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A study on effectiveness of task oriented strength training in gait in spastic cerebral palsy children

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Abstract
Abnormal gait is the common problem in children with cerebral palsy because of motor weakness and poor voluntary motor control. Crouched gait or Diplegic gate is an important functional biomarker in children with spastic diplegic cerebral palsy. In addition to that they have slower walking speed, a shorter stride length and more time spent with double support. Improvement in mobility function has been the primary goal in the rehabilitation of children with Cerebral palsy. Task oriented strength training program is linked to have improvement in mobility function in children with cerebral palsy.

Keywords: Task oriented strength training; stride length; cadence; gross motor function measure

Introduction
Cerebral palsy (CP) is a chronic neurologic disorder caused by a static lesion to the immature brain that is characterized by deficits in movement and postural control. Because of impairments such as weakness, spasticity, and incoordination. Many children with CP have difficulty with activities such as propelling their wheelchairs, walking independently, negotiating the steps, and running or navigating safely over uneven terrain. Improving one's ability to walk or to perform other functional activities are often the primary therapeutic goals for children with cerebral palsy. Cerebral palsy is a clinical syndrome characterized by a persistent disorder of posture or movement due to a non-progressive disorder of the immature brain. This condition leads in disorder of movement, muscle tone or posture that is caused by damage that occurs to the immature, developing brain, most often before birth. Cerebral palsy effect on functional abilities varies greatly some affected people can walk while others can't. Some children show normal or near-normal intellectual capacity, but others may have intellectual disabilities. Incidence of cerebral palsy is 2 per 1000 live births. The incidence increases with premature and very low birth weight babies. This incidence is higher in male than female. Based on neuromuscular deficit cerebral palsy is classified as spastic (70% - 80%), dyskinetic (including choreo-athetoid and dystonic), ataxic, hypotonic, mixed. Based on topographical classification they are monoplegia, diplegia (30% - 40%), hemiplegia (20% - 30%) and quadriplegia (10% - 15%). In an analysis of 1000 cases of cerebral palsy from India, it was found that spastic quadriplegia constituted 61% followed by diplegia 20%.
Spastic cerebral palsy is most common making up 61% to 76.9% of all cerebral palsy cases.

Spastic Cerebral Palsy
Spastic cerebral palsy is the most common type of cerebral palsy in which the muscles of the children with spastic cerebral palsy feel stiff and their movements may look stiff and jerky. Spasticity is the form of hypertonia, or increased muscle tone. This results in stiff muscles which can make movements difficult or even impossible. Muscles appear stiff because the messages to the muscles are sent incorrectly through the damaged part of the brain. When a muscle is affected of spasticity; the faster the limb is moved, the stiff it seems.
Spasticity arises as a result of damage to bundle of neurones in the brain and spinal cord called the corticospinal tract and corticobulbar tract. Affected individuals may have difficulty moving from one position to another and controlling individual muscle or muscle groups needed for performing certain tasks like handling objects.

Spastic Hemiplegia (20-30%)
Spastic Diplegia (30-40%)
Spastic Quadriplegia (10-15%)

Spastic cerebral palsy is sometimes referred as bilateral spasticity. This form of cerebral palsy mainly affects the muscle groups but can create associate disorder as well.

Risk factor

Risk factors can be divided by time period into antenatal, perinatal and postnatal factors. The maturity of the risk occurs in the antenatal period. Prematurity is a significant risk factor, predisposing to development of periventricular leukomalacia (PVL) 8.

Antenatal

- Prematurity and low birth weight
- Intrauterine infection
- Multiple gestation
- Pregnancy complication

Perinatal

- Birth asphyxia
- Complicated labour and delivery

Postnatal

- Non-accidental injury
- Head trauma
- Meningitis/Encephalitis
- Cardio pulmonary arrest
- Protective factor
- Obstetrical care
- Magnesium sulphate
- Antibiotics
- Corticosteroids

Pathophysiology

Preterm infants- the prenatal neonatal brain is susceptible of the main pathologies: -

Intraventricular hemorrhage: describe bleeding from the sub ependymal matrix into the ventricles of the brain. The blood vessels around the ventricles develop late in the third trimester. The risk of cerebral palsy increases with the severity of intra ventricular hemorrhage.

Periventricular leukomalacia: intra ventricular hemorrhage is a risk factor of periventricular leukomalacia. The pathogenesis of periventricular leukomalacia arises from two important factor:

Ischemia/Hypoxia: the periventricular white matter of the neonatal brain is supplied by the distal segments of adjacent cerebral arteries. Although collateral blood flow from the area when one artery is blocked.

