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Efficacy of Cold Therapy and Passive Stretching to Improve Gait in Spastic Diplegic Cerebral Palsy Children

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Abstract

Background

One of the most common causes of severe physical disability in childhood is cerebral palsy (CP). Mobility is one of the most important functions to fulfill the activities of daily living. We aimed to determine the effectiveness of cold application to improve the ambulation in spastic diplegic CP children.

Materials and Methods

In this clinical trial study, 40 subjects were included for the study. They were divided into two groups, namely experimental (n=20), and conventional group (n=20). Study was carried out in Holy Cross College, Department of Rehabilitation Science, Tiruchirappalli, India. Conventional group was given regular conventional training and experimental group was given cold therapy, passive stretching in both legs before training. Both groups received training for 45 minutes, 3 times a week for a duration of 6 weeks. Modified Ashworth scales were used to measure spasticity step length, stride length and Cadences were used to measure the gait parameters, and Timed Up and Go test (TUG) was used to measure the functional activity.

Results

Significant effect was observed in decrease in spasticity, there was increase in gait parameters and timed up and go test in two studied groups. The post-test mean values of all the variables of cold therapy, passive stretching in experimental group are improved compared with that of conventional group. The experiment improved with stride length, step length, cadence, timed up and go test and Modified Ashworth scale ($p<0.05$).

Conclusion

Based on the derived results, there was decreased tone in spastic muscles and improvement in gait parameters and functional ability in children with diplegic CP after application of cold therapy and passive stretching.

Key Words: Children, Cold Therapy, Diplegic Cerebral Palsy, Spasticity, Gait, Passive Stretching.

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1- INTRODUCTION

The term "cerebral palsy" (CP) describes a group of disorders of the development of movement and posture, causing activity limitations that are attributed to non-progressive impairments that occur in the developing fetal or infant brain (1). CP is the most common cause of childhood disability and is seen in 2–2.5 out of 1,000 births (2). Spasticity in children can result from any disease process that affects the upper motor neuron within the central nervous system. Injury to the upper motor neuron decreases cortical input to the downward reticulospinal and corticospinal tracts, resulting in weakness, loss of motor control, and decrease in volunteer motor unit numbers. Reducing these descending tracts removes the normal inhibition of the reflex arcs within the spinal cord's gray matter, resulting in a hyperactive reflex arc and spasticity. While in specific cases, there is no recognizable reason; typical causes include problems in intrauterine development (e.g. exposure to x-ray/ CT radiation or infection), asphyxia before birth, hypoxia of the brain, birth injuries during delivery and complications in the prenatal period or during childhood. Infections in the mother, low birth weight (less than 2.0 Kg) are risk factors for CP.

Also, between 40 and 50% of the children who develop CP are born prematurely. The premature infants are vulnerable, in part because their organs are not fully developed, increasing the risk of hypoxic injury to the brain that may manifest as cerebral palsy (3). Motor disorders are frequently observed in individuals with CP, along with disturbances of sensation, cognition, communication, perception, or behavior or seizure disorder, or both. Impairments in patients with cerebral paralysis is variable with a wide scope of physical disabilities prompting action constraints and support limitations (4). Complex motor problems such as abnormal gross motor functioning, abnormal fine motor functioning and abnormal motor control are the main features of CP and may lead to gait difficulties (5). Most of the children with CP exhibit a deviation in walking pattern such as stiff knee gait, crouch gait, increased hip flexion, in toeing or equinus (6). Equinus interferes with the gait cycle by decreasing stance stability and causing inadequate foot clearance during the gait cycle swing phase. An equinus deformity causes ambulation difficulty by causing the individual to have to strike first rather than heel strike in the gait cycle (4).

Gait problems may contribute to the negative cycle of physical latency, slowing down in walking function and physical de-conditioning. Reduced gait efficiency is also negatively associated with gross motor function and involvement in mobility-related activities, and may result in fatigue, which may further increase walking function deterioration. Given that gait is most inefficient in CP at the age of 12 and gross motor function skills deteriorate shortly after teenage age, targeted interventions during adolescence could interfere with this negative cycle (7).

