International Journal of Health Sciences and Research
Vol.13; Issue: 7; July 2023
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Efficacy of Soft Supination Splint in Comparison with Elbow Wrist Hand Orthosis in Spastic Forearm in Cerebral Palsy

Aryan Kr. Vishwakarma[1], Poly Ghosh[2], Dr. Prasanna Kr. Lenka[3], Bharat Bhushan Bharti[4]

[1]Orthotist, All India Institute of Physical Medicine & Rehabilitation, Mumbai
[2]Workshop Manager (P & O), M.sc (P & O), National Institute for Locomotor Disabilities, Kolkata
[3]Asst, Prof, HOD (P & O), National Institute for Locomotor Disabilities, Kolkata
[4]Prosthetists cum Orthotist, CRC, Patna

Corresponding Author: Aryan Kr. Vishwakarma

DOI: https://doi.org/10.52403/ijhsr.20230717

ABSTRACT

Aim of the study is to compare the efficacy of soft supination splint in comparison with elbow wrist hand Orthosis in spastic forearm. 30 subjects with spastic hemiplegic cerebral palsy were included in the study by random sampling. All the subjects were divided into two groups; A and B. Group A provided with soft supination splint and Group B provided with elbow wrist hand orthosis. Baseline data (spasticity, ROM, hand function and grip strength) was taken before use of the orthosis and post data was taken after 4 week use of orthosis. There was no significant difference in MAS score (p=0.403) and grip strength (p= .285) between the group A and group B. But there was significant difference in ROM (p= 0.009) and upper extremity hand function (p= 0.019) between the group A and B. It was concluded that soft supination splint is more effective than elbow wrist hand orthosis in the management of forearm spasticity in case of hemiplegic cerebral palsy without any complication.

Keywords: Hemiplegic CP, forearm spasticity, soft supination splint, elbow wrist hand orthosis

INTRODUCTION

Cerebral palsy (CP), a disorder of movement and posture resulting from a deficit or lesion of the immature brain, is the most common physical disability in childhood [1, 2]. This is a permanent disorder which manifests early in life and are non-progressive although the musculoskeletal effects often change as the child grows.[3,4]. Causes of cerebral palsy are various which includes congenital, genetic, inflammatory, infectious, anoxic, traumatic and metabolic. [5,6] The prevalence of CP rises in time from well below 2.0 per 1000 live births in the 1970s to well above 2.0 in the 1990s [7,8] There are about 25 lakhs CP children in India as per the last statistical information. [9,3] As per epidemiological report, from Assam for a period of 1 year, it was found that Spastic type was the predominant (80%) in CP, with quadriplegic subtype being the most common (43%). The other types were mixed type (8%), hypotonic (7%) and athetoid (5%) being the least. Contractures and deformities developed in 9% cases and behavioural problems developed in 7% cases. [9]

Limited hand function and impaired arm is characteristic of the movement disorders in children with hemiplegic cerebral palsy (CP) which limits activity and participation in activities of daily living. [11,12] Main reason for impaired hand and arm function is varying muscle tone causing imbalances

and sometimes contractures. The main significant deficits in CP child are in motor and process skill ability due to poor grip strength and restriction in bimanual activities. (13)

Pronation deformity of the forearm in association with a flexion contracture of the wrist is very common in patients with cerebral palsy.(14) It significantly limits function in patients with hemiplegia who are forced to use the dorsum of their hand or forearm for two handed tasks. This is as the pronation contracture prevents the palms of the hands facing each other, and thus manipulation of small objects between the hands is difficult. (OZKAN,) Due to the pronation deformity of the hand patients ROM of forearm rotation, grip strength all becomes hampered.(15)

Hand splinting:

Splinting is a widely used modality which is effective in stretching muscles which may not be sufficiently stretched by therapy alone,(16) although little reliable evidence is present to support this approach. Splints are used extensively to help reduce tone, improve mobility and increase functional skills. When a splint is applied over a specific joint in a tone inhibiting pattern, namely to position the thumb in abduction, wrist in extension and forearm in supination, and is worn for several hours a day, it allows the muscles to perform active movements and thus become stronger and more functional (17). Both static and dynamic splints are used to achieve these aims of therapy. Most of the splints do not involve the forearm movements, those splints only concentrate only on function and movements of the finger, thumb and wrist joints. Because dynamic splints have moving parts that allow the individual a range of voluntary controlled movement, it has been proposed that their use may prevent contractures while allowing opposing antagonist muscle force to counter the force of the spastic muscle.(18) Two previous studies provide anecdotal support for the use of dynamic splints, with children with spastic CP; however, no significant relationship was found between the type of splint and changes in hand use, grasp, or arm hand posture. Static splints are designed to be rigid for controlled support (immobilization) of the involved joint for improved function.(19) Although several case reports document subjective changes in children with CP using static splints,(20,21,22) only one study documented specific hand function changes in a case-study research design (23) reporting increases in measures of grip strength, dexterity, and active thumb range of motion.(24) For proper hand function to position the Forearm into supination is essential.[3] Thus, it would be of huge benefit to use a splint that incorporates forearm movement as well as wrist and thumb movement. Evidence suggested, Elbow wrist hand orthosis is also used to maintain the alignment of the forearm including hand. (21,)

In one study, comparison made between above elbow wrist hand orthosis and combination of elbow gutter with below elbow wrist hand orthosis in children with spastic Cerebral Palsy and found both orthoses are equally effective in reducing spasticity and improving hand functions in children with spastic cerebral palsy. Another study by Delgado, found that with soft supination splint, children with cerebral palsy to decrease their spasticity, increase their active range of movement and improve their hand function. (22). Till date very few studies are present which compares the soft orthosis with rigid orthosis.

The purpose of present study was to compare the spasticity, grip strength and upper limb function in subject with spastic forearm while subjects using soft supination splint and elbow wrist hand orthosis.

METHODOLOGY

Thirty children from both sexes (aged 3 to 7 years) with hemiplegic cerebral palsy children were enrolled for the study, because the children in this age are able to follow the commands and he/ she is able to

actively perform reach and grasp/release activities with verbal prompting.

Inclusion criteria were as follows: Children with hemiplegic spastic cerebral palsy, Mild To Moderate Spasticity (MAS scale upto 2), Agree to participate in this study, Able to understand command and patient undergoing Regular Therapy: Occupational And/ Or Physiotherapy At Least Once A Week. Only dominant side was selected.

Exclusion criteria for participation in the study included: Contracture Of Upper Limb -Elbow, Wrist, Arthrodesis Of Upper Limb, Burn Of Upper Limb, Visual Impairment, Other Associated Neurological Or Orthopaedic Condition, Child Had Previous Upper Limb Botulinum Neurotoxin-a and Splinting Within 6 Months.

Materials:

Two types of splints were used in this study shown in the figure1 and figure 2.

The supination splint: (Figure 1) was made out soft, stretchable nonslip elastic strap. The 5cm width roll was used for the construction of the supination splints used in this study.

The splint is a long strap, which is secured around the thumb metacarpal joint, positioning it in abduction. It is then rolled around the forearm gently pulling the arm into supination. It is strapped proximal to the medial and lateral epicondyles of the humerus. The splint positions the forearm midway between neutral position and 90° supination. It is a dynamic splint as it assists the child to move the forearm into supination. It allows the child to move his forearm between 30° of pronation and 80° of supination.

Elbow wrist hand orthosis (EWHO):

Elbow wrist hand orthosis was made of polypropylene and aluminium bar which is rigid material and very light weight. Measurement was taken by drawing a template; according to template elbow wrist hand orthosis was made. Medial and lateral bar was made curved as per contour of elbow joint and distal part of the bar was made curved opposite direction which keeps the wrist joint extension position, forearm in Midprone position and elbow joint in slight flexion. It maintains both the wrist and elbow joint in fixed position. No movements are allowed in wrist and elbow joint, only hand function is possible. One Forearm band was fixed at dorsal side and another band fixed proximal to the wrist joint.

Figure 1: Patient Wearing supination splint

Figure 2: Patient Wearing EWHO splint

Procedure: After obtaining an informed consent from parents, selected subjects were randomly assigned into two groups- Group A & Group B. Each group was included 15 subjects. In the Group A each subject was provided with soft supination splint and in

the Group B each subject was provided with elbow wrist hand orthosis. Before the fabrication of the orthosis data like spasticity, grip strength and Quest scale for Range of Motion, quality of movement of upper limb, were measured. Intensity of application of both the orthosis were 6 hrs per day for a period of 4 weeks. Others therapeutic intervention was continued.

