

Effect of Repetition of Single Leg Weight Bearing Exercises on Gait Parameters in Hemiplegic Children

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Abstract

Background: Hemiplegics presented with asymmetric weight distribution and impaired weight-shifting ability. The purpose of this study was to examine the effect repetitions of single leg weight bearing exercises on gait parameters in hemiplegic children.

Methods: Total 20 hemiplegic children were randomly assigned into two groups, control group (Group A) and experimental group (Group B). Children in group A received conventional therapy and group B were given 10 repetitions of single leg weight bearing exercises along with conventional therapy and both the group was given stretching and gait training program. Gait parameters were recorded on 0 day and at the end of 4 week.

Result : Significant difference was found in the groups, group B has shown more improvement compared to group A in step length, step width and cadence. But non-significant difference was found in stride length when both the group were compared.

Conclusion : Repetitions of single leg weight bearing exercises along with conventional therapy are effective than conventional therapy alone in improving gait in hemiplegic children.

Key words: Gait, hemiplegic children, single leg weight bearing exercises.

Introduction : Hemiparesis is the most frequent neurological deficit after stroke.^{1, 2} Any damage to brain involving one side of body before, during or shortly after birth will termed as congenital hemiplegia and any damage to brain in between 30 days and 18 years is termed as childhood hemiplegic. Perinatal strokes develop between 28 week of gestation and 1 month of age.³ Although stroke does occur in infancy and childhood (Nicolaidis and Appleton 1996), NDT classifies this condition as hemiplegic CP because impairments, motor functions and functional limitations

are influenced by growth and development, as are all other type of CP.⁴ Incidence of hemiplegia is estimated to be 1 in 1000,000 birth.^[5]

Hemiplegic or hemiparetic stroke patients presented with more posture sway, asymmetric weight distribution, impaired weight-shifting ability and decreased stability capability. The main and most cumbersome feature of an early immature gait pattern consists in co activation of all leg muscles during the stance phase of gait cycle. Children with borderline to moderate forms of Cerebral Palsy not only suffer from a limited motor repertoire but also from deficiencies in the processes of selection of proprioceptive, tactile, or visual information. This impaired sensory processing interferes with selection of specific motor task.^[5]

Weight-bearing exercises provide more consistent proprioceptive feed-back that in turns improves control of movement. Functional weight-bearing exercise programs have been shown to have effects on balance, gait, and lower-limb strength among subjects with moderate or no cognitive and physical impairments.⁶ Additionally Static weight-bearing exercises in children with cerebral palsy are believed to stimulate antigravity muscle strength.^[7]

Repetition of self-generated sensory input (Gordon & Duff, 1999, and augmentation of movement-related afferent information (Hadders- Algra et al., 1999b) result in a decrease of variation in motor output and thus in a better task-specific adaptation of motor behavior.^{8, 9} Task-specific training has show great promise in helping stroke and motor incomplete spinal cord injured patients regain some walking ability. Rehabilitation exercise is most effective when it is closely related to the particular task.^[10]

Exercise program in our study involve intensive training of affected limbs by repetitive use and is more task specific. Although many studies and their improvement following intervention have been documented, none of the study has emphasized on effect of single leg weight bearing exercises. Hence the purpose of this study was to examine the effect of single leg weight bearing exercises on gait parameters in hemiplegic children.

Methodology : 20 hemiplegic children (8 female & 12 boys, mean age + 11.98, range 5- 15 years) were recruited for the study. informed consent was taken from parent / caregiver after the approval of Institutional Review Board. Each child received independent examinations to determine their eligibility for the following inclusion criteria: (1) GMFCS level (Gross Motor Function Classification System) 1 and 2. (2) Cognitively stable and well oriented.(3) Spasticity

according to Ashworth scale should not be more than grade 1. Exclusion criteria were (1) Contracture of the affected lower limb that may interfere with the ability for full weight bearing. (2) Any recent surgical procedure of lower limb. (3) Botox done in last 6 month. Children were randomly assigned to (Group A) control group (conventional therapy + gait training) and (Group B) experimental group (10 repetitions of single leg weight bearing exercise + conventional therapy + gait training) by the research assistant. Both the group received training for 1 hour/ day, 6 days/ week, for 4 week. Training session was conducted by trained physiotherapist during regularly scheduled therapy session. Affected and normal legs were trained equally with single leg weight bearing exercise. Pre & post gait parameters (stride length, step length, step width, cadence) was documented by the research assistant