The management of gait problems in CP is often difficult to treat and is also challenging. The interdisciplinary interventions addressing impairments that affect the patients' gait can be treated in four categories: orthopedic surgery, spasticity management, physical therapy and orthotics. Guided by the issues looked at by every child with CP, interventions should be individually planned to help the child and family to accomplish their objectives (6). Cold treatment is broadly utilized as a medicinal treatment and this strategy is utilized in the management of different acute and chronic conditions. There are many microscopic effects that are promoted by applying cold therapy such as reduced swelling and edema in injuries, increased local circulation,

decreased acute inflammation that follows tissue damage, decreased muscle spasm, and restriction of pain. Cold therapy can facilitate muscle contraction and can be used to improve muscle contraction to increase joint motion after injury. Another cold therapy impact is a period - related spasticity decrease once the ice has been applied for a long time. Cold therapy can be applied to the body in three different ways: submerge the part in cold water, scour ice cubes or ice packs, or use evaporative sprays like ethyl chloride. After spasticity reduction, the ability of muscles to function varies under different conditions. It is not always easy to treat spasticity to acquire undeveloped skills. The significance of physical and occupational therapy treatment for accomplishing functional goals cannot be overemphasized (8).

In the 1990s many methods such as intrathecal baclofen pump and botulinum toxin medication were introduced to reduce spasticity. In the same period, treatment such as selective dorsal rhizotomy was popular. These techniques made it imperative to quantify spasticity, both for analyzing indication and for effectiveness of treatment. They range from simple stretching to surgery from the treatment available. Nonsurgical options for improving gait in children with cerebral palsy are stretching exercises, bracing, casting, and botulinum toxin injections (9). The medicines used to reduce spasticity have their own side effects. Spasticity is a devastating manifestation of numerous common neurologic conditions. So a multi-disciplinary approach, with non-operative and surgical options, is required to adequately treat patients suffering from this condition (10). The study focuses on effect of cold application on the spastic muscle that tends to decrease the spasticity in it, by which children with CP would establish an improved gait pattern along with passive stretching. It is assumed that this will have an increased walking speed, increased functional activity that would be a help in improving activities of daily living. The present study aimed to determine the effectiveness of cold application to the spastic muscle and look for improvement in the gait parameters and quality of life in children with spastic diplegic.

2- MATERIALS AND METHODS

2-1. Study setting

This randomized study was performed in Holy Cross College, Department of Rehabilitation Sciences, Tiruchirappalli, India, from October 2018 to January 2019. The study participants were 40 children, aged between 4 and 12 years with diagnosis of spastic diplegic cerebral palsy.

2-2. Sample size

40 subjects (20 subjects in each group) who were referred to the physiotherapy department with the provisional diagnosis as Spastic Diplegic cerebral palsy were included in the study.

2-3. Inclusion criteria

Children with Spastic Diplegic cerebral palsy, aged between 4-12 years, both male and female were included in the study with Ashworth Spasticity grading from 1 to 3 (11).

2-4. Exclusion criteria

Children who underwent orthopedic surgery, injection of botulinum toxin, no oral pills or intratheceal myo-relaxing drugs; have no severe limits in the passive range of motion in lower extremities, no mental retardation. When diagnosed with ataxia, dystonia, children with CP were excluded. Present history of seizures and participation in other therapeutic programs except for physical therapy (11).

2-5. Outcome measures

Outcomes for the study were tested on the subjects before commencing the study. Same outcomes were retested after the study duration of 6 weeks. Modified Ashworth Scale was used to measure spasticity in the Hip adductors, Hamstrings, gastrocnemius and soleus muscles by assessing the joint angle at which a 'catch' occurred in a fast passive stretch (12).

2-5-1. Gait parameters (11)

Gait parameters were measured by applying color over the foot of the subject who were then made to walk on a white spread sheet. The imprints on the papers were taken to find the distance covered by the subject before and after treatment protocol for both pre and post values which were measured using measuring tape and stop clock.

Step length: Average distance covered in a step, either from heel to heel or toe to toe (11).