Grip strength measurement:

Grip strength was measured by using Jamar Hand dynamometer. [23] The Jamar Handgrip Dynamometer is an instrument for measuring the maximum isometric strength of the hand and forearm muscles. It consists of a sealed hydraulic system with adjustable hand spacing that measures handgrip force in pounds per square inch. The instrument was calibrated and procedure followed by American society of hand therapist.

Protocol: The subject holds the dynamometer in the hand to be tested, Subjects were sited on chair with neutral shoulder adduction and rotation, 90° flexion of the elbow, and forearm and wrist in neutral on arm rest and asked to carry out the movement with maximum strength while the examiner is holding the device. Each trial lasts 5 second, with a 10-second interval as rest. In assessing the strength, the client grips the dynamometer with thumb facing the finger and finger alongside each other. No other body movement is allowed. The subject was strongly encouraged to give a maximum effort. Three trial data was taken and mean of three trial was taken as a subject data.

QUEST (Quality of Upper Extremity Skills Test: [24]

The Quality of Upper Extremity Skills Test (QUEST) is a standardized test that was developed to assess the qualitative components of movement in children who have a neuromotor dysfunction with spasticity. It evaluates quality of movement in four domains: dissociated movement, grasps, protective extension and weight bearing. In the present study quest total score was evaluated for dominant side only.

Data analysis:

The study was conducted between May,2017 to April, 2018. The data were recorded in the data collection form.

Data were exported from MAS Scale, QUEST, Goniometer and JAMAR hand dynamometer into Microsoft Excel, and final data analysis was performed in SPSS version 23.0 (SPSS Inc, Chicago, Illinios). The data were explored using appropriate descriptive and graphic techniques. Each data set was examined for a normal distribution prior to conducting any inferential analysis. Test of normality was done by using Shapiro Wilk test. Statistically the results were analyzed using independent t test for between group analysis and paired t-test for within group analysis. For QUEST score Man Whitney test was used for between group analysis and Wilcoxon sign rank test was used for within group analysis. The tests were applied at 95% confidence interval with α value set at 0.05. The results were considered significant at $p \leq 0.05$.

RESULTS

Demographic data

Parameters	Group-A (Mean ± SD)	Group-B(Mean ± SD)
Gender distribution	Male =11 Female = 04	Male =10 Female = 05
Age	4.6600± 1.45641	4.5067 ± 1.16525
Height	98.066 ± 2.64	99.67± 3.26
Weight	13.696 ± 0.6592	13.6 ± 0.495

Table 1: Demographic data

Outcome measures:

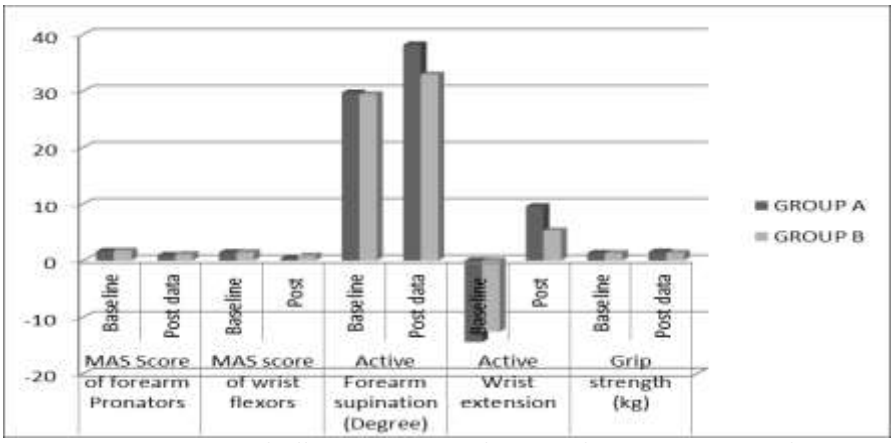
Parameter		GROUP A	GROUP B	t value	p value
MAS Score of forearm Pronators	Baseline	1.67 ± 0.36	1.75 ± 0.65	-0.419	0.678
	Post data	0.967± 0.44	1.12 ± 0.52	-0.849	0.403905
MAS score of wrist flexors	Baseline	1.46±.51	1.48±.52	0.00	1.000
	Post	.400±0.5	0.867±.7	-2.009	0.05
Active Forearm supination (Degree)	Baseline	29.733 ± 4.3	29.40 ± 4.687	0.202231	0.841198
	Post data	38.20 ± 5.62	32.93 ± 4.6	2.791	0.009
Active Wrist extension	Baseline	-14.4±4.28	-12.6±3.5	4.936	.222
	Post	9.60±2.09	5.33±2.6	-1.250	0.001
Grip strength (kg)	Baseline	1.340 ± 0.20	1.342 ± 0.20	-0.023	.984
	Post data	1.563± 0.29	1.370± 0.201	-1.110	0.28

