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"COMPARATIVE EFFECT OF CRYOTHERAPY WITH ACTION OBSERVATIONAL PHYSICAL TRAINING VERSUS PASSIVE SLOW SUSTAINED STRETCH WITH ACTION OBSERVATIONAL PHYSICAL TRAINING TO IMPROVE UPPER EXTREMITY FUNCTION IN CHILDREN WITH SPASTIC HEMIPLEGIC CEREBRAL PALSY"

Physiotherapy

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ABSTRACT

Background and Objective: Children with cerebral palsy face a variety of motor and sensory impairments that have an impact on their arm function. The comparative study was conducted to know the effectiveness of cryotherapy with action observational physical training versus passive slow sustained stretch with action observational physical training to improve upper extremity function on daily activities in children with spastic hemiplegic cerebral palsy.

Method: The 20 children with spastic hemiplegic cerebral palsy based on inclusion criteria were divided into Group-A and Group-B. The Group-A children received cryotherapy combined with action observational physical training and Group B children received passive slow sustained stretch combined with action observational physical training. The outcome measures such as Melbourne unilateral upper limb assessment scale (MUUL), and Box and block test (BBT) were measured before the intervention, at 10th session of intervention and at the 20th session of intervention. Duration of the intervention was for 4 weeks, one hour per session with 10 min rest within the treatment, five days a week.

Results: Subjects showed a statistically significant improvement in their upper extremity function in the activities of daily living in both the groups. The Group A showed greater mean difference in improving than Group B when the mean of Melbourne unilateral upper extremity assessment scale (MUUL) and Box and block test were analyzed between the group.

Conclusion: In this study of 4 weeks of intervention in combination of cryotherapy with action observational physical training has been proved to be more effective than in combination of passive slow sustained stretch with action observational physical training in improving upper extremity function on daily activities in children with spastic hemiplegic cerebral palsy.

KEYWORDS

Spastic hemiplegic cerebral palsy, cryotherapy, passive slow sustained stretch, Action observational physical training, Cerebral palsy, upper extremity function, Melbourne unilateral upper limb assessment scale, Box and block test.

INTRODUCTION

Cerebral palsy is a disorder of the development of movement and posture, causing activity limitations attributed to non progressive disturbances of the fetal or infant brain that may also affect sensation, perception, cognition, communication, and behavior.[1] Children with cerebral palsy face a variety of motor and sensory impairments that have an impact on their arm function.[2] Hemiplegic forms, characterized by a clinical pattern of unilateral motor and sensory impairment, constitute the most frequent expression of Cerebral palsy more than 38% of cases affects around 2 in 1300 live births and the second in term of prevalence, after diplegia, in premature infants around 20% of cases.[3]

Spasticity, one of the most common problems in children with cerebral palsy and a component of upper motor neuron syndrome. In spastic hemiplegic cerebral palsy usually there is an increasing asymmetry of upper limb movement observed on one side but not the other, extension of fingers when child is tipped sideways in the supported sitting position, the reduced movement, increased stiffness and abnormal posture. In severe cases the upper limb may remain almost immobile.[4]

The role of the multidisciplinary team in the management of spastic hemiplegic cerebral palsy has been well described, and physical therapy underlie the basic principles of treatment.[5] The aims of treatment is to improve function, to reduce the risk of unnecessary complication, to alleviate pain, and to assist with the maintenance of hygiene, dressing, and transferring.[6] Some of the Physiotherapy intervention to treat Spasticity and functional limitations includes cryotherapy, sustained stretching of longer duration and Action observational physical training. Local application of cold diminishes the resistance of spastic muscle and decrease clonus.[7] Cold application inhibits monosynaptic stretch reflex, changes the mechanical properties of muscles and lowers the receptor's sensitivity, thus inhibits spastic muscles, but the effect is short period. This could be suggested as one of the mechanisms of relieving spasticity by cold therapy.[8] Passive stretching is widely used for individuals with spasticity in a belief that tightness or contracture of soft tissues can be corrected and lengthened. There is limited evidence that manual stretching can increase range of movements, reduce spasticity, or improve walking efficiency in children with spasticity.[9] Evidence for the efficacy of passive stretching on individuals with spasticity is limited.[10]

Action observational physical training (AOPT) has become a new rehabilitative approach. It is now well-accepted that the observation of actions performed by others activates in the perceiver the same neural structures responsible for the actual execution of those same actions.[11] This type of training involves the observation of actions and repeated training on those actions by imitating them.[12] The effectiveness of Action observational physical training may be limited due to several factors, one of the factor is Spasticity. The efficiency of the AOPT can be enhanced when the specific treatment technique aiming to reduce the spasticity before AOPT. As there are limited studies found to find the combination of techniques aiming to reduce spasticity before AOPT and its influence on functional recovery. Hence the objective of this study is to compare the effectiveness of cryotherapy combined with action observation physical training versus passive slow sustained stretch combined with action observational physical training to improve upper extremity function on daily activities in children with spastic hemiplegic cerebral palsy.