Stride length: Distance between two successive placements of the same foot (12).

Cadence: Number of steps per given time (13).

Timed up and go test: Is used to find the improvement achieved by the subjects in his/her functional ability. The patient starts in a seated position. The patient stands up upon therapist's command: walks 3 meters, turns around, walks back to the chair and sits down. The time stops when the patient is seated. The subject is allowed to use an assistive device if required (14).

2-6. Methodology

Cold gel backs were applied over both lower limbs of CP children. This protocol was carried out by skilled physiotherapist. Randomization was performed by physiotherapist who was not involved in evaluation and data analysis. The intervention was a physical exercise, so blinding of patient was not possible.

2-7. Procedures

2-7-1. Evaluative Procedures

The children with spastic diplegic CP were selected for the study by random sampling. Informed consent was obtained from the parents or guardians before study, explaining about the benefits and adverse effects of the treatment to be conducted. Prior to treatment session, Spasticity was assessed using Modified Ashworth scale, gait parameters and timed up and go test values were recorded as pre-test values. Children were assigned into two groups with 20 children in each group. One group was given conventional physiotherapy and the other group was administered with cold therapy followed with passive stretching to both the legs before conventional physiotherapy. After the treatment session the children wore their regular splints.

2-7-2. Treatment Procedures

Both groups were given physical therapy exercise. The children participating in the study were asked to stop anti spasmodic drugs or other medication that can cause changes in spam of muscles, before commencement of the study. Physical therapy was given for 6 weeks of duration for both groups.

2-7-3. Physical and Occupational Therapy Program

Subjects in the conventional group were given passive movement and passive stretching followed by a) sit to stand (**Figure.1**), b) seated marching, c) kicking ball with both legs one after another **(Figure.2),** d) use hands to lift their affected leg up into their chest (Hip flexion), and hold this position for a second and slowly bring their leg back down to its original position, e) from a seated position, extend the leg out in front, parallel to the floor, hold it as long as they can hold it, followed by the other leg. Each

exercise was repeated for 10 times followed by gait training in parallel bar. Each exercise session lasted 45 minutes.

Fig. 1: Sit to stand training.

Fig.2: Kicking the ball.

Subjects in the experimental group were administered with cold pack (**Figure.3**) for 20 min over Hip adductors, Hamstring and to gastrocnemius and soleus, after ice pack was removed the skin was dried. Passive stretching of each muscle was performed for three sets, five repetitions. Manual static stretches, holding for 60 sec separated by 30 sec rest, with 60 sec rest between sets (15), on both the legs were performed (**Figure.4**). The subjects were given conventional training followed by the above protocol before gait training (**Figure.5**). This was administered for 45 min each session. The treatment for both groups was conducted for 6 weeks, 3 sessions per week, 45 min each session. After 6 weeks of duration the children were tested and documented for the post test values (**Figure.6**), to look for the improvement in outcome measures.

2-8. Data Analysis

Statistical analysis was carried out using the SPSS software package version 21.0for evaluation; values were presented as means+ standard deviation, paired student t-test were used to analyze the effectiveness of pre and post treatment values of step length, cadence and timed up and go test. P-value less than 0.05 was statistically significant.

2-9. Ethical approval

The design of the study was approved by Ethical Committee, Holy Cross College, Tiruchirappalli, India (ID-code: 41253/2/2018). Additionally, this clinical trial study was registered in Thai Registry of Clinical Trials (registration ID: TCTR20190808001).

Fig.3: Cold packs application over spastic muscles.

Fig.4: Passive stretching of lower limb.

Fig.5: Gait training in parallel bars.

Fig.6: Assessment of Gait parameters using colored foot prints.

3- RESULTS

40 children with spastic diplegic cerebral palsy were recruited for the study (**Table-1**). The control group consisted of 12 males and 8 females with the mean age of 4.63 and standard deviation of 2.31. The Experimental study consisted of 11 males and 9 females with the mean age of 5.94 and standard deviation of 2.27. To compare the pre and post conventional groups paired t-test was used. Similarly, to compare Ashworth scale scores within group, Wilcoxon signed rank test was applied (**Table-2**). To compare the conventional and experimental groups, independent sample t-test was used and Mann-Whitney test was used to compare the post- test values of Modified Ashworth scale (**Table-3**). The result showed that there is significant improvement in the experimental group compared to conventional group ($p<0.005$).

