EFFECTIVENESS OF TREADMILL TRAINING WITH BODY WEIGHT SUPPORT AND STRENGTHENING EXERCISES OF LOWER LIMB ON WALKING ENDURANCE AMONG STROKE PATIENTS

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ABSTRACT:

Background: *Stroke is the second most common cause of death due to disability in first world countries. Globally stroke is the main threshold of disability and functional loss, loss of function often leads to decrease walking endurance.*

Objective: *The objective of the study is to determine the effectiveness of treadmill training with body weight support and strengthening exercises of lower limb on walking endurance among stroke patients.*

Methodology: *The study design was a Randomized Control Trial.30 participants were selected, divided in to two groups, 15 in treadmill training with BWS and 15 in strengthening exercises of lower limb group. Outcome measure was walking endurance measured by 6 min walk test. Data was analyzed using SPSS (Statistical Package for Social Sciences.) version 21.*

Results: *The mean pre and post scores of walking endurance was 189.66 ± 24.38 and 383.00 ± 85.39 in treadmill training with BWS group and 206.66 ± 31.94 and 301.33 ± 51.80 in lower limb strengthening exercises group. Both had p value <0.000.When mean comparison of walking endurance was done between both the group strengthening group showed 94.66 ± 32.86 score with p value <0.00 while in treadmill training with BWS group it jumped to 193.33 ± 79.13 with p value <0.000.*

Conclusion: *Treadmill training with body weight support is more effective for walking endurance among stroke patients and it can be a choice of treatment for improvement of walking endurance in stroke patients.*

Keywords: Stroke patients, Treadmill training, Body weight support, strengthening exercises, walking endurance

INTRODUCTION:

Stroke is the second most common cause of death due to disability in first world countries. (Salbach NM et al., 2004) Stroke or Cerebrovascular Accidents occur when there is interruption of

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blood flow to the brain resulting in loss of neurological functions Severity of stroke depends upon the amount of injury, its location, collateral blood flow and acute management. As soon as brain swelling subsides, impairment is resolved .Time duration is usually 3 weeks. An impairment that duration is more than 3 weeks and causes permanent disability. (Hu X et al., 2017, Yang Y et al., 2011) It includes the risk factors of male gender, diabetes, smoking, age, heart diseases, TIA and hypertension. In ischemic stroke, account for 80% stroke patients, most common and has an 8 to 12 % mortality rate. (Gillen G, 2016) It occurs due to lack of supply or nutrition to the brain due to formation of thrombus or embolus. Cerebral embolus is made up of pieces of plaque and blood clot formed somewhere else and then released into the blood flow from where they travel to the cerebral artery and cause infarction or occlusion. Cerebral thrombosis occurs when a blood clot is formed in either the cerebral artery or its branches. Thrombi lead to ischemia which causes tissue death or cerebral infarction. (O'sullivan B S et al., 2007) Whereas the hemorrhagic Stroke occur when hemorrhage is formed due to abnormal bleeding into the brain's cerebrovascular area due to blood vessels trauma or rupture. It leads to increased intracranial pressure. It is further divided in to Primary cerebral hemorrhage in which aneurysm is formed due to weakness of small blood vessels, Intra cerebral hemorrhage in which bleeding in brain occur due to rupture of cerebral blood vessels and Sub arachnoid hemorrhage in which large blood vessels are affected due to bleeding in sub arachnoid space. (O'sullivan B S et al., 2007) Complications after stroke include contractures, spasticity, disuse atrophy, muscle weakness, increase risk of fall, osteoporosis, seizures, hydrocephalus, deep vein thrombosis, exercise intolerance, aspiration, dysphagia, urinary tract dysfunction and ulcers. (Gillen G, 2016) Physical rehabilitation starts in the intensive care unit as soon as the patient's vitals are stable. Stroke patient rehab demands a proper plan and goal setting as its long term program which may take from months to years. (O'sullivan B S et al., 2007) As soon as rehab starts the primary goal is prevention of bedsores and contractures

and maintaining joint and skin integrity. (Gillen G, 2016) Independent ambulation in stroke patients is a major focus in stroke rehab. Hornby et al study suggested that treadmill training with body support resulted in major gains in stroke patients who are able to walk. Use of treadmill provides an increased amount of stepping practice. (Hornby TG et al., 2016) Patient is made to stand on a treadmill and is supported by either overhead harness or patient wear a body weight supporting belt with therapist standing at the back providing support by holding the belt from the back. (O'sullivan B S et al., 2007) For best results time duration of body weight supported treadmill training is 5 days a week for 4 weeks i.e 20 sessions. In each session patient is allowed to walk 5 trials max, each trial 6 min long and with a period of rest. Total time limit of treadmill session is 30 mins.(Sirvastava A et al., 2016) Stroke survivors are noticed to have decreased strength due to muscle weakness. Strengthening exercises are performed to increase patient's ability to regain and learn motor skills and gain muscle performances. Graded strength training or strengthening exercises do not elevate spasticity in stroke survivors and improve strength. (Scianni A et al., 2010) Strengthening exercises are divided into open chains which are non-weight bearing exercises and closed chains which are weight bearing exercises. (Kisner C et al., 2017).