Table 2: comparison of MAS score of forearm pronators and wrist flexors, Active Forearm Supination, Active Wrist extension and Grip Strength before and after using both types of splint

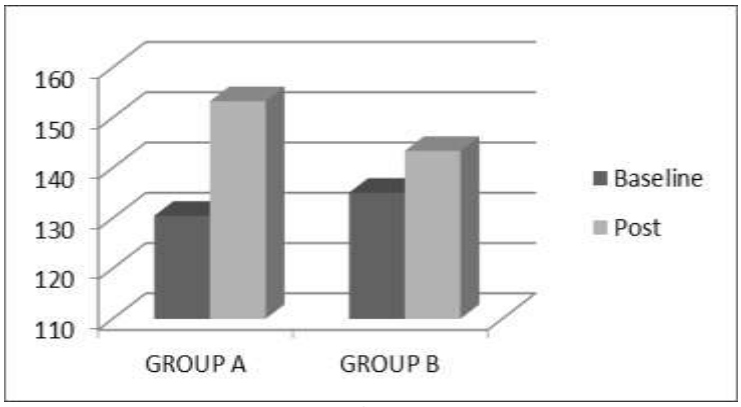
QUEST score Total:

Parameters	GROUP A (Mean ± SD)	GROUP B (Mean ± SD)	Z value	p value
Baseline	130.5406 ± 10.0158	135.1760 ± 6.2050	-1.182	.250
Post	153.3593 ± 13.349	143.4173 ± 7.5083	-2.344	0.019

Table 3: comparison of QUEST Score between groups before and after using both types of splint



Graph 1: Showing result of different parameters after and before using both types of orthosis



Graph 2: Showing result of Quest score between groups

DISCUSSION

The aim of this study was to investigate efficacy of soft supination splint in comparison with elbow wrist hand Orthosis in spastic forearm in cerebral palsy.

The result of this study showed that spasticity of forearm pronators was reduced in both the groups but it was relatively same for both the groups. There was no significant difference in MAS score between the group A (using soft supination splint)

and group B (using elbow wrist hand orthosis) (p=0.403) after 4 week use of orthosis. But there was a significant difference in MAS score of wrist flexors between both the groups (p=0.05). But more improvement was in group A compared to group B. Spasticity reduction was more in group A compared to group B. The change in spasticity may be a result of response of short end muscles to the continuous stretch. When the muscles are stretched, they are relaxed and sarcomere give is more than in the shortened position. When safe forces applied to the tissues statically or cyclically, they demonstrate a transient lengthening depending on the viscoelastic properties of the tissues. It may be the result of sustained prolonged stretch over a two joint muscle resulting in the lengthening of muscle length more effectively. The present findings is supported by Medelene Delgado (2006) whose study showed significant reduction in spasticity and overall reduction of hand function in the group receiving therapy and splint versus the one receiving therapy only. The result of this study also supported by Bertoti's which found that muscle tone decreased significantly in the group that combined inhibitory cast with NDT. The result by Yogita Chhawchhria [(24)] also supports the present findings which showed that the orthosis A (AEWHO) and B (BEWHO) are equally effective in reducing spasticity.