Table-1: Baseline characteristics of the participants.

Variables	Sub-group	Control group	Experimental group
Gender	Male	12	11
	Female	08	09
Age, mean± standard deviation		4.63±2.31	5.94±2.27

Table-2: Gait parameters, Timed Up and Go test and Modified Ashworth scale of studied patients before and after the study.

Step length	Pre-test value		Post - test value		T- value	P- value
	Mean	SD	Mean	SD		
Conventional group	16.21	2.01	23.00	3.85	-12.609	0.000
Experimental group	15.84	3.45	30.31	9.09	-7.939	0.000
Stride length	Pre-test value		Post - test value		T- value	P- value
	Mean	SD	Mean	SD		
Conventional group	31.05	4.10	44.47	7.01	-15.087	0.000
Experimental group	30.89	5.46	59.15	17.11	-8.137	0.000
Cadence	Pre-test value		Post - test value		T -value	P- value
	Mean	SD	Mean	SD		

Conventional group	48.52	16.88	58.02	20.95	-7.633	0.000
Experimental group	54.52	12.55	89.31	26.41	-8.408	0.000
Timed Up and Go Test	Pre-test value		Post - test value		T- value	P- value
	Mean	SD	Mean	SD		
Conventional group	58.15	33.09	44.42	14.72	2.493	0.023
Experimental group	43.21	25.08	20.78	9.20	5.426	0.000
Ashworth Scale	Pre-test value		Post - test value		T-value	P- value
	Mean	SD	Mean	SD		
Conventional group	2.05	0.22	1.00	0.00	161.5	0.000
Experimental group	2.15	0.37	1.10	0.31	161.5	0.000

SD: Standard deviation.

Table-3: Gait parameters, Timed Up and Go test and Modified Ashworth scale of studied patients between Conventional and Experimental group.

Step length	Pre-test value	Post - test value	T value	P-value
	Mean ± SD	Mean ± SD		
Conventional group	16.21 ± 2.01	23.00 ± 3.85	0.402	0.690
Experimental group	15.84 ± 3.45	30.31 ± 9.09	-3.227	0.003*
Stride length	Pre-test value	Post - test value	T value	P-value
	Mean ± SD	Mean ± SD		
Conventional group	31.05 ± 4.10	44.47 ± 7.01	0.101	0.920
Experimental group	30.89 ± 5.46	59.15 ± 17.11	-3.460	0.001*
Cadence	Pre-test value	Post - test value	T value	P-value
	Mean ± SD	Mean ± SD		
Conventional group	48.52± 16.88	58.02± 20.95	-1.243	0.222
Experimental group	54.52± 12.55	89.31± 26.41	-4.041	0.000*
Timed Up and Go Test	Pre-test value	Post - test value	T value	P-value
	Mean ± SD	Mean ± SD		
Conventional group	58.15± 33.09	44.42±14.72	1.569	0.125
Experimental group	43.21± 25.08	20.78± 9.20	5.933	0.000*
Ashworth Scale	Pre-test value	Post - test value	Z value	P-value
	Mean ± SD	Mean ± SD		
Conventional group	2.05 ± 0.22	1.00±0.00	-4.264	0.000*
Experimental group	2.15 ± 0.37	1.10± 0.31	-3.879	0.000*

SD: Standard deviation.

4- DISCUSSION

The present study aimed to determine the effect of cold therapy and passive stretching on spastic diplegic children with CP and improve their quality of life. The intervention in the experimental group was six weeks of physical training, including cold therapy and physical training for children. Children with diplegic CP were administered with cold therapy and stretching. The results showed improvement in terms of functional abilities. The experimental group showed statistical significance ($p<0.005$) in means of gait parameters, Timed Up and Go test and decreased spasticity. It was also supported by a study performed by Gehan et al., the study stated that, applying cold therapy along with physical therapy can reduce spasticity and improve function in spastic CP when applied to elbow (16). Mirska et al. in their study stated that by using multiple botulinum injections, spasticity was decreased in muscle. These decreases in spasticity helped in improving ROM and also improving the functional abilities of children with spastic hemiplegic CP (17).

