

Comparing the efficacy of treadmill training and a combination of bicycle ergometer and over-ground walk on functional ambulation after stroke.

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ABSTRACT

The study was conducted to compare the therapeutic efficacy of treadmill training and a combination of bicycle ergometer and over-ground walk training on functional ambulation (FA) following stroke in Mewar university physiotherapy Clinic, fifteen stroke survivors took part in a 6-week, two-group quasi-experimental study. Walking speed was used to assess participant FA. Participants were divided into two groups at random: A (treadmill training) and B. (bicycle ergometer and over ground walking training). To determine within and between group differences in FA, the data was analyzed using inferential statistics such as the Wilcoxon sign rank test and the Mann-Whitney U test. The mean age and baseline FA of participants in Group A and B were 45.40 (0.320.08 m/s) and 41.57 (0.340.15 m/s) years respectively. There was a significant within-group difference (pre and post intervention) in FA scores in groups A ($p=0.018$) and B ($p=0.043$). However, there was no significant difference in FA between groups (treadmill, bicycle ergometer and over ground walking) at baseline ($p>0.05$) and post intervention ($p>0.05$). This study concluded that both treadmill training and the combination of bicycle ergometer and over ground walking are effective in retraining FA after stroke; however, the combination of two task-oriented exercises yielded better FA recovery than treadmill training alone.

Key words: *Treadmill, over-ground walk, bicycle ergometer, functional ambulation.*

Method: A case study comparing the efficacy of treadmill training and a combination of bicycle ergometer and over-ground walk on functional ambulation after stroke, data was collected for the period of six weeks using two group quasi-experimental study

INTRODUCTION

One of the major consequences of having a stroke is motor impairment, which leads to impaired functional ambulation,

difficulty leaving the house, and participating in leisure activities (Pound P, Gompertz P, Ebrahim S, 1998). A significant decline in ambulation occurs in a number of stroke survivors, with up to 14.6% unable to walk independently in the community without supervision (vandeport et al, 2006). Walking ability improvement is one of the top priorities for stroke survivors (Eng. et al, 2007). Ambulatory independence was also identified as a highly desired goal among stroke survivors, and it is now used as a yardstick for measuring functional recovery by both patients and their relatives. (Hamzat, et al 2002) Loss of independent ambulation, particularly outside, has been described as one of the most disabling symptoms. Task-oriented training improves ambulation capacity after stroke by improving spatiotemporal gait parameters, muscle strength, speed, and gait endurance [Smith, et al, 1999]. Treadmill training has been proposed as an effective treatment for post-stroke gait asymmetries [Coenen et al 2012]. Treadmill training benefits functional mobility, cardiovascular fitness, stride length, cadence, and distance walked, and gait velocity [Macko, et al 2005]. Over-ground walking with partial body weight support improves spatiotemporal gait parameters in stroke patients [Sousa et al 2011]. Walking speed, endurance, and balance are all improved [Park, et al 2013]. A combined treadmill and over-ground walking programme was found to be effective in improving functional ambulation after stroke [Ada, et al 2003]. Furthermore, studies have compared the effectiveness of treadmill training and over-ground walking exercise on functional ambulation recovery after stroke, but there is no agreement on which of the two treatment protocols is the most effective as of yet. Over-ground walking, for example, has been shown to be more effective than treadmill training in improving gait endurance [Park, et al 2013]. When compared to robot-assisted treadmill walking, over-ground walking produced more muscle activity and activated more muscles during the gait cycle [Coenen et al 2012]. However, a study found that treadmill training was more effective than over-ground walking in improving functional ambulation and walking perception [Dean, et al 2010]. Other studies have found that the two treatment programmes have similar therapeutic effects on functional ambulation [DePaul, et al 2015]. As a result, it is unclear which of the two training techniques is superior based on the available literature.

Gait retraining is commonly done in most physiotherapy departments in India using a combination of different task-oriented training programmes. However, it is unknown whether combining two different task-oriented exercises will result in better functional ambulation recovery than practicing only one. It was hypothesized that individuals who received combined task-oriented programmes (bicycle ergometer and over-ground walking) would not perform any better in functional ambulation recovery than those who received only treadmill training.

In this study, 15 consenting participants were recruited using a purposive sampling technique. The study employed a between-group quasi-experimental research design. Stroke survivors attending an outpatient physiotherapy department comprised the population. Eligible subjects met the following inclusion criteria: ability to walk a minimum of 10 meters with or without therapist or walking aid assistance. The subjects would be excluded if they had severe cognitive deficits. Inability to comprehend verbal instruction or communicate (aphasia), as well as severe joint disorders (e.g., osteoarthritis) and comorbid obesity, which limits walking function.

