IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

A STUDY ON THE EFFECTIVENESS OF SPLIT-BELT TREADMILL TRAINING TO IMPROVE CADENCE IN HEMIPLEGIC CEREBRAL PALSY

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ABSTRACT

BACKGROUND: Cerebral palsy is caused by damage to the motor control centers of the developing brain and can occur during pregnancy, during childbirth, or after birth up to about age three. Resulting in limits in movement and posture causing activity limitation. When people walk on a split-belt treadmill that moves each leg at a different speed, there is an immediate reaction such that the slower leg spends more time in stance and the faster leg spends less time. This reaction persists during split-belt walking and immediately reverses when the belts are returned to normal treadmill conditions (i.e., the belts are tied at the same speed).
METHOD: The study is quasi-experimental of Twenty samples were taken for this study. This study was conducted in the outpatient department of physiotherapy, at Vinayaka Mission's Medical College Hospital. Salem. All subjects underwent Pretest measurements for cadence using a stopwatch. The number of steps walked in a minute was calculated using a stopwatch and this was taken as the pretest measurement. After the Pre-test, the subjects received split-belt treadmill training for 15 days. Post-test measurements were similarly taken on the 15th day as the pre-test measurements.
RESULT: The 't' calculated value of 11.96 was matched with the 't' table value of 2.093 at a 5% level of significance and found that the 't' calculated value is greater than the 't' table value. There is a significant improvement in cadence following split-belt treadmill training in Hemiplegic Cerebral Palsy.
CONCLUSION: The results of this study make us conclude that split-belt treadmill training is effective in improving the cadence of hemiplegic cerebral palsy.
KEYWORDS*:* Hemiplegic Cerebral Palsy, Cadence, Split-Belt, Baclofen Pump.

INTRODUCTION

Cerebral palsy is caused by damage to the motor control centers of the developing brain and can occur during pregnancy, during childbirth, or after birth up to about age three. Resulting in limits in movement and posture causing activity limitation. (1) When people walk on a split-belt treadmill that moves each leg at a different speed, there is an immediate reaction such that the slower leg spends more time in stance and the faster leg spends less time. (2) This reaction persists during split-belt walking and immediately reverses when the belts are returned to normal treadmill conditions (i.e., the belts are tied at the same speed). (3)

MATERIALS AND METHODOLOGY

The study is quasi-experimental Twenty samples were taken for this study. This study was conducted in the outpatient department of physiotherapy, at Vinayaka Mission's Medical College Hospital. Salem. All subjects underwent Pretest measurements for cadence using a stopwatch. The number of steps walked in a minute was calculated using a stopwatch and this was taken as the pretest measurement. After the Pre-test, the subjects received split-belt treadmill training for 15 days. Post-test measurements were similarly taken on the 15th day as the pre-test measurements. Inclusion criteria of the study were diagnosis of spastic hemiplegic cerebral palsy, Impaired ambulation abilities as evidenced by a decrease in gait velocity below 80% of age expected value or gross motor function classification scale (GMFCS) Level III or IV, Able to ambulate independently for 8 steps with/without assistive devices to allow for adequate motion analysis data collection, Between the ages of 6 and 13 years, Able to follow multiple step commands and to attend to tasks associated with data collection, Willingness to commit to home program 30 minutes per session, 5 times a week for 10 weeks, as well as adequate space and supervision for treadmill use at home, No reported musculoskeletal, cardiovascular or pulmonary conditions that would limit participation in a moderate exercise program, Minimum of 12 months post-surgery including soft tissue releases, At least 2 years post- dorsal rhizotomy. Exclusion Criteria of the study were Children with "mixed" types of CP (i.e. athetosis) or other movement disorders (e.g. ataxia), Children receiving intra thecal Baclofen (baclofen pump).

PROCEDURE

All twenty subjects with hemiplegic cerebral palsy completed 15 days of split-belt treadmill training. Each subject was monitored for the duration of the exercise training on the treadmill machine via a standard, commercially available heart rate monitor; heart rate was taken every 3 minutes.

The child is placed in a special suit or harness to prepare for the treadmill. The harness provides safety and support and is attached to a device that slightly suspends the child in the air. The height of the treadmill system can be adjusted so the child puts very little weight on his/her feet while walking, reducing the amount of effort needed to "walk."

Children were asked to walk on a custom-built treadmill comprised of two separate belts, each with a motor that permitted the speed of each belt (i.e., each leg) to be controlled independently. During different testing periods, subjects walked on the treadmill with the two belts either moving at the same speed ("tied" configuration) or different speeds ("split-belt" configuration). During the tied configuration, treadmill belt speeds were either "slow" (0.5 m/s) or "fast" (1.0 m/s). In the split-belt configuration, one treadmill belt was set at a slow speed while the other was set at a fast speed.

Each session consisted of three testing periods. In the Baseline period, the belts were tied and moved first at the slow speed, then at the fast speed, and then again at the slow speed. In the Adaptation period, the treadmill belts were split (one belt fast, the other belt slow). In the Post-adaptation period, the belts were returned to the tied slow configuration. The duration of each testing period was: Baseline 2 min (tied slowly), 2 min (tied fast), 2 min (tied slowly), Adaptation 15 min, and Post-adaptation 6 min.