Regarding another parameter ROM, this study revealed that active ROM has been increased in both the groups but it is comparatively more in the group A (38.20 ± 5.621388) than group B (32.93 ± 4.667) in case of forearm supination. There was significant difference in ROM between the group A and group B after 4 week use of orthosis (p= 0.009). In case of active wrist extension, also significant improvement was found between both the groups (p=0.001). It may be the result of decreased spasticity by which the splint applied a gradual force to stretch the pronator and wrist flexors and in so doing, allowed a slightly larger range of supination and wrist extension. The use of a splint that permits active movement provides weak muscles with the opportunity to move against gravity and to perform functional activities. The supination splint used in this study simultaneously stretched the forearm muscles and wrist flexors and allowed active movement, thereby providing the muscles with the opportunity to lengthen and 'strengthen'. As supination splint used in this study function on principles of creep based loading and elbow wrist hand orthosis function as stress relaxation. Elbow wrist hand orthosis allow progressive changes in joint position as the passive range of motion of the involved joint changes and improves over time, so it takes more time to improve joint range of motion. As the data was taken after 4 weeks use of orthosis, improvement in joint range of motion was less in elbow wrist hand orthosis compared to supination splint. In the Glasgow et al. study, [(25)] .patients using dynamic orthoses for PIP or metacarpal–phalangeal joint contractures wore these orthoses for either 6 h or 6–12 h. Those in the longer wearing time frame demonstrated significantly more passive joint range of motion.

Regarding another parameter grip strength, this study showed that grip strength is increased in both the group A and B but there is no difference between the groups. There was significant difference in grip strength within group A (p= 0.001) and group B (p= .012) but there was no significant difference in grip strength between the groups A and B (p= .285). As the active range of movement increased so the children's ability to grasp objects improved. It was observed that when the wrist was slightly extended and forearm supinated there was an increase in grip strength compared to the lack of grip or weakness experienced when the wrist is flexed and the forearm pronated. [(26)]

Regarding QUEST significant difference observed between group A and Group B (p= .0.019, z=-2.342) but significant difference was observed within group in pre and post (z=-3.408, p=0.001). That means total hand

function was improved using supination splint compared to elbow wrist hand orthosis. According to Graham, children with cerebral palsy have difficulty with immediate carry over of new functional skills, since motor learning needs to take place in order to benefit from the new biomechanical conditions of lengthened muscles, bigger ranges of movement and reduced spasticity. This was clearly evident in this study. Despite the subjects having decreased spasticity and slightly increased active range of movement by the second month of supination splint use, their hand function had not had any significant improvement. But as the children learnt to make use of their newly acquired active range of movement and lengthened muscles, their mean scores in the hand function assessment increased significantly. [19]

As the MAS score and upper limb function was improved more using supination splint and difference was observed in MAS score, upper limb function and grip strength, the study supported the experimental hypothesis in a significant way

CONCLUSIONS

From the above findings it is concluded that there was no significant difference in MAS score and grip strength between the group A and B. But there was significant difference in ROM and upper extremity hand function between the group A and B. Hence it was concluded that soft supination splint is effective in the management of forearm spasticity in case of hemiplegic cerebral palsy without any complication.

Future recommendation

The outcomes of this study are conclusive; however further investigations using a similar research design that includes a larger number of subjects and introduces a control group that does not receive any splint would confirm the results obtained in this study.

Declaration by Authors

Ethical Approval: Approved

Acknowledgement: The authors wish to thank the children and their families who agreed to participate in the study. Authors are grateful to National Institute for Locomotor Disabilities (Divyangjan) for giving permission to carry out this research.

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCE

1. Bax M. The spectrum of disorders known as cerebral palsy. Management of the motor disorders of children with cerebral palsy. 2004.
2. Reddihough DS, Collins KJ. The epidemiology and causes of cerebral palsy. Australian Journal of physiotherapy. 2003;49(1):7-12.
3. O'Flaherty S, Waugh M-C. Pharmacologic management of the spastic and dystonic upper limb in children with cerebral palsy. Hand clinics. 2003;19(4):5859.
4. Stanley FJ, Watson L. Trends in perinatal mortality and cerebral palsy in Western Australia, 1967 to 1985. Bmj. 1992;304(6843):1658-63.
5. Uvebrant P. Hemiplegic cerebral palsy aetiology and outcome. Acta Paediatrica. 1988;77(s345):1-100.
6. Nielsen HH. Psychological Appraisal of Children with Cerebral Palsy: A Survey of 128 Re-assessed Cases. Developmental Medicine & Child Neurology. 1971;13(6):707-20.
7. Herder GA. Cerebral palsy among children in Nordland 1977-91. Occurrence, etiology, disability. Tidsskrift for den Norske laegeforening: tidsskrift for praktisk medicin, ny raekke. 1998;118(5):706-9.
8. Colver A, Gibson M, Hey E, Jarvis S, Mackie P, Richmond S. Increasing rates of cerebral palsy across the severity spectrum in north-east England 1964–1993. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2000;83(1):F7-F12.
9. Apexa G. Vyas, Virendra Kumar Kori, S. Rajagopala, Kalpana S. Patel Ayu. 2013 Jan-Mar; 34(1): 56–62.
10. Fedrizzi E, Pagliano E, Andreucci E. Hand function in children with hemiplegic cerebral palsy: prospective follow-up and functional outcome in adolescence.