DATA COLLECTION PROCEDURE

Participants' consent was sought and obtained prior to participation. The respondents' eligibility was checked. Using simple random sampling, participants were divided into two groups: group A (treadmill training) and group B (bicycle ergometer and over-ground walking). The study's treatment protocols were explained to the participants. They were advised to dress

comfortably in order to perform dynamic exercises. Before the exercise, blood pressure was taken to ensure that participants did not have high blood pressure.

Treadmill training group

Group member's walk on a treadmill (Bonte Technology BV, Zwolle, Netherlands) at a comfortable treadmill speed. For six weeks, each participant was treated twice a week. In weeks 1-2, each treatment session lasted 6 minutes. In weeks 3-4, participants were asked to walk for a maximum of eight minutes. Finally, in weeks 5 and 6, they were asked to walk for 10 minutes. Participants who wanted to take a break were allowed to do so for a maximum of two minutes before being asked to resume their training. However, the rest period was not included in the total training time. Participants in Group B were asked to walk to and from a 20-meter pathway at a comfortable walking speed for 6 minutes at each treatment session, which was held twice a week for 6 weeks. Rest periods were allowed in between as needed by a participant, but they were not counted as part of the total time for the over-ground training.

Group B participants also trained on a bicycle ergometer (body guard ergo cycle 955, Norway). The seat was raised to a comfortable level (with knee slightly bent at lowest pedal position). For comfort and to prevent the participant's foot from sliding away, the weak lower limb was strapped to the bicycle ergometer pedal. The participants were then instructed to pedal at a comfortable pedaling speed on the bicycle ergometer. For six weeks, the participants were treated twice weekly. Participants were allowed to take breaks as needed. The rest period was not included in the total training time.

Total time of training for group B

Weeks 1-2 = 12 minutes (6 minutes bicycling + 6 minutes walking on the ground). Weeks 3-4 = 14 minutes (8 minutes bicycling + 6 minutes walking on the ground). Weeks 5-6 = 16 minutes (10 minutes bicycling + 6 minutes walking on the ground).

Outcome assessment

The improvement of walking speed was used to rate the participants' functional ambulation performance. At the start of training, the baseline walking speed was determined. To cover the 10-meter distance, participants were instructed to walk at a comfortable walking speed. A stopwatch was then used to record the time it took to cover 10 meters. Walking speed was calculated as the distance travelled in meters per second per unit of time. The post-intervention walking speed was measured in the same manner as the baseline measurement.

Data analysis procedure

Non-parametric statistics were used due to the small sample sizes in both groups (8 and 7, respectively). The combined bicycle ergometer and over-ground walking group's speed data was also not normally distributed. To determine within-group differences in walking speed, the Wilcoxon sign rank test was used. The Mann-Whitney U test was used to compare differences in walking speed, stroke duration, and age between groups. The significance level was set at 0.05. All calculations were performed on Windows using SPSS version 16.

Results

Twenty-three people were initially recruited for this study, but only 15 people finished it. Group A had 8 participants, with 5 males (62.5%) and 3 females (37.5%). Group B had seven participants, four males (57.1%) and three females (42.9%). As shown in table 1, the majority of the females in both groups were housewives, and the average duration of stroke for both groups was 9 months. At baseline and post intervention, participants in the treadmill group had average speeds of 0.320.08m/s and 0.370.10m/s, respectively. Table 2 shows that participants in the combined over-ground walking and bicycle exercise group achieved average walking speeds of 0.340.15 m/s before and after intervention, respectively. There was a significant improvement in functional ambulation in the test group ($p < 0.05$) and the combined over-ground walk and bicycle ergometer groups ($p < 0.05$), with post intervention scores significantly higher than pre intervention scores in both groups (table 3). Finally, there was no significant difference in functional ambulation between the two groups at baseline ($p > 0.05$) or post intervention ($p > 0.05$), implying that the combination of over-ground walk and bicycle ergometer is not superior to the treadmill (table 4).

Table 1. Demographic characteristics of participants. The following keys are use: n=number of participants, SD=Standard Deviation, %=%

VARIABLES	FREQUENCY
Age (years)	Range (Mean \pm SD)
Group A	30-56 (45.40 \pm 10.16)
Group B	25-55 (41.57 \pm 11.21)
Duration of stroke (months)	
Group A	7-13 (9.38 \pm 2.35)
Group B	5-18 (9.14 \pm 4.49)
Occupation	N (%)
Group A	
Housewife)	3 (37.5)
Civil servant	2 (25.0)
Trader	2 (25.0)
Student	1 (12.5)
Group B	
Housewife	3 (37.5)
Civil servant	2 (25.0)
Trader	2 (25.0)

The results shows that the age of the participants are range between 30- 55 years, the duration of the stroke for the both groups are 7-13 and 5- 18 respectively. Most of the participants are House wives.

