Combined Effect of Static and Dynamic Splints on Grip Strength and hand Functional performance in Children with Hemiparetic Cerebral Palsy

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Abstract

Background: Cerebral palsy is a common condition that has devastating effects on a child's ability to use hands. Either static or dynamic hand splints intervention often used to address deficits in upper limb skills. **Aim**: the purpose of the current study was to investigate the effect of combining both dynamic and static splints on improving hand function and grip strength, in children with hemiplegic Cerebral palsy. **Subjects and Procedures**: Twenty-four children (8 boys and 16 girls) ranged in age between 30 to 45 months old, free from contractures at the wrist or elbow joints, were participated in this study. They were randomly assigned equally into control group (that was treated by static splint) and study group (that received a combined dynamic and static splinting) Evaluation of hand grip strength using handheld dynamometer and hand function performance detected by Peabody was done at baseline and after 12-weeks of treatment application, **Results**: Post treatment mean values of grasping and object manipulation skills showed a statistically significant difference($p>0.05$) within and between control and study groups while mean value of grip strength showed insignificant difference in grip strength($p<0.05$) between both groups. **Conclusion**: Combined effects of dynamic and static splint have been appeared to be most beneficial on improving hand function in children with hemiplegic CP .

Keywords: static, dynamic splinting, cerebral Palsy, hand function performance, grip strength.

Introduction:

Cerebral palsy (CP) is a group of disorders that is attributed to non-progressive disturbance occurred in the developing fetal or infant brain that is causing activity limitations due to disorders of the development of movement and posture, that [1]. Up to 60% of children with cerebral palsy CP having hemiparesis or quadriparesis. Experience physical limitations, including those challenges related to upper limb skills that impact on a child's ability to participate in age-appropriate activities.[2,-3].The presence of spasticity in the upper extremity (UE) of these children often results in 1) stereotypical movement patterns of internal rotation of the shoulder, 2) elbow flexion with pronation of the forearm, 3) ulnar deviation and flexion of the wrist, and 4) thumb-in-palm and/or finger-swan neck deformities[4].CP Children with CP that may have neuromuscular disorders have that may result in difficulty in developing grip, pinch, and manual dexterity which are primary hand functions that support one's daily activities [5] .

Treatment interventions are used to assist with developmental meaningful skills by selecting and sequencing the appropriate treatment strategies to meet the needs of the client and be successful in the function or task [2]. The therapeutic intervention includes therapeutic exercise and strengthening, neurodevelopmental treatment (NDT), therapeutic handling, sensory integration (SI) and sensory processing disorder (SPD), modified constraint-induced Movement Therapy (mCIMT), electricl stimulation (ES), hand splinting and task-specific training and community programs [2-6]. Several factors help determine the desired treatment approach or treatment technique when working with those children with CP. The severity of the child's impairments, their functional limitations, as well as the child and family's goals all influence the design of an effective treatment plan.[6] Hand splints or orthoses as removable external devices are designed to support a weak or ineffective joint or muscle as removable external devices [7] . According to

the International classification of Functioning, Disability and Health (ICF) framework, hand splints may be under an environmental aspect as a physical support influencing the overall interaction of ICF domains that can may have impact on a child's body function and structure as well as on activity and participation[8]. In children with CP and brain injury, a variety of splints made from various materials are used in clinical practice, but with two overarching purposes. The first type are non-functional hand splints or static hand splints, which are designed to prevent or correct muscle contracture[9] so improving outcomes in the body function and structure domain of ICF [10]. The second type of hand splint are functional hand splints or dynamic hand splints, which are designed to promote optimal functional activities performance via optimal upper limb positioning for task performance [11], and for the primary purpose of improving outcomes in the activity and participation domain of the ICF[12], such as handwriting or utensil use during meal times. Static hand splints were are worn either at night or for short periods of time while dynamic hand splints are therefore worn during tasks or activities [8]. A systematic review of the evidence suggests that the use of static or resting splints as a therapeutic modality for children with neurological conditions as cerebral palsy to maintain or prevent joint mobility is not effective, although it continues to be utilized for this purpose and evidence continues to be unclear[13].

Although insufficient evidence exists to support or counter that functional hand splints provide a longer-term training effect [14] and that the gains experienced during splint wearing are eventually generalized and carried over to hand function when the splint is not in use and also there is limited rigorous evidence available regarding the use of dynamic hand splints for children with neurological conditions[8].

So the aim of this study was to detect study the combined effect of dynamic and static hand splints on hand functions performance and grip strength in children with hemiplegic CP.

