

# The Effect of Prefabricated Neoprene Hand Splint on Grip Strength and Hand Dexterity in Children with Hemiplegic Cerebral Palsy: A Pilot Study

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Received date: Nov 15, 2016; Accepted date: Nov 07, 2017; Published date: Nov 14, 2017

Citation: Mirbagheri SS, Gharebaghi S (2017) The effect of Prefabricated Neoprene Hand Splint on Grip Strength and Hand Dexterity in Children with Hemiplegic Cerebral Palsy: A Pilot Study. *Pros Orth Open J* 1:16.

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## Abstract

**Introduction:** Cerebral palsy is a disorder of movement and posture that is caused by a non-progressive and permanent damage to the immature brain. Splints are often using to prevent deformity, supporting affected limbs, positioning, decreasing spasticity, immobilization, and to help hand functions such as grip, pinch-and release objects.

**Material and methods:** Six children with hemiplegic cerebral palsy (4 boys, 2 girls) aged 8 to 13 years old were included in this study. Grip strength and hand dexterity were determined using Digital hand Dynamometer and 8th subtest of Bruininks-oserestsky test of Motor Proficiency Measure (BOTM) in respect, with and without prefabricated hand neoprene splint on a session.

**Results:** No significant difference was observed in grip strength between the ones without splint ( $4.83 \pm 3.92$ ) and with splint ( $5.4 \pm 6.18$ ), ( $p=0.345$ ). A manual activities without splint ( $4.83 \pm 3.92$ ) did not significantly differ from the splint- worn ( $5.83 \pm 3.6$ ) one ( $p=0.343$ ), as well as bimanual activities did not statistically significant difference without splint ( $2.16 \pm 1.6$ ) and with splint ( $2 \pm 1.26$ ) ( $p=0.1.705$ ). The comparison of the mean total score in the 8th subtest of Bruininks-Oseretsky, demonstrated no statistically significant difference ( $p=0.458$ ).

**Conclusion:** This study is pilot study and this sample size cannot show effect of prefabricated splint on grip strength and dexterity, so this pilot study showed defect of study that it should be considered in large sample size and obtain more exact conclusion.

that occurred in the developing brain [1-3]. There are significant functional limitations in 80% of the upper limbs of individuals with hemiplegic or quadriplegic CP [4]. Upper limb spasticity in this children lead to certain motor patterns including; 1) shoulder medial rotation, 2) elbow flexion with forearm supination, 3) wrist flexion and ulnar deviation and 4) swan neck and thumb-in-palm deformities [5]. The motor disorders of CP caused by the spasticity result in the decrease of joint range of motion, grip strength and hand manipulation skills [6].

Orthoses and splints are commonly used to improve hypertonicity of children with cerebral palsy [7], to prevent the spastic muscle shortening and deformities [4], to protect the involved extremity, positioning, immobilization [7], and to support motor control functions such as grip, pinch and release of objects [8]. Common static and dynamic splints which respectively provide complete joint immobilization and appropriate position with slight movement [5]. Dynamic splints permit controlled voluntary movements and may prohibit muscle shortening while activate antagonist force in order to resist spastic muscles [5,9].

Several case studies have indicated functional changes by using static splints in children with cerebral palsy [10,11]. Grip strength, dexterity and thumb active range of motion, have increased on account of these splints [12]. However static splints are rigid and immobilize the affected joint [5]. The hand splints in this study were made of soft material and might be biomechanically effective via appropriately positioning the wrist [13,14].

Former studies advocate the use of dynamic orthoses in children with cerebral palsy however there are a few studies on appraising the effect of prefabricated Neoprene orthoses on the hand function and skills of children with cerebral palsy.

No study assessed hand motor efficiency after using prefabricated Neoprene splint with Bruininks-oserestsky test of Motor Proficiency Measure (BOTM) in the children with CP. The purpose of the present study is investigating the effect of prefabricated Neoprene splint on hand grip and dexterity in children with cerebral palsy.

**Keywords:** Hand splinting; Cerebral palsy; Muscle strength

## Introduction

Cerebral palsy is a disorder of movement and posture that is caused by a non-progressive and constant (permanent) deficit

## Materials and Methods

This quasiexperimental study addressed the analysis of differences in grip strength, hand and fingers dexterity before and after wearing Neoprene splints. The sample was conveniently selected using non-probability sampling methods, consisted of hemiplegic children admitted to Farshchian Hospital and Sheikoreese day clinic in Hamadan City.

The inclusion criteria were 6-14 years old educable hemiplegic children diagnosed by the related specialist, having the 1<sup>st</sup> and 2<sup>nd</sup> levels of the Manual Ability Classification System reported by the occupational therapist and appropriate collaboration of the participant and his/her family. Clients with fixed contractures or orthopedic surgeries and medication for decreasing spasticity through the recent 6 months and other neurological defects (seizure, visual deficits etc.) were excluded. All of children with CP receive exercise of occupational therapy.

The Human Research Ethics Committee of the Hamadan University of medical Sciences approved the study protocol. Prior to participating, all parents of the participant children read and signed the consent form.

Grip strength and hand/fingers dexterity were assessed randomly using Digital hand Dynamometer and 8th subtest of Bruininks-Oseretsky in respect, with and without hand splint on a session (immediate effect) by a non-researcher.

All participants were positioned equally for the proximal joints during the session. Subjects were sited on chair with neutral shoulder adduction and rotation, 90° flexion of the elbow, and forearm and wrist in neuter on arm rest [15], and asked to carry out the movement with maximum strength while the examiner is holding the device. After three trials, the mean rate is recorded.