Weight Bearing Exercises :

1. One leg standing on stepper and other leg on ground and reach out towards the weight bearing leg on the ground, alternately on both the side with 10 repetitions.
2. Standing with one knee flexed to 90o over the appropriate size of physio-ball and other leg on the ground and reach out towards weight bearing leg on the

ground, alternately on both the side with 10 repetitions.

3. Step up and step down on 4 inch stepper in front, alternately on both the side with 10 repetitions.

4. Crossing Small bolster in front, alternately on both the side with 10 repetitions.

Conventional Therapy : Stretching (Hamstring, Rectus-femoris, Adductors), Weight free strengthening exercise of lower limb, pelvic bridging, Sit to stand, partial squat etc. as per there capacity and demand.

Gait Training :

1. Walking in a straight line.
2. Walking in curve line.
3. Walking in footprints marked on floor.

Test Procedure : The subjects were made to walk 5 meter on the floor with foot dipped in ink, their footprints were taken and gait parameters was measured subsequently. The subject footprint was taken on 0 day and at the end of 4th week.

Data Analysis : Data was analyzed using primer software. Paired't' test was used to compare pre and post values within the Group A & B and Unpaired 't' test was used to compare between the group A and Group B.

Result

Table 1: Statistical analysis of pre training and post training affected side stride length in GROUP A and GROUP B.

GROUP	TREATMENT	MEAN	DIFFERENCE	SD	SE	PAIRED t test	UNPAIRED t test
GROUP A	PRE	32.44	0.93	5.32	1.68	t= -1.306 P= 0.000	t= 1.535
	POST	33.37		5.04	1.59		
GROUP B	PRE	35.1	2.58	4.93	1.56	t= -2.43 P=0.038	P= 0.14
	POST	37.68		4.76	1.50		

TABLE 2: Statistical analysis of pre training and post training normal side stride length in GROUP A and GROUP B

GROUP	TREATMENT	MEAN	DIFFERENCE	SD	SE	PAIRED t test	UNPAIRED t test
GROUP A	PRE	40.5	1.14	7.19	2.27	t= 3.33 P=0.009	t= 1.90
	POST	41.6		6.89	2.17		
GROUP B	PRE	38.92	3	5.48	1.73	t= 3.27 P= 0.01	P= 0.074
	POST	41.92		5.9	1.86		

TABLE 3: Statistical analysis of pre training and post training affected side step length in GROUP A and GROUP B

GROUP	TREATMENT	MEAN	DIFFERENCE	SD	SE	PAIRED t test	UNPAIRED t test
GROUP A	PRE	12.86	0.91	2.89	0.915	t= 9.59 P=0.00	t= 2.878
	POST	13.77		2.93	0.929		
GROUP B	PRE	17.24	1.85	3.4	1.075	t= 5.89 P=0.00	P= 0.01
	POST	19.1		3.204	1.013		

TABLE 4: Statistical analysis of pre training and post training normal side step length in GROUP A and GROUP B

GROUP	TREATMENT	MEAN	DIFFERENCE	SD	SE	PAIRED t test	UNPAIRED t test
GROUP A	PRE	14.73	1.63	3.45	1.09	t= 11.5 P=0.000	t= 2.13
	POST	16.36		3.63	1.14		
GROUP B	PRE	18.42	2.97	2.77	0.87	t= 4.37 P=0.002	P= 0.047
	POST	21.39		2.56	0.80		

TABLE 5: Statistical analysis of pre training and post training step width in GROUP and GROUP B.