METHODOLOGY

Randomized control trial with two groups- Group A and Group B. As this study involved human subjects the Ethical Clearance was obtained from the Ethical Committee. This study was registered for subject for dissertation under Rajiv Gandhi University of Health Sciences. Subjects were recruited and study was conducted at Outpatient Physiotherapy department of Kempegowda Institute of Physiotherapy and Kempegowda institute of medical sciences hospital, Bangalore. Subjects included were children with spastic hemiplegic cerebral palsy by neuro imaging techniques (computed tomography [CT] or Magnetic resonance imaging [MRI] diagnosed by neurologist, age group: 5 to 12 years, both male and female children, mild or moderate severity of upper limb disability i.e. active use of affected upper limb from poor active assist use to complete spontaneous use according to modified house functional classification system grade between 4 and 8, Children with upper extremity muscle strength (Manual muscle test) not lower than grade 3 in manual muscle testing, Modified Modified Ashworth scale (MMAS) grade 2, normal skin sensation of upper limb.[10,11,12] Subjects were excluded with severe spasticity, cognitive

impairment, athetoid, ataxic and mixed cerebral palsy, uncooperative subjects with reduced attention span, subjects with vision and hearing impairment, Mental retardation, previous orthopedic surgery in the upper limb, and on medications for Epilepsy. Subjects were divided into two groups by Simple random sampling method. Subjects who meet inclusion criteria were informed about the study and a written informed consent was taken from children parents. The intervention was explained to the subject/family members in the language understood by the subject /family members.

Procedure of intervention for Group A:

In this group the subjects were treated with cryotherapy combined with action observation physical training five days per week for total four weeks.

Cryotherapy:[13,14] The subject in a sitting position. The upper arm and entire forearm was exposed and skin sensation was assessed. The upper limb of the child was positioned on a pillow with the shoulder maintained in mild abduction and forearm in mid flexion and supination. Cold pack rapped in a wet thin towel was applied intermittently over the skin of the treated area for five minutes in each area. The treated areas were shoulder flexors, elbow flexors and wrist flexors of affected upper limb extremity. The cold pack was applied for 20 minutes 5 minute five minutes rest provided within the treatment interval. Immediately after cold application the subjects were trained for action observational physical training.

Action Observational Physical Training (Videos for action observation physical training):[3,15-17] This training was common in both the groups. The subject practiced repeatedly the actions they observed on video clips in which normal child performed actions of daily living with their upper extremities. The contents of videos for action observation related to upper extremity functions are composed of 20 actions related to the children's daily lives. The videos used in the training are recorded from the front, sides, and rear of the actions so that the subjects could observe movements in the actions in three dimensions. Upper extremity action videos were presented to the subjects in line with the levels of their functions. Each video was edited to a length of approximately 2 minutes and 30 seconds and was repeated 2 times so that the replay time of each video was approximately five minutes. List of tasks presented through video clips and seen by cases during action observation treatment are 1. Unimanual tasks: Grasping and moving an object in the horizontal plane, Grasping and moving an object in the vertical plane, Using a pencil to draw a line, Using the spoon, Turning the cards upside down, Putting coins into a money box, Opening and closing zippers; 2.Bimanual tasks: Grasping the key, putting it into a lock and turning it, piling up cups, manipulating a cube with both hands, removing bottle caps, fastening buttons, transferring the water into the cups, towel folding, playing with cars, opening and closing a jar, putting the hat, unwrapping the chocolate bar, using the tooth brush and tooth paste, putting on a schoolbag. The subjects in the action observation physical training group were instructed to sit comfortably on the chairs (with back rest) in the room and to observe the laptop screen or the projected video carefully. After observing the videos containing upper extremity functional actions, the children repeatedly should imitate the observed actions. The researcher was asked the subjects to observe the actions in the videos with concentration. The subjects in the action observation physical training group observed upper extremity functional actions with videos at normal speed, then twice at lower speed and then again at normal speed. Each video was lasted for 5 minutes, 2 videos was be presented for each training session. Subjects were asked to practice same actions for 10 minutes each task training with maximum 15 repetitions each task, 5times per week, for 4 weeks. Treatment time in action observation training is 30 minutes. Rest period of 5 minutes within treatment interval.