Each trial lasts 3 second, with a 10-second interval as rest. In assessing the strength, the client grips the dynamometer with thumb facing the fingers and fingers alongside each other.

The subtest of the upper limb agility and dexterity in Bruininks-Oseretsky consists of 8 items.

Three items for bimanual activities (putting two coins in two boxes with hands, string beads and sorting cards) and remaining ones for a manual activities which are separately analyzed.

As intervention, a prefabricated Neoprene splint covers two-third of the forearm elongated distally to metacarpophalangeal joints while the thumb is free. This prefabricated splint has a volar thermoplastic bar so as to provide 20° wrist extensions.

This orthosis aims to improve the position of the hemiplegic child's affected hand (wrist flexion, ulnar deviation). If the child was bored with the implementation, he/she took a rest for a while, so on that session the grip strength and hand dexterity were tested after wearing the splint. The immediate effect of the prefabricated Neoprene splint was evaluated before and after the coverage of splint.

## Statistical method

Statistical analysis was completed through wilcoxon test using spss 16 software.

## Results

Six children with hemiplegic cerebral palsy (4 boys, 2 girls) with a mean age of  $9.5 \pm 2.07$  were included in this study (Table 1).

No significant difference was observed ( $p=0.345$ ) in grip strength between the ones without splint ( $4.83 \pm 3.92$ ) and with splint ( $5.4 \pm 6.18$ ). A manual activities without splint ( $4.83 \pm 3.92$ ) did not significantly differ from the splint- worn ( $5.83 \pm 3.6$ ) ones ( $p=0.343$ ), as well as bimanual ones without splint and with splint ( $2.16 \pm 1.6$ ), ( $2 \pm 1.26$ ) in respect ( $p=0.705$ ). The comparison of the mean total score in the 8<sup>th</sup> subtest of Bruininks-Oseretsky test, demonstrated no statistically significant difference ( $p=0.458$ ) (Table 2).

**Table 1:** Demographic data of the participants.

Participants	Gender	Age	MACS	GMFCS
1	male	8	2	1
2	male	10	2	1
3	female	10	2	1
4	male	7	1	3
5	male	13	1	1
6	female	9	2	1
Mean (standard deviation)		9.5 (2.07)		

**Table 2:** Comparison of the variables with and without Neoprene splint (Wilcoxon Test).

Variable	Without splint Mean (N=6) (SD)	With splint Mean (N=6) (SD)	p value
Grip Strength (kg)	4.62 (2.84)	5.4 (6.18)	0.345
A manual activities function	4.83 (3.92)	5.83 (3.60)	0.343
Bimanual activities function	2.16 (1.6)	2 (1.26)	0.705
Manual dexterity	7 (5.29)	7.83 (4.66)	0.458

## Discussion

The aim of this study was to investigate the effectiveness of prefabricated Neoprene splint on grip strength and hand dexterity in children with hemiplegic cerebral palsy. Application of dynamometer in order to measure the muscle strength in children with cerebral palsy was addressed in former studies which [16,17] indicated defect in muscular strength of these children. Muscle strength is effective in upper limb function of children with cerebral palsy [18,19].

The results of this study demonstrated no significant difference in grip strength with and without splint, although according to the **Table 2**, the mean of grip strength has increased. Patricia et al compared the effect of static splint with the dynamic one on grip strength and hand dexterity in children with hemiplegic cerebral palsy [5]. Results indicated that dynamic splints increased grip strength and hand dexterity significantly, however fine motor strength was higher without using splint than both with static and dynamic one. Thermoplastic static splints also decreased the electrical activity of the forearm muscles while increased the shoulder muscles. This study suggests the use of thermoplastic spiral dynamic splint which improve grip strength and hand dexterity [5].

Barroso et al. [14] evaluated the effect of a wrist extending/thumb abduction (WETA) orthosis with a volar thermoplastic bar on the range of motion of the trapeziometacarpal joint and grip strength and manual ability. The results showed significant increase in cylindrical grip, which could be result of wrist extension imposed by the splint.

In the present study, a prefabricated Neoprene splint with a thermoplastic bar was applied in the volar surface of the affected hand. Although no significant increase was observed in grip strength, the mean of grip strength with splint was increased.

As the size of children's hands differs from each other, splints should be customized according to child's hand in future studies. Patricia et al. investigated the impact of three positions (without splint, with dynamic and static splint) on hand dexterity of children with cerebral palsy by Purdue Pegboard Test; significant decrease was observed in testing time with dynamic splint than static one and without splint.

Louwers evaluated the immediate effect of wrist and thumb splint on bimanual activities of hemiplegic children, which resulted in significant improvement of bimanual activities [20].

In our study, no significant difference was obtained in hand dexterity (8th subtest of Bruininks-Oseretsky) with splint as well as a manual and bimanual item. Although a manual function with splint has insignificant increase. In this study a manual activities (pick up coins, draw the vertical line, was done with involved hand and according to this is a pilot study, maybe with increasing time using of splint, the well result was observed. there is no change in bimanual one. Maybe this is to because of the children was done bimanual activity with healthy hand and no increase was shown.

One of the limitations was that the clients were often below 6 years old and it was difficult to fabricate custom-made splints. Small prefabricated splints were also inappropriate for 6-9 years old children.

## Conclusion

According to this study is pilot study and this sample size cannot show effect of prefabricated splint on grip strength and dexterity, so this pilot study showed defect of study that it should be considered in large sample size and obtain more exact conclusion.

The results of this pilot study indicate that splints used for children with CP should be custom fitted or custom made and used for long periods of time.

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