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# Partial Body Weight Supported Training in Patients With Stroke: Evaluation of Changes in Certain Gait Parameters, Pre and Post Training

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**ABSTRACT**

An incidence of stroke is a catastrophic event in the life of the patient as well as to the family members. Rehabilitation of the stroke survivors is a much needed intervention to improve independence, mobility and economic health for the patient. Many studies have provided conflicting results on the outcome of partial body weight supported treadmill training in stroke survivors. In the present study, There was significant increase in the speed(p=0.01) and the stride length(0.01) of unassisted walking among the treadmill training group. We also recorded an increase in the mean percentage of single paretic stance(p=0.01) and decrease in double support phase(p=0.01) among the treadmill supported training group. No untoward incidences like falls, cardiac events were seen in the treadmill training group.

**KEYWORDS**

## INTRODUCTION

Stroke is the leading cause of death and disability in India. The adjusted prevalence rate of stroke ranges from 84-262/100,000 in rural and 334-424/100,000 in urban areas[1]. The expanding elderly population with rise in lifestyle diseases like diabetes mellitus, hypertension can only increase the risk of stroke in the general population.

Majority of stroke survivors continue to live with disabilities, and the cost of on rehabilitation and long term care are largely undertaken by family members, further impoverishing them[2].Various novel rehabilitation procedures have been advocated and practiced around the world, such as Neurodevelopmental therapy[3],Biofeedback[4], Functional electrical stimulation[5], Partial body -weight supported training in treadmill[6,7,] Constraint induced movement therapy[8,9,10], Bilateral movement training[11], Mental imagery approach[12] and Robotic training[13, 14].

## THERAPY FOR MOBILITY

An important rehabilitation goal for a hemiplegic patient is to achieve independent ambulation. In the early stages of recovery, or if recovery is limited to weak synergy patterns only, walking will not be possible because of poor upright trunk control, inability to achieve single-limb support during stance, and inability to advance the leg during swing phase. As recovery progresses, patients develop better gross motor skills and trunk balance and greater strength in the leg. Ambulation improves as motor recovery provides for selective phasic activation of muscles during the gait cycle[15].

There have been reports that hemiplegic patients benefit from intensive gait training when therapy consists of walking on a treadmill with body weight partially supported with a harness [16,17]. The harness substitutes for poor trunk control, and the motor-driven treadmill forces locomotion.

Pamela W. Duncan et al[18] in their study of 408 patients included in the intention-to-treat analysis, 139 assigned to early locomotion training, 143 to late locomotor training and 126 to home exercise. Locomotor training, including the use of body-weight support in stepping on a treadmill, was not shown to be superior to progressive exercise at home managed by a physiotherapist[18]. Various other studies have also shown that training on a treadmill with harness for support led to improved gait velocity and related cadence and stride-length parameters in subjects with subacute and chronic stroke[19,20,21].

## methods

### Design

The present study is a prospective, randomized clinical trial. All the participating patients provided informed consent. The participants were recruited from the out-patient clinic session at our clinic. The study was conducted to address the need to compare two different therapeutic exercise programs provided by the healthcare providers in rehabilitation of stroke. One intervention was a task specific walking program that included stepping on a treadmill with partial body-weight support. The other arm of the study was a generalized physiotherapy session along with over-ground gait training supported or unsupported by helpers

All the patients undergone neurological and physical examination and routine investigations such as *Complete blood count, RBS, SGOT, SGPT, urea, creatinine, ECG.CT scan or MRI, whichever were available was studied for localization of lesion.*

### inclusion criteria

Infarction or haemorhagic stroke, with residual paresis in the leg.

Stroke duration more than 6 months.

Able to follow instructions.

Ability to walk 3 meters with assistance from no more than one person.

Passive dorsiflexion of foot to neutral.

Hip extension no less than 20 degree.

Knee flexion deformity not more than 10 degree.

Able to be in a vertical position in standing frame without a significant drop of SBP for 5-10 minutes.

