Original Research Article

Comparison of task-related training and strength training on walking performance of stroke patients

Amruta D Doijad[1], Umiya I Pathan[2*]

[1]Associate Professor, [2]Assistant Professor, D. Y. Patil College of Physiotherapy, Kadamwadi, Kolhapur, INDIA.
Email: doijadamruta@gmail.com , drumiyapathan@gmail.com

Abstract

Background: Stroke is the second most common cause of mortality in the world. It affects gait in the majority of the patients. The rehabilitative process aims to help the patient achieve a high level of functional independence. However, there is no specific technique in the improvement of gait. The study was undertaken to compare the effectiveness of TRT and ST in the improvement of gait in stroke patients **Material and methods:** The prospective interventional study was performed on 25 strokes survived patients. They were divided into two groups such as Group I: task-related training (TRT) and Group II: strength training (ST). Patients were intervened for the 45-60 minutes for three time a week for 4 weeks. Pre- and post-intervention spatial variables (step length and stride length), temporal variables (speed and cadence) and two-minute walk test were recorded. **Results:** In Post-TRT and Post-ST a significant improvement was observed in spatial variables, temporal variable and two-minute walk test ($P<0.05$). When the group I was compared to group II, no significant difference was observed in spatial variables, temporal variable and two-minute walk test. **Conclusion:** TRT and ST were significantly effective in improving walking performance in stroke patients. However, the comparison between TRT and ST showed equal effectiveness in the improvement of gait performance.
Keywords: Brain injury, Gait, Muscle strength, Resistance training, Stroke.

***Address for Correspondence:**
Dr Umiya I. Pathan, Assistant Professor, D. Y. Patil College of Physiotherapy, Kadamwadi, Kolhapur, INDIA.
Email: drumiyapathan@gmail.com
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INTRODUCTION

Globally, stroke is the second most common cause of mortality and the third leading cause of disability with increased incidence in developing countries.[1] In India, among all deaths and disabilities, strokes contributing 7.3% and 3.5% of deaths and disability respectively.[2] The stroke resulted from interrupted blood flow to the brain or by a rupture of blood vessels in the brain. The clinical characteristics of the stroke are depending upon the affected region of the brain and extent of tissue damage. Acute manifestations from the stroke, in addition to chronic musculoskeletal adaptation, contribute to resulting weakness on the side contralateral to the brain injury.[3] Walking is a common component of independent function commonly affected by stroke.[4] Although the majority of stroke patients walk independently but unable to walk efficiently. They walk with altered spatiotemporal variables, uneven stride length, and short step length. Also, the walking speed of the patient decreases with increased energy expenditure therefore, patient lack flexibility in performances due to reduced muscle strength.[3, 5] It is reported that therapeutic intervention improves fitness, balance, speed and capacity of walking.[6] Task-related training (TRT) and strength training (ST) are reported to be effective in the improvement of gait.[3,5,7] However, there is a paucity of data regarding the comparison of TRT and ST. Therefore, the study was undertaken to compare the effectiveness of TRT and ST in the improvement of gait in stroke patients.

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MATERIAL AND METHODS

This prospective interventional study was performed for the duration of 6 months after obtaining ethical clearance from the Institutional Review Board. Twenty-five patients with 3-month post stroke resulted in hemiplegia (involvement of middle cerebral artery), able to walk independently for 10 meters with or without assistance, and residual walking deficit in terms of both walking pattern and walking velocity were recruited into the study after obtaining written informed consent from the patient. Subjects with orthopedic, and cardiovascular complications were excluded from the study. Post baseline assessment, participants were randomly divided into two groups based on intervention (Group I: Task-related training (TRT) and Group II: Strength training (ST)) with the use of three blocks, each block contain five cards of TRT and ST. The cards were selected by blindfolded persons and subjects were assigned for intervention.

Intervention

Subjects of both groups were intervened with TRT and ST for 45-60 minutes three times a week for four weeks. It aimed to prevent soft tissue adaptive shortening, elicit muscle activity, increase muscle strength and control to provide support, propulsion, balance and toe clearance, and train rhythm and coordination.