In Open chain exercises the distal aspect of extremity is free to move. In this type of strengthening exercise there are isolatory movements and cause isolated muscle activation. Where as in Closed chain both proximal and distal segments of extremity are unable to move. Closed chain strengthening exercises cause functional stimulation, movement at one joint cause movement at all other joints. (EllenBecker TS et al., 2001).

Several research papers after different studies came to the conclusion that strengthening exercises or training have quiet exemplary results in stroke patients and depending on the nature of open and closed chain exercises it is found that closed chain exercises are more effective in rehab program of sub-acute stroke

survivors. (Singh S, 2008) Closed chain exercises have equal marvelous results for chronic stroke patients, proved by a study conducted by Na Kyung Lee et al in 2013 which says that that closed chain exercises improve muscle performance lower limb muscle strength in chronic stroke. (Lee NK et al., 2013) Commonly it is seen that reduction in walking endurance in stroke patients leads to difficulty in adopting rehab programs involving lower limb. Various studies suggest strengthening exercises as a great tool for walking endurance while few claim body weight supported treadmill training as a benchmark. This study will help to conclude and prescribe the most effective protocol, either treadmill training with body weight support or strengthening exercise of lower limb for developing walking endurance

METHODOLOGY:

This study was a Randomized control trial. Sample size of 30 Participants above the 20 years old, both male and female were selected by using Purposive Sampling technique. All participants were recruited from BODY Works Physical therapy clinic and Imam Physiotherapy center. Those patients who diagnosed cases of either sub-acute or chronic stroke, patients of Ischemic stroke, patients with left sided stroke, functional Independence Measure (FIM) score above 5, patient in 1,2 or 3 grade of spasticity, Manual Muscle Testing score for strength 3 to 5 of targeted muscle were included in this study. Patients who meet the inclusion criteria were randomly selected using the chit method to meet the total requirement of 30 participants. After that Patients are equally divided into two groups i.e. 15 in each group by using simple random sampling technique Group A and Group B. Group A for Treadmill training with body weight support and Group B for strengthening exercises of Lower Limb. In both the groups 6 minutes' walk test was performed on the first day (before training or treatment) and on last day (after the completion of sessions of treatment) to determine the change in walking endurance. After 6 minutes number of laps completed in 6 mins were calculated for the results providing walking endurance of the patient. In Group A patients were executed for treadmill along

with body weight support for 5 days a week for 4 weeks i.e 20 sessions. Each session for 30mins. Body weight support was either provided by the portable belt attached with treadmill, a harness or therapist holding patient through belt tied around his waist and other point tied around patients waist. In Group B strengthening exercises of Hamstrings, Quadriceps, Calf and Gluteal muscles were performed in 3 sets each with 8 to10 repetitions and 2 or 3mins rest was taken in each set. Strengthening exercises were performed 5 times a week for 6 weeks. Permission taken was from the Ethical Review Committee board of Isra University. Informed consent form was taken from the participants before administering the intervention. Data was analyzed by Statistical Package for Social Sciences (SPSS) version 21. Mean comparisons at intra group level of 6 min walk test in Group A and Group B at pre and post level of treatment was done using paired t test and at Inter group comparison of mean value of both the group was measured using an independent t-Test.

RESULTS:

The mean age of Patients which was 52.2±7.93 in treadmill with BWS group and 50.6±5.2 in strengthening exercises group. Table 1. shows the mean, standard deviation and p-value comparison of walking endurance obtained through 6 min walk test at the time of pre and post training sessions at Intra group level. In BWS treadmill group prior execution of training walking endurance was 189.66 ± 24.38 which improved to 383.00 ± 85.39 after the last session showing p value <0.000. In strengthening exercise group walking endurance was 206.66 ± 31.94 before training and 301.33 ± 51.80 after the last session showing walking endurance improved in strengthening group also, it had p value <0.000. Both groups showed substantial enhancements in their 6-minute walk test performance after the respective treatments. These results suggest that both treadmill training with body weight support and strengthening exercises are effective interventions for improving walking endurance in the studied population.

Table-1
Mean comparison of Walking Endurance in 6min Walk Test at pre and post level of treatment at Intra Group Level

Comparison 6 minute walk test before and after treatment					
GROUP		**N**	**Mean**	**Std.**	**p-Value**
TREADMILL WITH BWS	6 MIN WALK TEST pre Training	15	189.66	24.38286	<0.000
	6 MIN WALK TEST post Training	15	383.00	85.39404	
STRENGTHENING EXERCISES	6 MIN WALK TEST pre Training	15	206.66	31.94117	<0.000
	6 MIN WALK TEST post Training	15	301.33	51.80550	

Result of table 2. gives an insight to the inter group comparison of Mean of walking endurance determined by 6 min walk test between BWS treadmill training group and strengthening group. On comparison results revealed that walking endurance was improved in both the groups but a very significant improvement was visible in BWS treadmill training group showing a mean difference and standard deviation of 193.33±79.13 with p value <0.000 whereas in strengthening group mean difference and standard deviation was 94.66±32.86 with p value <0.000.Thus BWS treadmill training turned out be a winner and more practical approach in stroke patients for improving walking endurance.