**EXCLUSION CRITERIA**

1. Vertebro-basilar circulation stroke including brain stem infarction.

2. Severe cognitive deficits or unable to follow verbal instructions.

3. Any orthopaedic, renal, pulmonary or cardiac condition which may hamper gait training or walking on treadmill.

**INTERVENTIONS**

A total of 63 patients were selected for the study. 42 patients satisfying the inclusion and exclusion criteria were chosen and randomlyinto two group, Group A (n=20) and Group B(n=22).

Prior to the study, all the patients have already participated in at least 2 months of exercise sessions at physiotherapy centres, hospitals or home based programme.

Materials

A 5 meter white gait strip,with markings on it.

Motorized treadmill*(Welcare treadmill 2100, minimum speed 0. 3 km/hr, max speed- 12 km/h) in figure 1.*

A steel structure around the treadmill with an overhead bar for holding the harness, in figure 1.

A harness system to hold the patient, in figure 1.

A camera for video recording with timer setting on the screen.

A weighing scale.

**Figure 1** **Figure 2**

**INTERVENTION**

The patient is helped on to the treadmill walking track by two helpers. Briefly, patients were supported ina modified harness suspended centrally by aset of pulleys connected to a flexible spring. At thebeginning of the therapy, two therapists provided manual help to correct gait deviations. One therapistsitting by the paretic side facilitated the swing of the paretic limb. The second therapist stood behind the patient and facilitatedhip and trunk extension, as shown in figure 2.

The harness system support about 30% of the body weight (on a weighing scale), then adjust the height of the strap after removing the scale.The Support by the harness gradually decreased as the patient improves. The treadmill is run at the minimum speed of 0.3km/hr and the speed is gradually increased according to the patient's comfort. Use of an ankle foot orthosis(AFO) or assistive device was documented.

On a separate day, subjects performed a series of overground walks without their usual assistive device while traversing the 5 metre gait strip. Three trials were collected, with 2-minute seated rests between trials.

**Group A:**

Treadmill training with a body support harness.

Training for a period of 1 month.

Five days a week. 2 days off in a week.

Twenty sessions of treadmill training of 30 minutes each.

*Group B:* Over-ground gait training supported or unsupported by helpers.

Gait training on the floor with assistance or an aid.

Thirty minutes of training, 5 days a week, for 1 month.

The patients were given a trial to withdraw their aids or assistance, as they become more comfortable.

**Physiotherapy session**

All the patients in both the groups were given equal duration of physiotherapy of 30 minutes daily, 5 days a week, for 1 month.The session consisted of stretching and strengthening programmes of lower and upper limb muscles, pelvic bridging, side planks, kneeling and quadruped exercises. Balance training on a wobble board was also added.

**Measurement at baseline and at the end of 1st month.**

Patient walks on the 5 meters gait test strip at a comfortable, self-selected pace. Video recording was done from the middle of the strip. A total of 3 strides(which came in the view of the camera) viewed from both the affected and the unaffected side were recorded. Such recording were repeated 4 times from each side.

So a total of 12 strides/24 stepsof affected and unaffected side evaluated. Rest period of 2

Minutes was taken between each trial. Steps taken during the initial acceleration and final deceleration were removed to ensure that subject's best steady state walking patterns determined the gait parameters. Patients were made to wear the same shoe and AFO which they use prior to the study.

**EVALUATION**

**A. Primary gait parameters**

**1.** *Global measures of*

- *Average velocity,*

- *Stride length.*

**2. Elemental gait parameters for the paretic and the non-paretic leg.**

- *Individual step length,*

- *Percentage of stance phase, swing phase*

- *Double support.*

The above gait parameters were measured only for those patients who could walk unassisted, pre and post training.

**B. Secondary parameters**

For those who could walk with assistive devices, only the change in gait velocity(with aid) was measured. The assistive device selected in the regular therapy session is used during the measurement.

No. of patients who could be weaned off walking aid or assistance.