GROUP	TREATMENT	MEAN	DIFFERENCE	SD	SE	PAIRED t test	UNPAIRED t test
GROUP A	PRE	14.97	0.87	2.45	0.77	t= 4.408 P=0.002	t= 2.240
	POST	14.1		2.51	0.79		
GROUP B	PRE	13.46		2.29	0.72	t= 4.652 P=0.001	P=0.038
	POST	11.24	2.22	2.73	0.86		

TABLE 6: Statistical analysis of pre training and post training cadence in GROUP A and GROUP B.

GROUP	TREATMENT	MEAN	DIFFERENCE	SD	SE	PAIRED t test	UNPAIRED t test
GROUP A	PRE	109.3	5.8	10.31	3.25	t= 5.40 P=0.000	t= 5.481
	POST	115.1		10.41	3.29		
GROUP B	PRE	105.5		9.265	2.93	t= 11.61 P=0.000	P= 0.000
	POST	120.5	15	8.34	2.63		

Discussion :

This study demonstrates that combining single leg weight bearing exercise (SLWS) with conventional therapy (CT) significantly improve gait parameters in hemiplegic children. Despite limited sample size of 20 hemiplegic children, this impressive research may shed light on continued research. The result support our hypothesis that combination of the treatment techniques may increase treatment benefits.

To our knowledge this study is the first to report the effect of single leg weight bearing exercise with conventional therapy. Our study found the positive effect in improving gait parameters. There are several possible reasons that, Weight-bearing exercises provide more consistent proprioceptive feed-back that in turns improves control of movement, On other hand weight-bearing exercises allow for reactivation of the proprioceptors, whose role is to sense the amount, speed and timing of joint positioning.^[11]

On other hand our study emphasized on number of repetitions of single leg weight bearing exercise which is task specific exercise, this is the other reason to show more improvement in experimental group, it involve intensive training of affected limbs by repetitive use and shaping procedure, was proven to produce use dependent cortical reorganization by neuroimaging and transcranial magnetic studies.^{12,13,14} According to the system's theory, integration of many systems – including central nervous system – by repetitive practice of functional and goal-directed activities, results in organized and normal movement.¹⁵ Meaningful performance of activities, repetitive and concentrated practice that might be playing a role in brain plasticity is the main principle.¹⁶ In order to understand the mechanisms of recovery obtained by repetitive single leg weight bearing exercise treatment, neuroradiological studies investigating cortical reorganization are also needed. These will also help us to improve our knowledge about the neuromuscular treatment approaches.

Although the study findings on stride length were not significant when two groups was compared, but statistical significant relation was found, when compared pre and post training mean values within the group. Although the training task in our treatment protocol of bolster crossing is directed to improve stride length. This non significant finding may be because; we may not have enough statistical power to detect existing true effects when both the groups were compared. Such findings hold promise that their effects may be better demonstrated in an investigation with a large sample size

We have found significant finding in step length, step width and cadence. Increase in cadence is might be due to decrease in stance time on limbs. This finding might indicates the direct effect of our specific intervention, which is task specific and repetitive. Two exercise protocol included in the study was one leg standing with other leg flexed 90° on a physioball while weight shifting toward weight bearing side, and other one was one leg standing with other leg on a stepper in front and weight shift towards weight bearing side, has helped in improving balance by more challenge to the affected limb to bear a weight. And this has helped to decrease the step width and increase cadence.

Exercise protocol in our study is more task specific and functional. It is commented that functional weight-bearing exercise programs have been shown to have effects on balance, gait, and lower-limb strength among subjects with moderate or no cognitive and physical impairments.⁶ The proposed concept of training consists of increasing the activity of the receptor organ in the joints during exercise, activating the integrating mechanism in the central nervous system by offering sensory inflow through somatosensory system, and training the neuromuscular effector system.¹⁶

In summery study found positive effect of combined single leg weight bearing exercise and conventional therapy on gait parameters, especially step length, step width and cadence. Future study should be done in large sample size to make finding more accurate.

Conclusion :

This study concludes that repetitions of single leg weight bearing exercises along with conventional therapy are statistically and clinically effective than conventional therapy alone in improving gait in hemiplegic children

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