Treatment session is for one hour per session, five days per week for total four weeks.

Procedure of intervention for Group B:

[18] Subjects in this group were treated with passive slow sustained stretching with action observational physical training. Passive Slow Sustained Stretching was performed while the subject and therapist in sitting position. Therapist perform passively a slow sustained stretch for all shoulder flexors, elbow flexors and wrist flexors of affected limb with a hold of 30 seconds for each group of muscles for 5 times each. The duration of treatment session was 20 minutes. Rest time period five minutes rest within the treatment interval. Immediately after stretch application the subjects were trained for action observational physical training as same used in Group A.

Outcome Measurements:

The two outcome measurements such as Melbourne Assessment of Unilateral Upper Limb Function (MUUL) for measuring the functional independence of children in daily living, and Box and Block Tests (BBT) were used for measuring the upper limb dexterity. The outcome measures were assessed on the day 1st (Before), end of 2nd week (at 10th session) and end of 4th week (at 20th session).

1. Melbourne Assessment of Unilateral Upper Limb Function (MUUL):[19] The MUUL is an evaluative tool that measures unilateral upper extremity quality of movement in children with neurological impairments aged from 5 to 15 years. MUUL is a criterion-referenced test based on 16 items scored on a 3- to 5-point ordinal scale comprising tasks that are representative of the most important components of unilateral upper limb function (reach, grasp, release, and manipulation). Most items are further subdivided in 2 to 4 sub-items (total of 37 sub items) that represent an aspect of the required movement, such as range of movement, fluency, target accuracy, speed, and quality of movement. The total score can range from 0 to 122 points and can be converted to a percentage. The interrater reliability for the total score is 0.97 (ICC). Percentage of agreement of 32 sub-items varied between 35% and 95%. The intrarater reliability is also high (ICC 0.97).

2. Box and block test:[20,21] The box and block test (BBT) is a simple, useful method for evaluating upper limb functionality. Child was seated at a table, facing a rectangular box that is divided into two square compartments of equal dimension by means of a partition. Sixty cubes, 2.5 cm, wooden cubes or blocks were placed in one compartment or the other. The child was instructed to move as many blocks as possible, one at a time, from one compartment to the other for a period of 60 seconds. To administer the test, the examiner was seated opposite the individual in order to observe test performance. The BBT was scored by counting the number of blocks carried over the partition from one compartment to the other during the one-minute trial period. Higher scores on the test indicate better gross manual dexterity.

STATISTICAL METHODS

Descriptive statistics were used to calculate Mean, SD. Repeated measure ANOVA have been used to analysis the variables within groups. Independent 't' test have been used to compare the means of variables between two groups. The Statistical software SPSS 16.0 was used the analysis the data.

RESULTS

The analysis within the Group-A (Table-2) and Group-B (Table-3) shown that the mean value of MUUL Score and Box & Block Test score found statistically significant change when analyzed from pre measurement to measurement at 10th Session, and after 20th Session. These values are significant at df= 19 and $P<0.05$ level. This shows that the unilateraal upper extremity quality of movement in children is improved significantly in both groups.

Comparative analysis (Table-4, and Graph-1 &2) of mean value of MUUL Score and Box & Block Test score shows significantly difference in improvement when means of pre measurement, measurement at 10th Session, and after 20th Session were compared between the groups. The mean difference in improvement is found greater value in Group-A subjects than in Group-B subjects, which shows that the unilateral upper extremity quality of movement in children is improved significantly more mean difference in Group A children who received cryotherapy combined with action observation physical training than in Group-B children who received Passive slow sustained stretch combined with action observation physical training.

Table -1: Frequency and Percentage distribution of age and affected side in Group-A and Group- B

Affected Side Determination				
LEFT	14	70	13	65
RIGHT	6	30	7	35
Total N=20	20	100	20	100
	Group – A		Group - B	
	Frequency	Percentage	Frequency	Percentage
Age				
5 - 9 Years	11	55	10	50
10 - 12 Years	9	45	10	50
Total N=20	20	100	20	100