Infection/Inflammation: the process involves microglial cell activation and cytokine release when cause damage to a specific cell type in the developing brain called the oligodendrocyte.

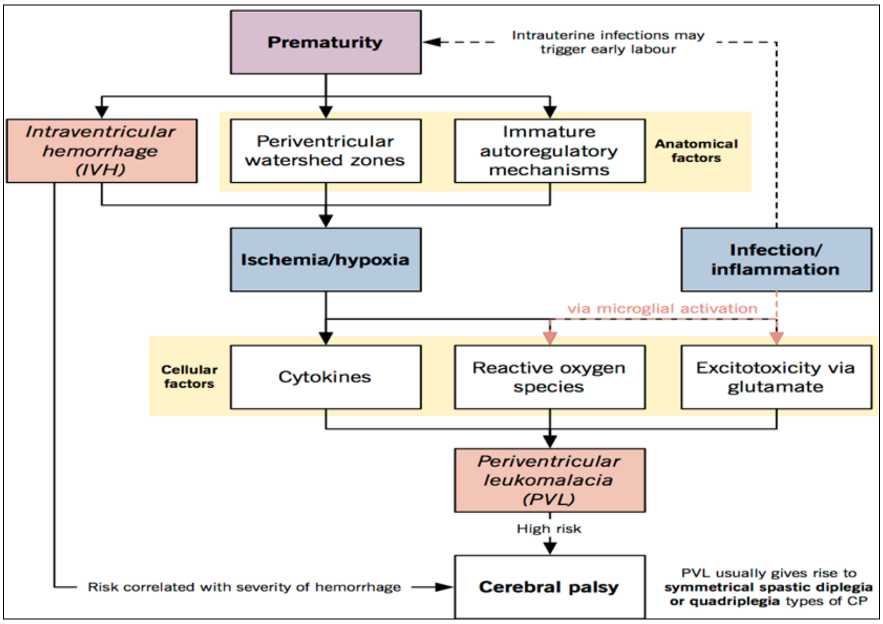

Fig 1: PVL usually gives rise to symmetrical spastic diplegia or quadriplegia types of CP

Gait abnormalities in Children with CP

Abnormal gait is the common problem in children with cerebral palsy because of motor weakness and poor voluntary motor control. Crouched gait or Diplegic gate is an important functional biomarker in children with spastic diplegic cerebral palsy. In addition to that they have slower walking speed, a shorter stride length and more time spent with double support. Due to the above-mentioned problem, a general decrease in physical activities as well as walking capacity has been observed in these children. So, gait capacity limitation in children with cerebral palsy appear to be related to the ability to participate in day school activities such as playground games and moving to other areas of the school.

Task Oriented Strength Training

Improvement in mobility function has been the primary goal in the rehabilitation of children with Cerebral palsy. Task oriented strength training program focuses mainly on lower extremities strengthening. This training program is linked to have positive outcomes in improving mobility function in children with cerebral palsy.

Gross Motor Function Measure (GMFM)

The GMFM is a standardized observational instrument designed and validated to measure change in gross motor function over time in children with cerebral palsy. The scoring key is meant to be a general guideline. However, most of the items have specific descriptors for each score. It is imperative that the guidelines contained in the manual be used for scoring each item.

Scoring Key
0 = does not initiate
1 = initiates
2 = partially completes
3 = completes
9 (or leave blank) = not tested (NT) [used for the GMAE-2 scoring*]

It is important to differentiate a true score of "0" (child does not initiate) from an item which is Not Tested (NT). In clinical setting, task-oriented strength training helps in management of gait in spastic CP subjects. Strength training in improving gait in spastic cerebral palsy is a new concept. This study has been conducted in attempt to find the effectiveness of strength training in gait in cerebral palsy diagnosed pediatric children. The aim of the present study is to find out the effectiveness of task-oriented strength training on improving stride length and cadence thereby improving gross motor function.

Methodology
Study design: Experimental study.
Effectiveness sample size: 20
Selection of samples: Subjects with Spastic CP between the age group between 7-15 years were taken for the study. Purposive sampling.

Sampling design: Convenient sampling.
Study setting: Outpatient department of Hosmat Hospital, Ravi Kirloskar Hospital and schools for special children in and around Bangalore.

