Effect of Elliptical Training for Balance and Gait Training in Patients with Chronic Stroke-A Case Report

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ABSTRACT

Background: *Balancing and walking are important predictors of independence and mobility. Clinicians need to find effective and inexpensive interventions for improving balance and gait in patients with chronic stroke.* **Aim:** *To evaluate the effect of elliptical training for balance and gait training in patients with chronic stroke. Methods and Material: The patient was 36 years old male with chronic stroke (>6 month) who was able to walk on a level surface without assistance. The elliptical trainer was used for 20 minutes per session, 3 times a week for four weeks. The pre and post interventions score was measured with Tinetti Performance Oriented Mobility Assessment (POMA) and Voluntary Control Grading (VCG). Results: The participant demonstrated an improved score in Tinetti's Performance-Based Mobility Assessment (POMA) and Voluntary Control Grading.* **Conclusion:** *The study concluded that elliptical training emerged to be a safe and practicable training for improving balance and gait training in chronic stroke.*

Keywords: Elliptical trainer, POMA, Chronic stroke, Balance, Gait training

Abbreviations: POMA: Performance- Oriented Mobility Assessment, LE: Lower Extremity, VCG: Voluntary Control Grading, BP: Blood Pressure, HR: Heart Rate

INTRODUCTION

Stroke is defined as an abrupt neurological outburst caused by impaired perfusion through the blood vessels to the brain [1]. According to the 2012 updates to the India Stroke factsheet, the approximate age-adjusted prevalence rate of stroke in rural areas is between 84/100,000-262/100,000 while in urban areas it is between 334/100,000-424/100,000 per year and more than 13.7 million new strokes occur [2,3]. There are two forms of stroke: Ischemic (which occurs in 85% of cases) and Hemorrhagic (which occurs in the remaining 15% of cases) [4].

The most common type of stroke is Middle Cerebral Artery stroke (MCA). The most common impairments of MCA infarct are spastic hemiparesis and sensory loss with the face and upper extremity more involved than lower extremity and is associated with lesions in the motor and sensory cortex [5].

Stroke leads to serious long-term disability all over the world [6]. Literature showed that two-thirds of individuals are unable to walk or require physical assistance to walk immediately after their stroke and a third of individuals still require assistance or are unable to walk 3 months post-stroke. These chronic limitations in mobility can lead to a decrease in the endurance and fitness of the individuals [6]. Also, limited mobility affects the physical, social, mental, and activity of daily living. As balancing and walking are important predictors of independence and mobility, clinicians need to find effective and inexpensive interventions for improving balance and gait in patients with chronic stroke [6].

There are various conventional and advance treatment protocols for improving lower limb functions which include treadmill for locomotor training, robotic-assisted locomotor training, electro-mechanical gait training, and motorized elliptical machine. For ambulatory individuals with chronic stroke, elliptical training appears to be a viable and healthy alternative training option. Most elliptical trainers work on the user's upper and lower body (although some models

do not have moving upper body components). Though elliptical trainers are considered to be minimal-impact, they are an example of a weight-bearing form of exercise. They can be self-powered by user-generated motion or need to be plugged in for adjustment of motion and/or for supplying their electronic consoles and resistance systems. It demonstrates increased stamina, balance, and functional mobility.

Hence present, the study aimed to evaluate the effect of elliptical training for balance and gait training in patients with chronic stroke.

CASE PRESENTATION

The patient was a 36-year-old man with right hemiparesis with chronic stroke (>6 months) who had suffered an ischemic stroke in the left frontal, parietal, and temporal lobes due to a blockage in the Middle Cerebral Artery (MCA). According to American Heart Association and American Stroke Association practice guidelines (Chronic Stroke is described as >6 months after a stroke) [2]. The patient was presented with Extensor Synergy Pattern with Voluntary Control Grading-3 for the right-side lower limb and was able to walk without assistance. Before the examination, the patient's balance and gait were assessed using the POMA scale with a score of 16 and VCG grade 3. The patients were briefed about the study and written informed consent was taken before enrolment into the study (Table 1).

Table 1 Patient characteristics

Age	36 years
Gender	male
Height (m)	1.70 m
Weight (kg)	76 kg
Hand dominance	Right
Time since stroke (m)	11 months
Type of stroke	Ischemic
Stroke location	left frontal, parietal, and temporal lobes
Resting heart rate, beats per minute	76 bpm
Resting blood pressure, mm Hg	120/80 mm Hg

Elliptical Trainer

The training was performed using a commercially available Elliptical machine (ketller) (Figure 1). This device was chosen because it has several unique features that make it practical for training individuals with physical impairments: an electronically controlled adjustable step length of 41 cm to 53 cm (17 in-26 in) enabled us to match the comfortable step length for each participant and to increase this length as tolerated during training. The distance between the pedals is 5 cm, which is closer to average step width than most elliptical machines (which are usually >10 cm); handrails on each side of the unit allowed participants to use their upper extremities more effectively for support during training and when mounting/dismounting the unit; and a wide range of workloads (10 W-300 W) and integrated telemetry for Heart Rate (HR) [6].