In another study, Tyler et al. stated that passive stretching is a mainstay of spasticity treatment, as it decreases the excitability of motor neurons and maintains flexibility. Also, the exercise improves motor control, strength, and overall function along with trunk, pelvic, and shoulder girdle muscles to control distal movements. The exercise may not directly reduce spasticity, but it does not worsen hypertonia, Additionally, weight bearing reduces spasticity, improves bone mineral density, enhances psychological health, and aids lung, bowel, and bladder function; all of these benefits are especially important to improve daily life for people with disabilities (10). In another study, Aycardi et al. studied the benefits of the CP children by applying the CP walker on them. They used gait parameters (step length, stride length and cadence) to compare their study benefits and it supports our study by using the gait parameters as tool of assessment (18). A study done by Rasmussen et al. states that in an interdisciplinary study, physical therapy was used as functional training of specific elements of the gait. Authors state that they used gait parameters such as step length, stride length and cadence as an outcome tool to measure the improvement in gait patterns (6). Noelle et al. in their review study state that many studies are conducted on gait analysis. Their main focus was on effectiveness of treatment that improved gait speed in ambulatory children with CP. In their review they that state that gait training was a more effective treatment in improving gait speed in children with CP. They conclude that strength training even when properly administered is not effective in improving gait speed. They suggest conducting further studies that would be helpful to improve the gait parameters (19). Along with supporting studies conducted on gait improvement techniques, the results show that there is improvement in the functional activity this is also supported by statistics values of the study.

4-1. Study Limitations

The study sample was too small to be generalized. The intervention of present study was carried out for 3 days a week, for a duration of 6 weeks. It was considered that duration of visit can be increased for better outcome.

5- CONCLUSION

The result of this study showed that there was significant statistical improvement in the gait parameters as a result of decreased spasticity and improved functional abilities in children with spastic diplegic CP. Conventional treatment too had improvement in all outcomes whereas the children administered cold therapy had remarkable improvement when compared.

The results suggest that children with diplegic CP can be advised to use cold therapy followed by passive stretching to improve gait parameters and that could help in their functional ability.

6- CONFLICT OF INTEREST

There were no conflicts of interests between the authors during the collaboration of this paper.

7- REFERENCES

1. Koen J.F.M. Dekkers, Eugene AA. Rameckers, Rob J.E.M. Smeets, Yvonne J.M. Janssen-Potten. Upper Extremity Strength Measurement for Children with Cerebral Palsy: A Systematic Review of Available Instruments. Physical Therapy. 2017; 94(5): 609-21.

2. Elanchezhian C and SwarnaKumari P. Physical therapy approaches to improve gait in cerebral palsy- a review. International Journal of Recent Scientific Research. 2018; 9 2(K): 24553-556.

3. Alireza Shamsoddini, Susan Amirsalari, Mohammad-Taghi Hollisaz, Alireza Rahimnia, Amideddin Khatibi-Aghda. Management of Spasticity in Children with Cerebral Palsy. Iran J Pediatr. 2014; 24 (4):345-351

4. Eli Saleh, Noe mi Dahan-Oliel, Kathleen Montpetit, Thierry Benaroch, Rita Yap, Nadia Barakat, and M. J. Mulcahey. Functional Gains in Children With Spastic Hemiplegia Following a Tendon Achilles Lengthening Using Computerized Adaptive Testing—A Pilot Study. Child Neurology Open.2018; Volume 5: 1-7.

5. Eva Swinnen, Laura Vander Goten, Berdien De Koster and Marc Degelaen. Thorax and pelvis kinematics during walking, a comparison between children with and without cerebral palsy: A systematic review. Neuro Rehabilitation. 2016; 38:129–146.