Inclusion criteria
1. Children with spastic Cerebral Palsy
2. Age group 8 -15 years
3. Both male and female children diagnosed with cerebral palsy.
4. Ambulatory children with or without aids
5. Follows simple commands
6. GMFCS level III

Exclusion criteria
1. Children with any cardio-respiratory condition.
2. Children with any true fractures
3. Mentally retarded children
4. Children with behavioural disorders
5. Psychological disorder
6. Subjects with visual impairment

Materials used
1. Couch
2. Treadmill with hand rails
3. Parallel bar
4. Mirror
5. Stairs
6. Assessment form
7. Data collection form
8. Consent form

Outcome measures
- Stride Length – Inch Tape
- Cadence – Stopwatch
- Gross motor function measure

Procedure
The children were recruited from the outpatient department of HOSMAT hospital and Special Schools in and around Bangalore. The aim and objectives of the study was explained to the children guardian and the care taker at school ⁄ hospital and taken permission to take part in the study. The children were selected by convenient sampling method. The aim and objective of the study was explained to the children. The children willing to take part in the study were scrutinized for inclusion and exclusion criteria included in study. Gross Motor Function Measure is used as an outcome measurement tool for baseline assessment before and after the exercise protocol.
The children meeting the inclusion, exclusion and diagnostic criteria were selected for the study and guardians were requested to sign the consent form.

Measurement of Cadence
1. Stopwatch used for correct measurement.
2. Started the stop watch when patient started walking.
3. The number of steps in one minute were counted.
4. Stopped the watch.

(Cadence is a number of steps taken by a person per unit of time. It may be measured as the number of steps per second or per minute. Cadence = Number of steps/Time)

Measurement of stride length
1. Marked the starting point of the heel of the subject's feet.
2. Taken 10 steps in a straight length.
3. Marked the ending point of the feet, same foot as the start.
4. Measured the distance between the 2 marks.
5. Divided the result by 10 to get the average stride length.

(Stride Length is the linear distance between two successive points of contact of opposite extremities. It is usually measured from the heel strike of one extremity to the heel strike of the opposite extremity. A comparison of right and left step length will provide an indication of gait symmetry.)

Gross motor function measure
The Gross Motor Function Measure (GMFM) is used for quantifying change in the gross motor abilities of children with cerebral palsy. The new version of the scoring program has now been released, and includes two abbreviated methods of estimating GMFM-66 scores using the GMFM-66-Item sets and the GMFM-66-Basal & Ceiling.

Procedure for intervention
Lower limb strengthening exercises
Sit to Stand Test
Position: Sitting to standing position
Procedure: The subject was instructed to sit on the chair with a height adaptable seat (no back rest and no arm rest). The upper legs were parallel to the floor, the feet parallel on the ground (as flat as possible) and the trunk erect. The child was asked to stand up, as erect as possible with symmetric hip strategy ("flex hips and move trunk forward until the shoulders are above the knee joint and then stand up"). A full movement (standing up and sitting down) was founded as one correct repetition.

Lateral Step-up Test

Position: Standing position

Procedure: the subject was instructed to stand next to the step and put the more impaired (tested) leg on the step where it remains throughout the entire test. The child was asked to lift his/her less or un-impaired (not tested) leg up and put it on the step, by fully extending the hip and knee of the tested leg. After this, he/she set the non-tested leg back on the ground, next to the step. A full movement (stepping up and down) was counted as one repetition.

Treadmill Training

Muscles of lower extremities is strengthened by using treadmill with hand rails to improve gait. While motor activity is the primary aim of a split treadmill workout, it can offer some benefits for endurance and strengthening.

Position: standing

Procedure: The children were instructed to stand upright as possible and body weight support were reduced until the child began either to flex at the hips or knee or to sit in the harness. The treadmill was started at the lowest speed (0.1km/h) and increase in 0.1km/h increments to a speed at which the child stepped forward comfortably. If required, the physiotherapist provided assistance to initiate weight shift or the swing phase of the gait cycle. Sessions finished earlier if the child asked to stop, or if the child stopped stepping. The treatment timing was for 5 minutes.

Safety measures for Treadmill

1. The child was instructed- "walk like you usually walk, but don't run".
2. The child was instructed to keep his/her back straight and not lean forward or backward since it can increase the chances of falling or having back problems.
3. The child had to hold the handlebars of the treadmill to ensure stability. The therapist or the care taker had to help the subject if not able to hold them properly.
4. All children began treadmill training at or near their baseline therapist-selected walking speed.
5. Treadmill speed was increased within each session as the child tolerated and subsequent sessions were initiated at the maximum speed achieved during the previous session

Statistical

Demographic data of the subjects including sex, age, task oriented strength training were summarized. The dependent variables for statistical analysis was help to improve the stride length and cadence in the children with CP. Statistical analysis was done by parametric test statistic. The outcome measures was compared within the group using paired't' test and improvements were compared using independent sample 't' test.

