provide the large number of repetitions which is predicted to fasten the cortical re-organization and functional recovery of the patient after the episode of stroke. To find a more effective treatment protocol for post middle cerebral artery stroke patient to improve their motor function. Therefore in this study the training using activity based programme (with bicycle ergometer) is been selected to compare it with the regular conventional therapy and to achieve maximum lower extremity function of hemiparetic patient following repetitive bilateral leg training as much as possible at the earliest.

Methodology

Study Design: Quasi-Experimental Pre-Post test control group design.

Sampling Technique: Purposive sampling

Sample Size: 30 patients satisfying the criteria were selected. They were divided into 2 groups.

Group A: Visual feedback assisted bicycle ergometry training group(15 patients)

Group B: Conventional therapy group (15 patients)

Inclusion Criteria:

- Age group 45-70 years of age
- First time unilateral stroke
- Less than or equal to 4 weeks of MCA stroke
- Ischaemic stroke
- Patients with stable cardiovascular parameter.
- Both males and females
- Co-operative patients (able to follow commands)
- Able to initiate the movement (FMA Score between 18-24)
- Patients with mini mental score > 24
- Right or left hemiparesis.

Exclusion Criteria:

- Chronic stroke
- ACA and PCA territory Stroke
- Bilateral lesion
- Hemorrhagic stroke
- Visually impaired patients
- Recurrent stroke
- Severe joint deformities
- Rheumatoid arthritis
- Recent fractures
- Any other neurological problems
- Cognitive and mental impairment
- Non co-operative patients
- Recent cardiac problems and unstable cardiac parameters

Treatment Procedure: Totally 20 patients who satisfied the criteria were selected and allocated randomly into two groups with 10 in each group, experimental group and conventional therapy group. The patients were examined before and after the treatment. They were given assigned treatment for the study duration.

Treatment Duration: 15 sessions were given after the pretest assessment.

- Group A received one hour of conventional physiotherapy followed by 30 minutes of cycle ergometry training consist of forward and backward p
- Group B received one hour of conventional physiotherapy alone

Conventional Physiotherapy: Conventional physiotherapy includes Active assisted exercises to all affected joints, manual stretching, bed mobility exercises, Balance training exercises (both in sitting and standing), Co-ordination exercises (both equilibrium and non-equilibrium exercises) and Gait training exercises.

Bicycle Ergometry Training:

In the cycle ergometry, Based on the initial cycling performance, each patient have been assigned with an individual exercise programme. The patient was advised to use the affected extremity for pedaling. Symmetry of limb usage being displayed in the monitor, it gives the visual feedback to the patient to perform efficiently and the exercise will be stopped if the patient reports fatigue or discomfort in the affected extremity.

Pulse rate and blood pressure measurements was continuously monitored for any adverse cardio vascular reaction during the exercise period.

Cycle ergometry training consist of 2 sets of exercising in each session, the duration of each set is 15 minutes with intermittent rest period of 5 minutes between the sets.

Set 1: Forward pedaling alone with 0 resistance and gradual increase in resistance based on patients ability.

Set 2: Backward pedaling alone with 0 resistance and gradual increase in resistance based on patients ability.

Each session consist of 30 minutes, totally 15 sessions was given.

Outcome Measure:

- The lower extremity section of the Fugl-Meyer assessment of motor recovery after stroke.
- Step test (a dynamic balance test)
- Functional ambulation category scale.