Table 2: Functional ambulation of the participants

Variables	Mean ± S.D. (m/s)	N	Kolmogorov-Smirnov P-value	Shapiro-WalkP-value
Pre-treatment Treadmill training group	0.32±0.08	8	0.20*	0.92*
Post-treatment Treadmill training group	0.37±.10	8	0.20	0.38
Pre-treatment Combine over-ground walk and bicycle training group	0.34±0.15	7	0.01	0.02
Post-treatment Combine over-ground walk and bicycle training group	0.40±0.23	7	0.00	0.001

Functional ambulation (walking speed) of participants at pre- and post-intervention.

Table 3. Within group comparisons of pre and post-intervention scores of functional ambulation (walking speed) using Wilcoxon sign rank test per second

Variable	Speed Mean rank	Sum of ranks	Z	P-value Treadmill
Treadmill group	Pre-intervention	A	A	-2.37 p=0.018*
Combine over -	Pre-intervention			
Ground walk and bicycle	Pre-intervention	3.00 ^a	15.00 ^a	-2.02 p=0.043
Training group	Pre-intervention			

Post-^a=positive rank (post intervention score is greater than pre intervention score),

Table 4. Comparisons of pre- and post-intervention scores of functional ambulation (walking speed) across groups using Mann-Whitney

Variables	Intervention	N	Mean Rank	U-Value	P-Value
	Treadmill group	8	8.25		
Baseline	Combine over-ground walk and bicycle training group	7	7.71	26.00	0.82

Post-intervention	Treadmill group	8	8.44		
	Combine over-ground walk and bicycle training group	7	7.50	24.50	0.68
Age	Treadmill group	8	8.56		
	Combine over-ground walk and bicycle training group	7	7.36	23.50	0.60
Duration of stroke	Treadmill group	8	8.75		
	Combine over-ground walk and bicycle training group	7	7.14	22.00	0.482

Discussion

Walking ability recovery is an important focus of rehabilitation for both stroke survivors and their rehabilitation teams. The purpose of this study was to determine the effect of the number of task-oriented exercises on functional ambulation recovery after stroke.

Treadmill training significantly improved functional ambulation recovery after stroke in this study. This implies that treadmill training is a reliable rehabilitation protocol capable of improving functional mobility (walking speed). This result was consistent with previous research findings. Treadmill walking was associated with an increase in walking speed and quality in chronic stroke patients, according to one study [Silver K.H., et al 2000]. Another study found that treadmill exercise improves functional mobility in chronic stroke patients [Macko, et al 2005]. Treadmill training was found to improve walking speed and gait endurance, which is consistent with the findings of this study [Park et al., 2013]. It also improves gait and balance in stroke patients [Kim .et al, 2010].

Furthermore, this study discovered that combining task-oriented exercises (over ground walking and bicycle ergometer) significantly improved functional ambulation (walking speed) after stroke. This implies that combining two task-oriented trainings is beneficial for improving stroke patients' walking ability. This finding was consistent with Tang et al. [Tang, et al 2009], who discovered that adding cycle ergometer training to traditional rehabilitation leads to improvements in aerobic and walking capacities after intervention. It was also reported that adding cycle ergometer exercise to traditional exercise improved the balance and gait abilities of chronic stroke patients [Kim, et al 2009]. Furthermore, the findings in this study may be similar to those of Tang et al. [Tang. et al 2009] and Kim et al. [Kim, et al 2009] in that most conventional physiotherapy exercises for stroke patients typically include over-ground walking training. This study discovered that there is no significant difference in functional ambulation after intervention between the treadmill group and the combined task-oriented training group. This finding implies that combining two task-oriented exercises may not result in a better recovery of walking function than performing only one. It also implies that treadmill training is comparable to a combination of over-ground walking and bicycle ergometer training in terms of improving functional ambulation after stroke. As a result, combining over ground walk and bicycle ergometer training is not superior to treadmill training for improving walking function after stroke. In line with the findings of this study, another study found no significant difference in

gait and balance between treadmill and non-treadmill users. Group of bicycle ergometers [Kim. et al 2010]. A programmer of varied over-ground walking was also found to be inferior to body weight supported treadmill training for improving gait speed [DePaul. et al 2015].

Conclusion

Treadmill training, as well as a combination of over-ground walk and bicycle ergometer training, resulted in significant improvements in functional ambulation after stroke. For functional ambulation recovery, combined task-oriented programmes (bicycle ergometer and over-ground walking) are no better than treadmill training. When planning functional ambulation training for stroke survivors, consider the effectiveness of each task-oriented exercise rather than the combination of exercises.

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