Table-2
Mean comparison of Walking Endurance in 6min Walk Test at Inter Group Level

Mean Difference- Comparison between group				
Group		**Mean Difference**	**Std. Deviation**	**p-value**
TREADMILL WITH BWS	6 MIN WALK TEST Base Line and after Treatment	193.33	79.13	<0.000
STRENGTHENING EXERCISES	6 MIN WALK TEST Base Line and After Treatment	94.66	32.86	<0.000

DISCUSSION:

Treadmill training with body weight significantly support to the stroke survivors this this intervention led to improved gait and walking endurance in stroke patients. (Sirvastava A, 2016) Similarly, the study by Druzbicki M, et al., supported the efficacy of treadmill training with body weight support, especially in terms of enhancing walking speed and endurance. (Drużbicki M et al., 2018) Another study highlighted that while treadmill training may not offer exceptional improvements in walking ability, it significantly increases walking endurance and speed in a short duration. (Mehrholz J et al., 2017) A study explored the benefits of body weight supported treadmill training and the combination of treadmill training with functional electrical stimulation. The results suggest that these interventions can enhance walking speed and functional movement in stroke patients. (Mulroy S.J et al., 2010, Lee H.J. et al., 2013) 6-minute walk test is crucial for evaluating walking capacity and endurance in stroke patients. (A. Dunn, D.L et al., 2015, Wevers LE et al., 2011). This test can persist over time, indicating the importance of considering these factors in long-term

rehabilitation. (Wu G et al., 2003) Task-oriented interventions for enhancing walking distance and speed in stroke patients, especially for those with moderate deficits. (Salbach NM et al., 2004) The factors contributing to post-stroke fatigue, highlighting the significant impact on patients' quality of life and functional abilities. (Choi-Kwon S et al., 2005) The present study results showed that patients in Body Weight Support (BWS) treadmill group prior to treatment on first day walking endurance was 189.66 ± 24.38 but after four weeks and last session it improved to mean 383.00 ± 85.39 when 6 min walk test was done. P value was <0.000.A systematic review emphasizing the positive impact of strength training on stroke rehabilitation. Contrary to concerns about spasticity, their research demonstrated that strengthening techniques improve strength and activity without exacerbating spasticity, highlighting the importance of incorporating these exercises into stroke rehabilitation programs. (Ada L et al., 2006) The study by Na Kung Lee et al., delved into the effectiveness of open and closed kinetic chain exercises on muscle activity and balance in chronic stroke patients. Their findings favored closed chain exercises, indicating that these exercises significantly enhance muscle strength, particularly in the gastrocnemius and tibialis anterior muscles. Additionally, closed chain exercises led to improved balance and overall functional performance in chronic stroke patients. (Lee NK et al., 2013) Another research provided a comparative analysis of open chain and closed chain kinetic exercises in sub-acute stroke survivors. Both types of exercises were found effective in improving hemiplegic gait, but closed chain exercises were deemed even more beneficial for enhancing gait-related performance. (Singh S et al., 2008) Several studies, such as the one underscore the effectiveness of treadmill training with body weight support in improving walking capacity. This intervention proves particularly beneficial for sub-acute non-ambulatory stroke patients, leading to significant improvements in walking distance during assessments like the 6-minute walk test. The integration of partial body weight support and power-assisted functional electrical stimulation further enhances the outcomes, emphasizing

the importance of combining different modalities for comprehensive rehabilitation. (Dean CM et al., 2010) A study emphasizes the significance of progressive resistance training in stroke rehabilitation. Resistance exercises, especially those targeting multiple joints of the lower extremity, have shown substantial improvements in muscle strength, mobility, and gait speed. The research suggests that tailored resistance training programs play a vital role in enhancing balance, posture, and overall gait in stroke survivors. Resistance exercises can lead to improvements in muscle strength, balance, posture, and gait. (Wist S et al., 2016, Pontes SS et al., 2019) Increasing physical activity levels not only improves mobility but also positively impacts cognitive functions. This finding underscores the need for holistic rehabilitation programs that address both physical and cognitive aspects, promoting overall well-being in stroke survivors. (Cumming TB et al., 2012) Combining resistance training and cardiorespiratory exercises not only improves functional status but also reduces mortality and disability. These findings emphasize the importance of sustained physical activity and structured exercise programs for stroke survivors, ensuring long-lasting benefits. (Saunders DH et al., 2020) In result of current study highlighted that strengthening exercises group before exercises were initiated 6 min walk test showed that mean of walking endurance was 206.66 ± 31.94 but after the last sessions somewhat improvement was visible with mean 301.33 ± 51.80. P value was <0.000.

CONCLUSION:

The results concluded that training with body weight support is more effective for walking endurance among stroke patients. The results shows that it can be a choice of treatment for improvement of walking endurance in stroke patients as it improves walking capacity.

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