Task-related training

In this training, major emphasis was given on the method of training support and propulsion of lower limb and balance of the body mass over one or both feet and control of the foot and knee path through the swing. In step 1 the analysis of walking performance of the subject was analyzed by observing the walking pattern and it was compared with the list of most commonly missing components. In step 2 practice of missing component, missing components of walking were practised by giving explanation, instruction, verbal and visual feedback and manual guidance to the patient. In step 3 practice of task, practice of individual components of walking was followed by practice of walking itself which enabled the patient to put these components together in their proper sequence, followed by re-evaluation. The process of analysis was continued throughout step 2 and 3 of the program. In step 4, patients were encouraged to practice correct pattern of walking by themselves by use of environmental modifications. In case of unimproved performance re-analysis of the problem as well as the effectiveness of the training was evaluated.

Strength training

It includes open-chain exercises targeting anti-gravity muscles such as hip flexor, extensor, abductors, knee flexor and extensors, ankle plantar flexors, and dorsiflexor with low-intensity progressive resisted exercises. Initially, all patients were subjected for a warm-up for 3-5 minutes followed by a circuit of open chain exercises that was started for 20 min, and the subject was asked for walking. After every cycle of 3 sets of 10 repetitions, 2-minute rest was given. The training load for resisted exercise was determined by one repetition maximum (IRM). Based on muscle type the RM was set either 0.5 kg or 1 kg. The training load initially was set at 20% of 1 RM to minimize post-exercise stiffness and increased up to 50% of 1 RM. However, weak muscles were assisted physically. However, very weak muscle were given physical assistance. From the physiotherapist to perform the action. Once muscle group developed control, low intensity strength training was commenced.

Outcome measures

Pre and post interventional outcome measures were evaluated by a trained physiotherapist. This includes spatiotemporal variables such as step length, stride length and speed, cadence, and two-minute walk test.

Spatial variables

The variables were measured by obtaining coloured water-dipped sole impressions on printing paper placed on the floor. To avoid the effect of acceleration and deceleration measurements were taken at a middle 3 meter of 5-meter walkway. The stride length of both extremities was measured as the distance between points of the heel of the same extremity. Whereas, step length was measured as the distance between heels strikes of one lower extremity to heel strike of opposite extremity.

Temporal variables

Walking speed was measured by recording the time taken to cover the middle 10-meter of 14 meter walk way. Cadence was measured as the number of steps per minute.

Two-minute walk test

The test was used to measure walking endurance. The subject walked for 2 minutes up and down on a 10-meter walkway which was marked at 1-meter distance. The total distance covered in 2-minutes was determined by counting the laps, using the clock, and measuring the distance from the last marker with tape to the nearest centimeter.

Statistical analysis

Data were analyzed using R Studio V 1.2.5001 software. Continuous variables were expressed in terms of mean±SD whereas, categorical variables were expressed in percentage and frequency. Paired T-test and Wilcoxon-Sign-Rank-Test were used to find the difference within and between the group. $P<0.05$ was considered statistically significant.

RESULTS

The average age of the patients was 53±15.93 years and 60% (n=18) of patients were male. A significant mean age difference was observed in both groups (P=0.01). In post-TRT, a significant improvement was observed in step length (affected to unaffected), stride length (affected to unaffected), speed, cadence, and 2 min walk test when compared to pre-TRT (table 1).

Table 1: Comparison of pre and post TRT variables

Outcome measures	Pre-TRT	Post-TRT	P-value
Step length (A to U) (cm)	27.84 ± 11.58	39.40 ± 13.38	0.00525**
Step length (U to A) (cm)	37.98 ± 10.27	46.04 ± 16.71	0.1024
Stride (A) (cm)	63.97 ± 17.65	84.13 ± 25.80	0.00244**
Stride (U) (cm)	65.33 ± 16.82	83.91 ± 28.25	0.00212**
Speed (seconds)	20.60 ± 5.86	16.69 ± 4.91	0.00054***
Cadence (steps/min)	87.33 ± 8.07	95.92 ± 8.51	7.90E-05***
2-minute walk (meter)	62.02 ± 20.19	74.15 ± 23.24	0.00019***

TRT-task related training, A-affected, U-unaffected, '**'-P<0.01, '***'- P<0.001

Post ST, spatial variables (step length and stride), temporal variables (speed and cadence), and two-minute walk were significantly improved compared to pre-ST (table 2).