Statistical Analysis: Pre-test and Post-test values of the study were collected and assessed for variation in improvement & their results were analyzed using Independent 't' test and Paired 't' test,

Table 1: Paired t Test result for all three outcome measures

Scale	Groups	Mean Values		Calculated 't' Value	Table 't' Value	Level of Significance
		Pre Test	Post Test			
Fugl Meyer Lower Extremity Scale	A	20.1	30	11.1802	1.8331	0.05
Fugl Meyer Lower Extremity Scale	B	19.6	25.4	6.3010	1.8331	0.05
Step Test Score (Unaffected As Standing Leg)	A	1.8	5.1	19.6061	1.8331	0.05
Step Test Score (Unaffected As Standing Leg)	B	1.9	3.1	10.0000	1.8331	0.05
Step Test Score (Affected As Standing Leg)	A	0.9	3.1	8.8196	1.8331	0.05
Step Test Score (Affected As Standing Leg)	B	0.9	1.5	2.2942	1.8331	0.05
Functional Ambulation Category Scale	A	0.8	3	10.5393	1.8331	0.05
Functional Ambulation Category Scale	B	0.7	2.1	5.9648	1.8331	0.05

Table 2: Independent t Test

Scale	Pre Test/ Post Test	Mean Values		Calculated 't' Value	Table 't' Value	Level of Significance
		Group A	Group B			
Fugl Meyer Lower Extremity Scale	Pre Test	20.1	19.6	0.3597	1.734	0.05
Fugl Meyer Lower Extremity Scale	Post Test	30	25.4	2.8328	1.734	0.05
Step Test Score (Unaffected As Standing Leg)	Pre Test	1.8	1.9	0.1855	1.734	0.05
Step Test Score (Unaffected As Standing Leg)	Post Test	5.1	3.1	3.9380	1.734	0.05
Step Test Score (Affected As Standing Leg)	Pre Test	0.9	0.9	0.0319	1.734	0.05
Step Test Score (Affected As Standing Leg)	Post Test	3.1	1.5	5.5668	1.734	0.05
Functional Ambulation Category Scale	Pre Test	0.8	0.7	0.6306	1.734	0.05
Functional Ambulation Category Scale	Post Test	3	2.1	2.0672	1.734	0.05

Discussion

Repetitive bilateral leg training is an effective method for improving lower extremity motor function in hemiparetic middle cerebral artery stroke patients. The cycling treatment has been given only half an hour a day but still the patients treated with cycle ergometer have shown better improvement than the patients treated only with conventional therapy. After the stroke, the physiotherapy given by the therapists as well as the self directed exercises is short, therefore the cycling will be an effective treatment. In additional when it is given earlier at the acute stage, it helps the patient in reducing his disabilities and regain his functional activities as soon as possible. The intensity of the treatment after the stroke

also contribute to the earlier recovery of the patients regarding his functional abilities. In data analysis, all the post test scores shows significant improvement in all three scales in both the groups but very effectively in Group A. The Calculated 't' value is greater than table 't' value, rejecting the null hypothesis shows there was a better improvement in Group A patients lower limb activities assessed with fuglmeyer lower extremity scale, step test and functional ambulation category scale Comparing to Group B patients

Summary and Conclusion

Results have shown that the lower limb functional activities was improved statistically in bicycle ergometry group than the conventional therapy group. It has been shown to improve lower extremity motor functions and the patients find the method relatively easy to perform. So bilateral training can be considered as an effective method for home or clinical based rehabilitation of stroke patients.

Limitations:

1. Sample size was small.
2. Study assessed only the short term progress of the patient and no follow- ups have been done.
3. Lesion side was not considered.
4. Only middle cerebral artery territory stroke was taken.
5. First time stroke patients only were taken.
6. Only subjects were selected between the age groups 45 – 70 years.
7. Only ischaemic type hemiparetic stroke patients have been included in this study.
8. In this study no detailed gait assessment was taken.

Suggestions:

1. Larger sample size can be used.
2. Further carry over and transfer of training can be assessed.
3. Treatment technique can also be studied in other types of stroke and considering the lesion side.
4. Follow up can be done.
5. Further studies can be done with detailed gait assessment.
6. Study can also be done with younger stroke patients with age group less than 45 years

Source of Funding: Self Funding

Conflict of Interest: Nil

Ethical Clearance: Got consent form signed from patients.

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