**Statistical analysis**
SPSS or (software package for the social sciences) 13.0–IBM SPSS statistics was used for statistical analysis.Paired t tests were used to evaluate differences between pre and post training evaluations.P-value for the patient's baseline parameters were derived from analysis of variance test.

**results**
There were no significant differences in the age at the onset of stroke and the duration of stroke between the two groups. The average duration of stroke in weeks in group A was 42.52 weeks38. The shortest duration was noted at 47 weeks and the maximum at 74 weeks as shown in table1.

The average duration of stroke in the group B was 48.12 with 40.1. The minimum duration was noted at 48 weeks and the maximum at 82 weeks. There were 8 right and 12 left sided hemiparesis in group A and 10 right and 12 left sided hemiparesis in group B.

Lacunar infarction was the commonest cause of stroke in both the groups.Hypertension was the most common comorbidity in both the groups followed by diabetes mellitus. Those with diabetes mellitus continued with oral hypoglycemic agents which their consulting physicians prescribed.

**table 1.Baseline characteristics of the study group**

| | Group A=20 Mean | Group B=22 Mean | P-value |
|---|---|---|---|
| Age at stroke | 54 8(47-74) | 56 | 0.08 |
| Duration of stroke(weeks) | 42 38(34-92) | 48.12 (36.18-102) | 0.12 |
| Side of hemiparesis<br>Right<br>Left | 8<br>12 | 10<br>12 | 0.42 |
| Stroke type<br>Large vessel<br>Lacunar<br>Hemorrhage | 5<br>11<br>4 | 3<br>13<br>6 | 0.86 |
| Coexisting conditions<br>Diabetes mellitus<br>Hypertension<br>Peripheral vascular disease<br>COPD<br>Cardiovascular disease | 5<br>15<br>3<br>1<br>4 | 6<br>13<br>1<br>2<br>2 | 0.74<br>0.85<br>0.05<br>0.09<br>0.09 |

**A. Primary gait parameters**
There was significant increase in the speed(p=0.01) and the stride length(0.01) of unassisted walking among the treadmill training group, shown in table 3. But no such changes in speed(p=0.18) and stride length (0.24) were noted among the over-ground training group, as shown in table 4. There was significant increase in the mean percentage of single paretic stance(p=0.01) and decrease in double support phase(p=0.01) among the treadmill supported training group. No significant changes in the paretic swing phase(p=0.08) were noted, as shown in table 7. We could not observe any significant changes in any of the above parameters evaluated among the patients of group B. No incidence of untoward events like angina, respiratory discomforts or blackout occurred during the training sessions.

**Table 3:Mean (unassisted) Walking speed (m/s) and stride length(m)**

| | Treadmill training group<br>p- value<br>Pre testpost test | |
|---|---|---|
| Walking speed | 0.16(0.21)<br>0.42(0.28) | 0.01 |
| Stride length | 0.36(0.24)<br>54(0.21) | 0.01 |

**Table 4: Mean (unassisted) Walking speed (m/s) and stride length(m)**

| | Overground training group<br>p- value<br>Pre testpost test | |
|---|---|---|
| Walking speed | 0.18(0.16)<br>0.28(0.20) | 0.18 |
| Stride length | 0.39(0.14)<br>0.46(0.18) | 0.24 |

**table 5.Mean (assisted) Walking speed (m/s) .**

| Parameters | Pre testvelue | Post test value | P value |
|---|---|---|---|
| Treadmill training | 0.37 | 0.62 | <0.001 |
| Overground training | 0.32 | 0.41 | 0.45 |

**TABLE 6: WEANING OF ASSISTANCE OR ASSISTIVE DEVICES**

| Mode of assistance | Treadmill walking, N=14 | Over ground training, N=13 |
|---|---|---|
| | Pre test<br>post test | pre test post test |
| Assistance of 1 person | 1<br>0 | 3 2 |
| Walker | 4<br>2 | 2 1 |
| Forearm crutch | 2<br>1 | 1 1 |
| Quad cane | 1<br>1 | 2 2 |
| Single point cane | 6<br>3 | 5 5 |
| Total | 14<br>7(50 %) | 13 11(15.39%) |