Table 2: Comparison of pre and post-ST variables

Outcome measures	Pre-ST	Post-ST	P-value
Step length (A to U) (cm)	27.76 ± 8.96	35.94 ± 8.95	0.00475**
Step length (U to A) (cm)	30.63 ± 11.18	36.58 ± 9.88	0.03644*
Stride (A) (cm)	60.13 ± 14.29	72.97 ± 15.26	0.00122**
Stride (U) (cm)	59.76 ± 14.58	72.13 ± 15.78	0.00122**
Speed (seconds)	24.78 ± 8.15	21.72 ± 7.61	0.00418**
Cadence (steps/min)	75.69 ± 13.97	82.23 ± 13.64	0.00192**
2-minute walk (meter)	52.27 ± 19.04	59.29 ± 18.31	0.0063**

TRT-task related training, A-affected, U-unaffected, '*'- P<0.05, '**'-P<0.01

Both groups were similar concerning spatial variables, temporal variables, and two-minute walk test except cadence (P=0.006) (table 3).

Table 3: Comparison between post test scores of group I and group II

Outcome measures	Group I (mean±SD)	Group II (mean±SD)	P-value
Step length (A to U) (cm)	39.40 ±13.38	35.94 ± 8.95	0.4611
Step length (U to A) (cm)	46.04 ± 16.71	36.58 ± 9.88	0.1059
Stride (A) (cm)	84.13 ± 25.80	72.97 ± 15.26	0.2095
Stride (U) (cm)	83.91 ± 28.25	72.13 ± 15.78	0.2202
Speed (seconds)	16.69 ± 4.91	21.72 ± 7.61	0.06148
Cadence (steps/min)	95.92 ± 8.51	82.23 ± 13.64	0.006488*
2-minute walk (meter)	74.15 ± 23.24	59.29 ± 18.31	0.09188

TRT-task related training, A-affected, U-unaffected, '*'- P<0.05.

DISCUSSION

The present study was undertaken to compare the effectiveness of TRT and ST in the walking performance in stroke patients. In this study, post-TRT a significant improvement was observed in spatial variables, temporal variables, and two-minute walk test of the patient compared to pre-TRT. These findings are similar to the previous report.[8] The reason for the improvement in the TRT may be the plasticity following the brain lesion. It is suggested that complex organization provides the foundation for functional plasticity in the motor cortex. Cortical representation reflects changes associated with skill development which is stimulated by repetitive training and practice.[5] Muscle weakness in stroke patients can result in immobilization or reduced physical activity. The strength of hip flexor muscles, knee extensor muscle, and ankle plantar flexor muscle are the main factors for comfortable or fast walking speed in stroke patients.[12] A meta-analysis of Wist S. *et al.* suggested that appropriately targeted progressive resistant training is effective in improving muscle strength.[9] Similarly, in this study progressive resistance ST significantly improved spatial variables, temporal variables, and two-minute walk of the patient compared to pre-ST patients. The reason for these results may be ST reduced muscle atrophy and potentially altered passive viscoelastic properties of muscle and tendons which could influence hypertonia.[3] These findings suggested that ST significantly improves the walking performance in stroke patients. Similar results were observed in the studies of Yang YR *et al.* and Park BS *et al.*[10,11] No significant difference was observed in both groups regarding spatialvariables, temporal variables and two-minute walk test of the patient which suggests that TRT and ST produce the same effect in the improvement of walking performance in the stroke patients. The limitations of the study were the small sample size, quantitative measure for the assessment of muscle strength was not used. A combined study of TRT and ST with a large sample size including all variables and measures is the further recommendation of the study.

CONCLUSION

The study showed that TRT and ST were significantly effective in improving gait performance in stroke patients. However, the comparison between TRT and ST showed equal effectiveness in the improvement of gait performance. Further studies are warranted to confirm these findings.

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