Elliptical Trainer Protocol

The treatment protocol was for 3 days a week for 4 weeks on an elliptical trainer machine. The training goal was to exercise for 20 minutes. The patient was standing on an elliptical trainer under the supervision of a therapist (Figure 2). Patients both hands were holding the handrails. The right hand and foot were tied with a band. The duration of the training sessions was progressively increased to achieve a target training duration of 20 minutes of uninterrupted elliptical training. If the patient was unable to complete 20 minutes of training initially, attempts were made on each subsequent session to increase the total training time while giving as many rest breaks as needed.

Figure 1 Elliptical machine

At the start of each training session, the patient has adjusted the step length to comfort and performed a 1 minute to 3-minute warm-up at 20 rpm to 30 rpm at the lowest level of resistance. Following the warm-up, the patient attempted to achieve a cadence of 50 rpm to 55 rpm while maintaining 75% of HR or less and perceived exertion of 6 or less on the Borg scale. If they exceeded either the HR or perceived exertion threshold, then they were asked to reduce their effort or stop and rest in either a standing or sitting position until HR and perceived exertion returned to acceptable levels. To increase training time while maintaining the appropriate training parameters, the therapist could reduce the training workload by grasping the moving hand bars and providing physical assistance as needed. The blood pressure values were assessed immediately after each training session. During the first several sessions, BP was also assessed during the rest breaks to ensure a normal exercise response. To begin training after a rest break, the patient was required to have systolic pressure less than 180 mm Hg, diastolic pressure less than 110 mm Hg, and HR less than 100 beats per minute.

Figure 2 Patient performing elliptical trainer

Outcome Measures

To assess balance and gait, the POMA was used. The test consists of 16 items (9 balance-related items and 7 gait-related items), with a maximum score of 28 points available. It takes about 10 minutes to administer the scale. A higher score reflects better balance, while a lower score reflects a bad balance [7].

Voluntary Control Grading (VCG) is a method of assessing a stroke patient's voluntary motor function. It has three components upper limb, lower limb, and hand. Each component has six items. It can be used as a reliable measure for patients with post-stroke hemiplegia [8]. Both the outcome measure was assessed before the intervention and last day of the intervention.

RESULTS

After 24 sessions with an elliptical trainer, we found positive effects on lower limb motor functions and improvement in balance and gait. Pre-therapy POMA Balance score was 9, Gait score was 8 and Total score was 16. The post-therapy score was improved for POMA balance score 14, gait score 11, and total score of 25. The VCG grades for the lower limb were changed from grade 3 to grade 4 (Table 2).

Table 2 Effects pre- and post- therapy

Outcome Measures	Pre-Intervention	Post-Intervention	Difference
Poma	16/28	25/28	9
Balance	9/16	14/16	5
Gait	8/12	11/12	3
VCG	Grade 3/6	Grade 5/6	2

DISCUSSION

The effect of elliptical training on balance and gait training in a patient with chronic right hemiparesis showed improvement in POMA score and Voluntary Control Grading score. This could be because the task requires alternate hip and knee flexion greater than typically used during walking. Elliptical training induces greater hip and knee flexion than walking over the ground and may therefore underlie the improved performance on this task. However, an alternative explanation for the improved POMA was to step on and off the elliptical machine pedals on several occasions each time they trained. Performing these activities, including managing the increased vertical movement of the body while training on the elliptical machine, may have led to greater confidence in the transitional, stepping, and turning movements involved in both the POMA [8].

The improvement in Voluntary Control Grading score of the right lower limb may be due to 24 sessions of treatment, reduction in Spasticity, increased Proprioception of joints because of more intensive, repetitive, and task-oriented training performed by the patient. It can be also a result of conventional physiotherapy treatment which was going on alternative days [9].

CONCLUSION

The current study showed that the use of an elliptical trainer improves lower limb motor functions in the chronic stage of stroke along with improvement in balance and gait which backs up previous research. However, this study varies from previous research in that treatment sessions are held on alternating days and the treatment period is short.

DECLARATIONS

Conflicts of Interest

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Patient Perspective

The patient shared his perspective that compared to day one he found significant changes in his balance and gait pattern hence, improvement in quality of life.

Consent

As per international standard or university standard patients' written and informed consent has been collected and preserved by the authors.

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