Subjects were given standing or seated rest breaks every 5 minutes during Adaptation, or more frequently as requested.

Subjects who take a longer paretic step during Baseline are trained with the paretic leg on the slow belt to induce an after-effect that leads to greater symmetry. Subjects, who took a shorter paretic step in Baseline, are trained with the paretic leg on the fast belt to induce an after-effect that leads to greater symmetry. If we train in the wrong direction, we get after-effects that worsen their step length asymmetry. This session was followed for 15 days.

STATISTICAL ANALYSIS & RESULTS

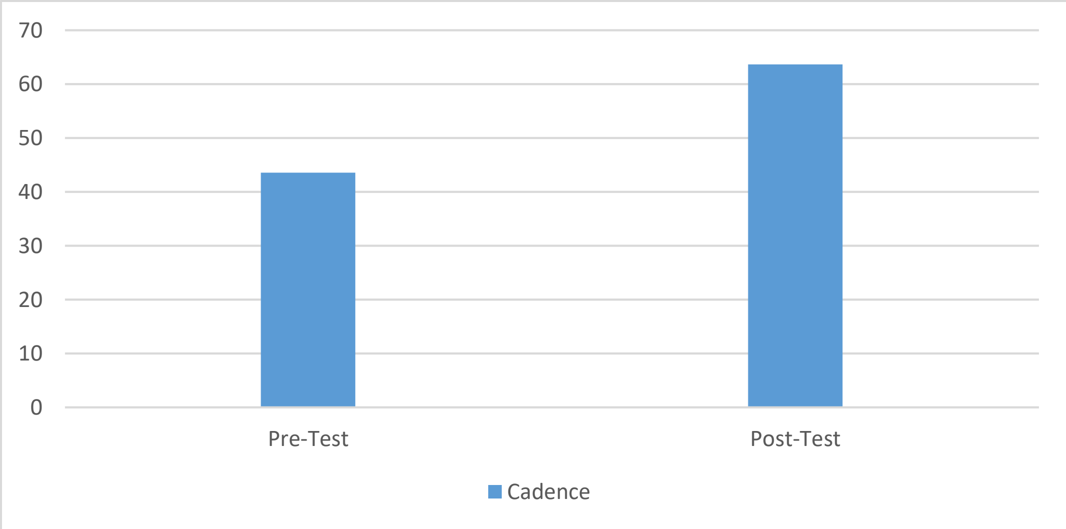
The collected data were analyzed using paired "t'' test.

Values obtained from paired t-test Calculated value of the Cadence test for 19 degrees of freedom and a 5% level of significance was 53.71 greater than the 't' table value of 1.729 (Table 1). In the statistical analysis obtained from the Cadence test, the mean values and SD of the pre-test were 43.6 and 3.05 then the post-test was 63.7 and 2.30 respectively.

There is a significant improvement in cadence following split-belt treadmill training in Hemiplegic Cerebral Palsy.

Table 1: Showing the pre and post-test values of the Cadence Test (Paired t-test values)

Cadence Test	Mean	SD	t-value	p-value
Pre-Test	43.6	3.05	53.71	<.00001
Post-Test	63.7	2.30		



Graph 1: Within Group Analysis of Cadence Test

DISCUSSION

The results of this study indicate that 15 days of split-belt training significantly improve cadence in hemiplegic cerebral palsy.

In this study, we have demonstrated that hemiplegic cerebral palsy causing a range of sensory and motor deficits did not impair a person's ability to make immediate reactions or slower adaptations during split-belt treadmill locomotion. Importantly, we found that hemiplegic cerebral palsy could temporarily store new inter-limb relationships, demonstrating that the compromised nervous system can still produce a more normal pattern.

Yaniagihara and Kondo et al found that decerebrate cats showed that they could adapt inter-limb coordination when walking on a split-belt treadmill. When the function of the cerebellum was altered through nitric oxide deprivation, adaptation was impaired. This suggests that cerebellar, rather than cerebral structures, are more involved in this process. The circuit in the cat likely involves cerebellar influences on brainstem structures contributing to the vestibulo- and reticulospinal pathways. Our human work has also shown that cerebellar damage disrupts inter-limb adaptation. (4) This coupled with the results of the current work suggests that cerebellar projections to brainstem motor areas might be more important than projections to cerebral motor areas for this adaptive process. After the split-belt treadmill training, hemiplegic cerebral palsy children retain sufficient adaptability of the central nervous system to alter spatiotemporal inter-limb relationships. After split-belt treadmill walking, hemiplegic cerebral palsy subjects demonstrate after-effects in double support and step length that improve the symmetry of these variables. The increased adaptability of the central nervous system for inter-limb relationships and improvement in the double support and the step length asymmetry will help the stroke patients to get improvement in their cadence after the split-belt treadmill training.

CONCLUSIONS

The results of this study make us conclude that split-belt treadmill training is effective in improving the cadence of hemiplegic cerebral palsy.

LIMITATIONS AND RECOMMENDATIONS

The limited number of participants included in this study varied widely in days post-stroke, types of right-sided hemiplegic cerebral palsy, and severity of symptoms which may have led to difficulties in identifying firm trends regarding the effectiveness of the group. Further research would need a larger more homogeneous sample size to establish a relationship between gait asymmetry and split-belt walking training.

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