Developmental Medicine & Child Neurology. 2003 Feb;45(2):85-91.
11. Arner M, Eliasson AC, Nicklasson S, Sommerstein K, Hägglund G. Hand function in cerebral palsy. Report of 367 children in a population-based longitudinal health care program. The Journal of hand surgery. 2008 Oct 1;33(8):1337-47.
12. Adler C, Berweck S, Lidzba K, Becher T, Staudt M. Mirror movements in unilateral spastic cerebral palsy: specific negative impact on bimanual activities of daily living. European journal of paediatric neurology. 2015 Sep 1;19(5):504-9.
13. Sakellarides HT. Treatment of pronation contractures of the forearm in cerebral palsy by changing the insertion of the pronator radii teres. Journal of Pediatric Orthopaedics. 1981 Dec 1;1(4):458.
14. Waters PM, Van AH. Spastic hemiplegia of the upper extremity in children. Hand clinics. 1998 Feb;14(1):119-34.
15. Case-Smith J, Allen AS, Pratt PN. Occupational therapy for children: Mosby Toronto; 2001.
16. Yang TF, Fu CP, Kao NT, Chan RC, Chen SJ. Effect of botulinum toxin type A on cerebral palsy with upper limb spasticity. American journal of physical medicine & rehabilitation. 2003;82(4):284-9.
17. Graham HK, Aoki KR, Autti-Rämö I, Boyd RN, Delgado MR, Gaebler-Spira DJ, et al. Recommendations for the use of botulinum toxin type A in the management of cerebral palsy. Gait & posture. 2000;11(1):67-79.
18. Rogers S, Gordon C, Schanzenbacher K, Case-Smith J. Common diagnosis in pediatric occupational therapy practice. Occupational therapy for children. 2001:136-87.
19. Law M, Cadman D, Rosenbaum P, Walter S, Russell D, DeMatteo C. Neurodevelopmental therapy and upper-extremity inhibitive casting for children with cerebral palsy. Developmental Medicine & Child Neurology. 1991;33(5):379-87.
20. 21.Hill S. Current trends in upper extremity splinting. Improving upper body control. 1988:131-64
21. Sanger TD, Delgado MR, Gaebler-Spira D, Hallett M, Mink JW. Classification and definition of disorders causing hypertonia in childhood. Pediatrics. 2003;111(1):e89-e97.
22. Bonutti, Peter M., et al. "Static progressive stretch to reestablish elbow range of motion." *Clinical orthopaedics and related research* 303 (1994): 128-134.
23. Burtner PA, Poole JL, Torres T, Medora AM, Abeyta R, Keene J, Qualls C. Effect of wrist hand splints on grip, pinch, manual dexterity, and muscle activation in children with spastic hemiplegia: a preliminary study. Journal of hand Therapy. 2008 Jan 1;21(1):36-43.
24. Chhawchhria Y. Comparison between above elbow wrist hand orthosis and combination of elbow gutter with below elbow wrist hand orthosis in children with spastic Cerebral Palsy. Indian Journal of Occupational Therapy (Indian Journal of Occupational Therapy). 2014 Sep 1;46(3).
25. Glasgow, Celeste, Judith Wilton, and Leigh Tooth. "Optimal daily total end range time for contracture: Resolution in hand splinting." *Journal of Hand Therapy* 16.3 (2003): 207-218.
26. LaStayo P, Chidgey L. Quantification of the relationship between dynamic grip strength and forearm rotation: a preliminary study. Plast Reconstr Surg. 1995; 35:191-196

How to cite this article: Aryan Kr. Vishwakarma, Poly Ghosh, Prasanna Kr. Lenka et.al. Efficacy of soft supination splint in comparison with elbow wrist hand orthosis in spastic forearm in cerebral palsy. *Int J Health Sci Res.* 2023; 13(7):102-109.
DOI: *https://doi.org/10.52403/ijhsr.20230717*

******