Subjects and procedures:

The purpose of the study was clarified to the participants and their parents before their participation. All parents signed a consent form indicating their approval for their children participation in the study. The study was conducted after the approval of the Ethical Review Committee of the Faculty of Physical Therapy, Cairo University.

1-Subjects:

Twenty four spastic hemiparetic cerebral palsied children of both sexes with cerebral palsy were ranged in age between 30 -to 54 old months, had with spasticity grade II according to modified Ashworths scale participated in the current study. They were selected according to the following inclusion criteria: 1) able to understand and follow orders, and 2) can grasp pellet with thumb and index fingers and drops it into a cup (. They had no contractures, or fracture, or burn and or didn't have Botox injection three months before the starting the study. They were selected from Outpatient clinic- of Faculty of Physical Therapy- Cairo University. 2- **Evaluation Procedures**:

a- Detection of hand grip strength:

Hand held dynamometer which is reliable and valid in measuring hand grip strength was used in the current study. in children[15]. Each child were was asked to seated sit on an armchair with legs are supported on the ground and, with forearms rested on the arms armrest of the chair., The child was asking asked to hold the dynamometer with the hand that was placed free from the arm support of the chair and sequeeze with maximum possible strength by squeezing the calibrated dynamometers firstly with the noninvolved uninvolved hand firstly then with the involved hand then with involved hand .

Each trial was repeated for 3 times and take the mean of repetitions (Trials was calculated). The procedure was performed according recommendations made by the American Society of Hand Therapists (ASHT)[7].

B_Hand function performance:

Object manipulation and grasping skills were measured hand functions by using Peabody Developmental Motor Scales (PDMS-2). Object manipulation includes 24 subtest items measure a child's ability to manipulate balls, while, Grasping includes 26 subtest items that measures a the child's ability to use his or her hands. Each subtest must was be repeated up to three times for each item if needed, to give the child an opportunity to achieve a maximum score on the item. Each item was scoring scored is based on our judgment the child's performance, and the specific criteria provided for each item as 2; the child performs the item according to the criteria specified for mastery, 1; the child's performance shows a clear resemblance to the item mastery criteria but does not fully meet the criteria, and 0; the child cannot or will not attempt the item, or the attempt does not show that the skill is emerging[10].

Treatment procedures: Splints children who subjected to the inclusion criteria were randomly and equally assigned into control and study groups by using lottery method. Each child in both groups received his conventional physical therapy treatment program based on the intial therapist evaluation. In this study, two types of splints were used. The static thermoplastic wrist thumb neoprene splint was designed as a wrist thumb splint made with thermoplastic material that to maintain 20º , the wrist in extension 20º , and in10° ulnar deviation 10º with30º 30º-to 45º flexion of metacarpophalangeal and proximal interphalangeal joints, and the thumb was placed in s abduction and opposition that was applied for the children in

the control group for 8hours per day for3 months. The second type splint was dynamic cockup splint, that was a foam padded aluminum splint that was fabricated with 20 degrees of wrist extension and molded according to the grip of arm, springs attached to keep the fingers in extension, malleable extended rod holds fingers in extension and allowed 30 degrees of movement atthe wrist. This splint was applied for patients in the study group at frequency of day time with alternation with the static splint at frequency of night time.

Procedures

Before the study, parents of children were instructed with aim and steps of the study and assigned an informed consent. The selected children were randomly and equally assigned into group I and group II by using lottery method. During the first session, children were fitted with custom static and dynamic splints fabricated by the research team. Because the control children used static splint only, two splints were fabricated for involved hands, for a total of two splints.

The participants with CP had splints fabricated for only the hand with spasticity.Active and passive range of motion (ROM) for major joint actions at the shoulder, elbow, and wrist were recorded to rule out contractures as outlined in exclusion criteria.

Statistical analysis:

Data obtained from both groups pre and post treatment regarding Peabody Developmental Motor Scales (PDMS-2)- object manipulation and grasping- and grip strength were statistically analyzed and compared.

Twelve children with spastic cerebral palsy were included in each group. Their mean ± SD age was 44 ± 10.2 months(table 1).