PAIRED t-TEST

Paired t-test has been used to find the significance of the study parameters i.e. pre and post-test VR and traditional therapy within the same sample group. The formula is to find out the value of `t' using:

$\sum d$ = sum of the differences

$\sum d2$ = sum of the squared differences

$(\sum d)$ 2 = sum of the differences squared

Square root of following = n times the sum of the differences squared minus the sum of the squared differences (n-1).

In the structured study of 3 months, presented study was undertaken to determine the effect of task oriented strength training in children with cerebral palsy.

The paired ´t´ test was used in the study to compare the pre-test and post-test in task oriented strength training to improve stride length and cadence.

When we analysed the mean values of pre-test and post-test interventions, it was found that pre-test and post-test mean values of:

Stride length (pre-test 39.73±5.08) and (post-test 42.12±5.15)

Cadence (pre-test 50.45±9.41) and (post-test 55.70±9.34).37, 38, 39.

GMFM assessment done pre and post- test. Slight improvement in the standing and walking dimensions observed in the scores of GMFM.

Results

Study design: An Observational Study Design.

Statistical Methods: Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. The following assumptions on data is made,

Assumptions: 1. Dependent variables should be normally distributed, 2. Samples drawn from the population should be random, and Cases of the samples should be independent. Student t test (two tailed, dependent) has been used to find the significance of study parameters on continuous scale with in each group. Paired Proportion test has been used to find the significance of proportion in paired data. Smaller percentage of Improvement becomes significant at lower tail compared to higher tail. E.g. Improvement from 10% to 20% is difficult than the Improvement from 80% to 90%.

Significant figures

+ Suggestive significance (P value: $0.05<P<0.10$)

* Moderately significant (P value: $0.01<P \leq 0.05$)

** Strongly significant (P value: $P \leq 0.01$)

Statistical software: The Statistical software namely SPSS 18.0, and R environment ver.3.2.2 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

Discussion

The purpose of the study was to determine the effectiveness of task oriented strength training on stride length and cadence in children with spastic cerebral palsy.

According to MK Franklin Shaju (2016) [11] concluded that task oriented training group showed relatively more positive results in comparison to conventional physiotherapy in improving mobility in spastic diplegic Cerebral palsy children.

Also Salem (2009) [2] in his study concluded that mobility function in children with cerebral palsy improves by task oriented strength training program. The findings demonstrate that the application of a task-oriented strength training program is linked to positive functional outcomes.

There is growing body of evidence that support task oriented training as beneficial for children with cerebral palsy. The purpose of this study was to examine the effects of task oriented training in mobility function in children with cerebral palsy. The result of this study supports the task oriented training for improving mobility function in children with cerebral palsy. The training included practice of functional activities used in everyday life. In interpreting the result of this study several limitations must be considered and the sample size was small. Despite the limitation of the study the result have clinical implication for clinicians working with children with cerebral palsy.

This study provides an evidence based recommendation on the potential benefits of task oriented strength training programme for children with cerebral palsy. The findings demonstrated that the application of a task oriented training is linked to positive outcome.

The purpose of the study was to determine the effectiveness of task oriented strength training in case of spastic cerebral palsy. Studies have been previously done to determine the effect of circuit training and strength training of lower limbs. Our finding suggest that task oriented strength training showed clinically and statistically beneficial effects.

The findings are in agreement with other studies which have shown that strength training in patients which cerebral palsy is associated with improvement.

The result of the current study showed that 3 months of task oriented strength training resulted in significant improvement in gait in cerebral palsy. The result suggests that the children with spastic cerebral palsy benefit from task oriented strength training. Further studies with a larger randomized sample and longer post interventions follow up are necessary to document the long term effect of participation in task oriented strength training program in cerebral palsy population.

Conclusion

The task oriented strength training contributes to significant improvement in the stride length and cadence. In conclusion there is promising evidence for the efficacy of task oriented strength training in improving cadence and stride length in case of spastic cerebral palsy. And it should be the primary treatment of choice in spastic cerebral palsy. Children in task oriented strength training confirmed that there is increased stride length and cadence following intervention. The present study showed a positive effect of task oriented strength training.

Before intervention all children exhibited little to moderate walking and the less stride length and cadence. After intervention children received task oriented strength training displayed increased stride length and cadence.

GMFM scores too have showed improvement in standing and walking dimensions.

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