Table-2: Analysis of means of MUUL Score and Box & Block Test within Group-A

within Group-A	Pre Mean±SD	Multi Variate Test	Within Subject Effect	Between Subject Effect	Mean Difference	t' Value	df	Significance P value
MUUL Score								
Pre treatment	53.2± 5.75	**35.28***	**60.67***	**177.1***	**4.52**	**8.62***	**19**	**P<0.005****
At 10th Session	54.82± 5.57							
After 20th Session	57.72± 6.52							
Box & Block Test								
Pre treatment	20.5± 3	**41.02***	**59.57***	**128***	**6.4**	**8.51***	**19**	**P<0.005****
At 10th Session	23.45± 3.21							
After 20th Session	26.9± 3.69							

** Statistically Significant difference p<0.05; NS- Not significant; a. Pared t test.

Table-3: Analysis of means of MUUL Score and BOX & BLOCK Test within Group-B

within Group-B	Pre Mean±SD	Multi Variate Test	Within Subject Effect	Between Subject Effect	Mean Difference	t' Value	df	Significance P value
MUUL Score								
Pre treatment	48.91± 5.76	68.92*	23.28*	129.7*	2.17	1.42	19	P<0.005**
At 10th Session	49.00± 5.96							
After 20th Session	51.08±7.01							
Box & Block Test								
Pre treatment	19.05± 3.91	62.97*	65.76*	505.1*	4.55	9.85*	19	P<0.005**
At 10th Session	20.65±4.23							
After 20th Session	23.6±4.78							

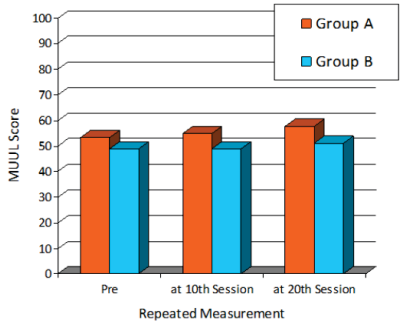
** Statistically Significant difference p<0.05; NS- Not significant; a. Pared t test.

Table-4: Comparative analysis of means of MUUL Score and Box & Block Test between Group-A and Group- B

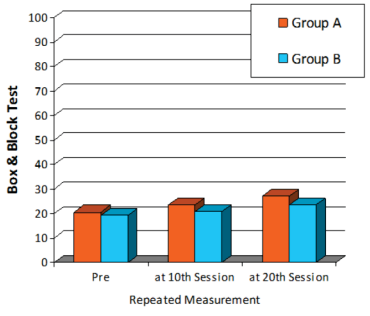
	Group -A	**Group -B**	**Mean Difference**	t value[a]	Significance P value
MUUL					
Pre treatment	53.2± 5.75	48.91± 5.76	4.29	2.85*	p=0.010**
At 10th Session	54.82± 5.57	49.00± 5.96	5.73	2.28*	p=0.003**
After 20th Session	57.72± 6.52	51.08±7.01	4.09	2.25*	p=0.003**
Box & Block Test					
Pre treatment	20.5± 3	19.05± 3.91	1.45	1.56	p=0.13 (NS)
At 10th Session	23.45± 3.21	20.65±4.23	2.8	3.88*	p=0.001**
After 20th Session	26.9± 3.69	23.6±4.78	3.3	4.41*	p=0.001 **

** Statistically Significant difference p<0.05; NS- Not significant; a. Pared t test.

Graph-1: Comparative analysis of means of MUUL Score between Group-A and Group- B



Graph-2: Comparative analysis of means of Box & Block Test Score between Group-A and Group- B



DISCUSSION

The finding of this study based on statistical analysis shown that the both the combined techniques in Group-A who received cryotherapy combined with action observational physical training and Group-B who received passive slow sustained stretch combined with action observational physical training shown statistically significant improvement in upper extremity function on daily activities when measured using MUUL Score and Box & Block Test score in children with spastic hemiplegic cerebral palsy. The Group-A subjects found greater improvement with higher mean difference than Group-B subjects.