Table 1: Demographic data

	Control group	Study group	p- value
Age(months)	41.83 ± 8.58	44 ± 10.2	0.57 (NS)

Sex(boys/ girls)	6 /6	4/8	0.4 (NS)

Mean values and standard deviations for object manipulation, grasping skills and grip strength of the involved hand in both groups are displayed in Table (2). Control and study children demonstrated significantly greater grip with no significant difference between them. While there were significant differences between them regarding hand manipulation and grasping skills

Table 2: Mean values of object manipulation, grasping score, and grip strength of both groups

		Control group X±SD		Study group X±SD	MD	p- value
Object manipulation	**Standard score**	**pre**	2.5 ± 0.79	2.25 ± 0.62	0.88	0.82
		post	3.16 ± 0.71	3.91 ± 0.9	-0.75	0.03*
		MD PC p-value	-0.66 26.4 0.01*	-1.66 73.77% 0.0001*		
	Age equivalent	pre	14.58 ± 1.92	14.75 ± 1.76	-0.17	0.82
		post	14.58 ± 1.92	15.83 ± 1.85	-1.25	0.009*
		MD PC p-value	-0.66 26.4 0.01*	-1.66 73.77% 0.0001*		
Grasping	**Standard score**	pre	1.16 ± 0.38	1.33 ± 0.49	-0.17	0.88
		post	1.66 ± 0.77	2.41 ± 0.79	-0.75	0.02*
		MD PC p-value	-0.5 43.1% 0.007*	-1.08 81.2% 0.0001*		
	Age equivalent	pre	7.25 ± 0.45	7.5 ± 0.52	-0.25	0.22
		post	1.66 ± 0.77	2.41 ± 0.79	-0.75	0.02*
		MD PC p-value	-0.5 43.1%0.007* 	-1.08 81.2% 0.0001*		
Grip strength (bar)		pre	0.035 ± 0.016	0.039 ± 0.015	-0.004	0.53
		post	0.061 ± 0.016	0.074 ± 0.022	-0.013	0.13
		MD PC p-value	-0.026 74.28%0.0001* 	-0.035 89.74% 0.0001*		

Pre: before treatment post: after treatment MD: mean of difference PC: percentage of change *: significant

Discussion

The aim of this study was to evaluate the combined effect of using dynamic and static hand splints on hand grip strength and functional performance of children with hemiplegic CP. Because of limited evidence supporting use of splints has resulted in continued controversies as to the efficacy of splint use: whether or not to splint, how long to wear a splint, and what type of splint design to use [16]. Despite these controversies, splinting remains a practice that is used to treat adults and children with spastic hemiplegic CP.

The method used in this study may be beneficial due to combination using of dynamic splint which has moving parts that allowed the individual to practice a range of voluntary controlled movements, so it has been proposed to prevent contractures while allowing opposing antagonist muscle force to counter the force of the spastic muscle, following it by static splint allowed to keep the range of motion through stabilization [17] . Also to reach to the target purpose of the current study, the selected sample age to be younger than four years before developing of mature grasp and secondary problems to spasticity. Improvement in both control and study groups hand function performance may be attributed to the effect of using both static and dynamic splints, as although much evidence suggests that spasticity and pathological flexor patterning in the upper extremity is a result of cortical disinhibition, the effects of splinting on spasticity were clinically important, and there was a common belief that hand splinting reduces spasticity [18].

The statistical significant difference between both groups after treatment application results of both groups of children would demonstrate increased grip strength and improve hand grasping and object manipulation scores when wearing dynamic and static wrist hand splints and when wearing static wrist splints only in favor to the study group. The new technique appeared to demonstrate a greater impact on hand function in those children who were

treated than those with static splint only, however, there is no difference between them in grip strength.

The grasping and object manipulation scores might be enhanced by using dynamic splint which can be an effective intervention for the hemiplegic wrist on improving passive range of motion specifically in persons with unbending joint stiffness, severe contracture, or high levels of spasticity.[19] Combination between static and dynamic splints The difference seen with the hand grip in children of both groups in the study may be the resulted in of the wrist stabilization by the static splint while the dynamic splint allowed and hand function training. It was found that increase shoulder muscle activity was recorded with the static splint condition as compared with the dynamic splint.

This shoulder activation may reflect an increase of muscle activity proximal to the joint that is fixed or immobilized[16], also recruitment of muscle activity was more dependenton the task than the type of splint [20]. Results of our study suggest that no significant differences in grip strength were found between groups which mean using of static splints did not decrease activation at the wrist or lead to more shoulder muscle activity. **Jansen et al**.[20] suggested that with the splints either static or dynamic , persons may be straining themselves to obtain the same maximum gripstrength to overcome any restrictions made by the splints, showing no differences between them.

Conclusion

The technique of using combined combination between Dynamic S and Static Splints has been appeared the most beneficial to functional performance of children younger than 4 years with hemiplegic CP and this may be an obvious area for future research. In addition, it may be expedient to conduct a dose response study in order to optimize treatment parameters. Limitations of this study were, small numbers included in regard to age,

diagnosis and motor abilities, and age of selected children is very young that make difficulty in prescription of dynamic splint use as they have short attention spans and little or no understanding of the need for therapy or its aims, and less tolerance. Declaration of interest: The authors declare that they have no competing interests

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Conflict of intrest.

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