6. Helle Matzke Rasmussen, et al. The use of instrumented gait analysis for individually tailored interdisciplinary Study. Child Neurology Open.2018; 5: 1-7.

interventions in children with cerebral palsy: a randomised controlled trial protocol. BMC Pediatrics. 2015; 15(202):1-13.

7. Jennifer M Ryan, et al. Strength Training for Adolescents with cerebral palsy (STAR): study protocol of a randomised controlled trial to determine the feasibility, acceptability and efficacy of resistance training for adolescents with cerebral palsy. BMJ Open 2016; 6-012839:1-13.

8. Gehan M. Abd El-Maksoud, Moussa A. Sharaf, Soheir S. Rezk-Allah. Efficacy of cold therapy on spasticity and hand function in children with cerebral palsy. Journal of Advanced Research. 2011; 2:319–325.

9. Gunnar Hagglund and Philippe Wagner. Development of spasticity with age in a total population of children with cerebral palsy. BMC Musculoskeletal Disorders. 2008; 9(150):1-9.

10. Tyler S. Pidgeon, Jose M. Ramirez, Jonathan R. Schiller. Orthopaedic Management of Spasticity. R I Med J. 2015; 98(12):26-31.

11. Bar-On, et al. The Relationship between Medial Gastrocnemius Lengthening Properties and Stretch Reflexes in Cerebral Palsy. Front. Pediatr. 6:259:1-11.

12. Anna Mirska, Wojciech Kułak, Bożena Okurowska-Zawada, Elżbieta Dmitruk. Effectiveness of multiple botulinum toxin sessions and the duration of effects in spasticity therapy in children with cerebral palsy. Child's Nervous System.2019; 35:141–147.

13. Luis Felipe Aycardi, Carlos Andrés Cifuentes, Marcela Múnera, Cristina Bayón, Oscar Ramírez, Sergio Lerma, Anselmo Frizera and Eduardo Rocon. Evaluation of biomechanical gait parameters of patients with Cerebral Palsy at three different levels of gait assistance using the CP Walker. Journal of Neuro Engineering and Rehabilitation. 2019; 16(15):1-9.

14. Eli Saleh,et.al. Functional Gains in Children With Spastic Hemiplegia Following a Tendon Achilles Lengthening Using Computerized Adaptive Testing, A Pilot

15. Barbara M. Kalkman Lynn Bar-On Francesco Cenni Constantinos N. Maganaris Alfie Bass Gill Holmes Kaat Desloovere Gabor J. Barton Thomas D. O'Brien. Medial gastrocnemius muscle stiffness cannot explain the increased ankle joint range of motion following passive stretching in children with cerebral palsy. Experimental Biology. 2018; 103 (3) : 350-357

16. Gehan M. Abd El-Maksoud, Moussa A. Sharaf, Soheir S. Rezk-Allah. Efficacy of cold therapy on spasticity and hand function in children with cerebral palsy. Journal of Advanced Research. 2011; 2: 319–325.

17. Anna Mirska, Wojciech Kułak, Bożena Okurowska-Zawada & Elżbieta Dmitruk. Effectiveness of multiple botulinum toxin sessions and the duration of effects in spasticity therapy in children with cerebral palsy. Child's Nervous System. 2019; 35:141–147.

18. Luis Felipe Aycardi, Carlos Andrés Cifuentes, Marcela Múnera, Cristina Bayón, Oscar Ramírez, Sergio Lerma, Anselmo Frizera and Eduardo Rocon. Evaluation of biomechanical gait parameters of patients with Cerebral Palsy at three different levels of gait assistance using the CP Walker. Journal of Neuro Engineering and Rehabilitation. 2019; 16(15): 1-9.

19. Noelle G. Moreau, Amy Winter Bodkin, Kristie Bjornson, Amy Hobbs, Mallary Soileau and Kay Lahasky. Effectiveness of Rehabilitation Interventions to Improve Gait Speed in Children with Cerebral Palsy: Systematic Review and Meta-analysis. Physical Therapy. 2016; 96(12):1-18.