The improvement in both groups in upper extremity function on daily activities could be due to the effect of action observational physical training. This training involves the observation of actions performed by others activates in the perceiver the same neural structures responsible for the actual execution of those same actions. Areas involved with this action observation–action execution matching system are known as the mirror neuron system.[11] This type of training involves the observation of actions and repeated training on those actions by imitating them. This training is closely related to observational learning and imitation and has been introduced for effective induction of neuroplasticity by doubling the effects of task training. A number of studies carried out with different neurophysiological and brain imaging techniques have shown that this system plays a role in action understanding, intention coding, and imitation.[12] Kim JY et al., conducted a study on the effect of action observational physical training on the upper extremity function in children with cerebral palsy. The study concluded that greater positive effects were seen on upper extremity in children with cerebral palsy in response to action observational physical training compared to simple physical training.[15] Basu AP et al., conducted a study on early Intervention to Improve Hand Function in Hemiplegic Cerebral Palsy. The study concluded that, at present the role of action observation therapy though intuitively 15 appealing as a natural way of learning through watching and copying, remains to be established.[2] Buccino G et al., conducted a study on improving upper limb motor functions through action observational treatment in children with cerebral palsy. The study concluded that action observational training appears a promising rehabilitation tool in children with cerebral palsy, well grounded neurophysiology and easy to apply.[16] Kraskov A et al., conducted a study on the role of inhibition in action observation treatment. The study concluded that action observational therapy is a promising therapeutic tool which deserves closer investigation on a bigger scale. It can potentially benefit not only patients but be very helpful in revealing functional properties of action observation network and its relation to the action execution network.[9] Sgandurra G et al., conducted a study on effects of upper limb children action observational training in hemiplegic cerebral palsy was assessed using Melbourne assessment scale and they concluded that action observational physical training can improve upper extremity function in children with hemiplegic cerebral palsy.[17] Therefore in the present study, the improvement in upper extremity function on daily activities that was measured using MUUL Score and Box & Block Test score in children with spastic hemiplegic cerebral palsy could be due to the effect of action observational physical training given to children for four weeks period.

The Group-A subjects found greater improvement with higher mean difference than Group-B subjects. This improvement in Group-A subjects could be due to the effect of cryotherapy on Upper limb spasticity which shown great effect than passive slow sustained stretch. Many studies had found the effect of cryotherapy in Spasticity. El-Maksoud GM et al., conducted a study on efficacy of cold therapy on spasticity and hand function in children with cerebral palsy and concluded that cold therapy was effective in reducing spasticity and improved hand function.[13] Akinbo SR et al., conducted a study on comparison of the effect of neuromuscular electrical stimulation and cryotherapy on spasticity and hand function in patients with spastic cerebral palsy and concluded that Cryotherapy and NMES were found to be effective and generally well tolerated by the patients. The study revealed that cryotherapy was not superior to NEMS and vice versa in the treatment of patients with spastic CP.[14] Similarly, there are studies found the effectiveness of passive slow sustained stretch. Tremblay F et al., conducted a study on prolonged muscle stretch and voluntary muscle activations in children with spastic cerebral palsy and concluded that prolonged muscle stretch was found to be effective as it reduced spasticity in children with spastic cerebral palsy movements, delays in reaching motor skills milestones, a crouched gait, a scissors-like gait with knees crossing or a wide gait, Excessive drooling or problems with swallowing, difficulty with sucking or eating, delays in speech development or difficulty speaking, difficulty with precise motions, such as picking up a crayon or spoon.[18]

Therefore there are no studies found the comparative effect of cryotherpy and passive slow sustained stretch in spasticity, hence in our present study the greater mean difference between Group- A could be due to the effect of application of cryotherapy which inhibits monosynaptic stretch reflex and lowers the receptor's sensitivity, thus inhibits spastic muscles, and changes in the mechanical properties of muscles after the application of cryotherapy could also contribute to decreased spasticity. Whereas the passive stretching has limited evidence on its effectiveness in increase range of movements, reduce spasticity, or improve walking efficiency in children with spasticity.[18] It appeared that sustained stretching of longer duration was preferable to improve range of movements and to reduce spasticity of muscles around the targeted joints.

The results obtained in this study shows that the application of cryotherapy and action observational physical training showed significant greater improvement than passive slow sustained stretch and action observational physical training.

LIMITATIONS OF THE STUDY

The study was conducted on wide range of age group children between 5 to 12 years, the action observational physical training was not standardized specific to age group but few recorded videos used by matching the common functional activities based on individual child ability to perform activities. No long term follow up was carried out to assess whether subjects retained the gained improvement after 4 weeks of intervention. The study did not consider the severity of spasticity, influence of abnormal movements during intervention which may influence the outcome.

RECOMMENDATION FOR FUTURE RESEARCH

Further study is needed to find the effectiveness of action observational physical training with standardized video graph specific to the child age and abilities. Further study can be conducted in combination of different techniques used to reduce spasticity. Further study can be carried to find the effectiveness using different standardized outcome measured in different types of hemiplegic cerebral palsy.

CONCLUSION

In this study of 4 weeks of intervention in combination of cryotherapy with action observational physical training has been proved to be more effective than in combination of passive slow sustained stretch with action observational physical training in improving upper extremity function on daily activities in children with spastic hemiplegic cerebral palsy.

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Conflicts of interest: None

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