**TABLE 7:Mean percentage of gait cycle spent in stance, swing and double stance**

| Mean percentage of gait cycle | Treadmill training<br>Pre test post test | | P-value | Over ground training<br>Pre testpost test | p-value | P-value |
|---|---|---|---|---|---|---|
| Paretic single stance | 16.9 (14.8) | 22.6(12.8) | 0.01 | 18.2(15.1) | 18.8(12.4) 0.09 | 0.86 |
| Paretic swing | 34.2 (18.9) | 30.2(12.8) | 0.08 | 35.1(19.8) | 34.2(17.3) 0.18 | 0.4 |
| Double support | 54.6 (26.8) | 46.3 (16.0) | 0.01 | 49.2(23.8) | 47.2(17.9) 0.08 | 0.21 |

**B. Secondary parameters**

In the assisted walking group, significant changes were recorded in speed ($p<0.001$) among the treadmill training group. No significance changes in speed($p=0.45$) could be observed among the group B, as shown in table 5.

Among the assistive devices, single point cane was used most commonly in both the groups. Out of 14 patients in the treadmill training group who need assistance for walking, 7 could be weaned off those aids(50%). Only 2 of the 13 patients who require help were able to wean off any form of assistance(15.39%),as shown in table 6.

## Discussion

The theoretical background of locomotor therapy isbased on experiments in adult signalized cats and incompletelylesioned primates. These studies show activationof presumed spinal and supraspinal gait patterngenerators by locomotor therapy[22]. Adult spinalizedcats, which do not regain locomotor ability spontaneously,re-learn weight-bearing steps with their hindlimbs following a several month training period on the.treadmill[22].

One of the major functionally-limiting impairments resulting from a stroke is an often marked decrease in gait velocity. Since walking velocity is the product of step length and cadence, a reduction in either one or both of these parameters may account for gait slowing[24]. The absolute amount of time spent in single leg stance on the affected side remains fairly constant regardless of walking speed, but the proportion of total gait cycle duration spent in single leg stance on the affected side progressively lessens with increasing gait speed [24, 25, 26, 27]. Conversely, soon after a stroke more time, both absolutely and relatively, is spent in single leg stance on the unaffected side and also in double-limb support (DLS) on the affected and unaffected sides, which is the basis for low gait velocity.

The percentage of the gait cycle that the single leg stance represents increases progressively with normalization of gait in stroke[26]. Improved performance and gain in speed leads to increase in percentage of single leg stance of the hemi-paretic side. Conversely, the percentage of double limb stance decrease with improvement of gait performance[26]. Similar results have been found in our study, which points to the change in performance of gait among the patients being trained on treadmills.

The significant increase in our study of the mean percentage of single paretic stance and decrease in double support phase among the treadmill supported training group may reflect improve balance, although what proportion is due to increased velocity is unclear.

Both groups progressed to using assistive devices which provide less external support, even though the treadmill group showed much more improvement.The decreasing amount of external support by the aid range from assistance with one person, walker, forearm crutches, quad cane and then single point cane in their decreasing order.

## LIMITATIONS

Limitations of the study include small number of the participants, short duration of study, lack of cardiovascular monitoring, absence of angular kinematics study and evaluations of the lower limb joints. Furthermore, the patients of the study were carefully selected so that a generalized statement can only be drawn with great caution, particularly as the patients were not completely homogeneous with respect to gait ability and stroke.

## CONCLUSION

While explicit comparisons of various approaches of stroke gait training are confounded by methodological and technical differences, the common theme is that task oriented locomotor training can lead to improve motor function in stroke patients through neural plasticity, joint and muscle changes and improvement in aerobic capacity.Future work should include power analysis to indicate the number of subjectsnecessary to reach significant conclusions with such a heterogenous sample.

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