International Journal of Community Medicine and Public Health
Kumari R et al. Int J Community Med Public Health. 2021 May;8(5):2614-2618
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20211799

Review Article

Effectiveness of hand splints on upper limb skills and functional activities in children with cerebral palsy: a review

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Received: 21 February 2021
Revised: 01 April 2021
Accepted: 02 April 2021

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ABSTRACT

Cerebral Palsy is a non-progressive neurological disorder in which children may experience similar physical limitations, including those related to upper limb skills that affect the child's ability to participate in age-specific activities. The use of hand-splints in children with neurological conditions is little reported, they continue to be widely used to improve upper limb skills and functional activities. This review was done to investigate the use and effects of hand splints in Cerebral Palsy patient as orthotic treatment found to be very positive result in correcting and maintaining the achieved results. Electronic database search was conducted using Google scholar, Science direct, Pub Med, Cochrane Library and reference lists from all retrieved articles. Common problems in upper limb due to CP are flexion contractures of the fingers and wrist due to spasticity, pronation deformity of the forearm, thumb-in-palm deformity and hand-related disabilities, all lead to decrease in grip and muscle strength. Hand splints are often used to help a weak or ineffective joint or muscle to enhance a person's arm or hand posture, mobility, quality of motion, and function. The findings suggest that children with CP experience increased grip strength and fine motor dexterity when using different hand splints. This review summarizes the present state of understanding the extent to which orthotic management in CP can improve in the patient's skills and functional activities by improving the muscle strength and hand function, also offers clinical suggestions for prescribing orthosis in order to optimize efficacy.

Keywords: Cerebral palsy, Upper extremity, Spasticity, Hand splints, Hand function

INTRODUCTION

Cerebral Palsy is a neurological disorder caused by non-progressive lesions at single or multiple locations in the immature brain in the uterus during or shortly after birth and characterized by movement and posture disorders that result from brain development disorders leading to primary and secondary sensory, neuromuscular and musculo-skeletal system impairments. The prevalence is not well known, but figures in the developed world are 1.5-5.6 cases per 1000 live births and the incidence is higher in males than in females (ratio of 1.33:1). Although some therapeutic approaches have underestimated the significance of characteristics such as strength and intrinsic muscle properties for motor function in individuals with CP, evidence suggests that these characteristics play an important role in the movement patterns observed in these children.[1-4]

Grip, pinch and manual dexterity are the key functions of the hand that assist the everyday activities. If children are unable to acquire these functions due to neuromuscular conditions such as cerebral palsy (CP), they report diminished success in tasks such as school assignments, self-care, and play with peers. Muscle impairments due to the prevalence of spasticity in this children's population also lead to limitations in the range of motion, timing accuracy, development of force and skills of hand manipulation.[5]

Table 1: Different types of splints used in upper extremity.

Splint	Description
Volar splint[14-16]	The resting volar splint was one of the earliest splint designs which attempted to reduce spasticity by placing a muscle under constant stretch with increased tone. This excessive stretching of spastic muscles was thought to cause their muscle spindles to rebase so that they would become less sensitive to stretching.[16]
Dorsal splint[15,16]	Using their rationale, a dorsal splint is expected to facilitate the forearm's extensor musculature by cutaneously stimulating the dorsal aspect and inhibiting the flexor muscles.[16]
Finger spreader[16]	The use of a foam finger spreader to cover the fingers and thumb is recommended; this role is suggested to encourage extensor muscles and to prevent flexor muscles.[16]
Firm cone[16]	The use of a firm cone inserted in the palm of the hand to minimize flexor spasticity has resulted in excessive pressure on the entire flexor surface of the fingers, which was thought to inhibit the flexor muscles.[16]
MacKinnon splint[17,18]	MacKinnon splint provided pressure on the volar side of the metacarpal heads and activated the intrinsic muscles, thereby reducing the tone in the adductor pollicis and flexors of the fingers.[16]
Orthokinetic cuff[17]	This system was designed with an Ace bandage and contained both elastic and nonelastic parts. Using a variation of the continuous fold over method it was constructed and consisted of three layers. A piece of nonelastic material (Velfoam) was sewn into the pieces. The cuff was designed to fit snugly around the upper forearm and comply with the width of the muscle bellies of the wrist and finger extensors for the elastic (active) area.[17]
Short opponens thumb splint[19,17]	This splint was made of orthoplast, with particular consideration provided to holding the thumb out of palmar adduction-opposition by having leverage over the eminence of the thenar. Both the thumb MP and IP joints were strengthened but enough of the thumb pad was left exposed to allow an opposite grip to be used. The orthoplast proceeded over the hand dorsum, stopping over the eminence of the hypothenar. This portion has been stabilized with a Velcro strap to the thumb portion.[17]
Lycra orthoses[20,21,22]	In the last ten years, many types of Lycra based orthosis have emerged, with styles ranging from full body suits to smaller garments such as sleeves / gloves and leggings. Children with CP demonstrate practical benefits when using Lycra orthosis.[22]
WETA orthosis (wrist extension thumb abduction orthosis)[23]	It was designed with mechanisms that can overcome the spastic pattern and enhance the positioning of a hypertonic hand (i.e., a hand that experiences wrist flexion, ulnar deviation, ulnar flexion and thumb adduction).[23]

Table 2: Impact of splints in upper extremity.

Author	Title	Conclusion
Hughes (2017)	The effect of neoprene thumb abduction splints on upper limb function in children with cerebral palsy	The study showed a positive effect on the function of the upper limb in children with CP with thumb-in-palm deformity, requiring monthly individual therapy and a home plan over a three-month span when a soft neoprene thumb abductor splint was compared with a control group that was not given a splint.[24]
Exner et al (2015)	Comparative Effects Of Three Hand Splints On Bilateral Hand Use, Grasp, And Arm Hand Posture In Hemiplegic Children: A Pilot Study	Of the three splints, the MacKinnon splint was most generally associated with enhanced gripping ability and/or use of bilateral hands. The short opponence splint was related less frequently to changes in grasp or bilateral hand use. The orthokinetic cuff was specifically related to improvement in the use of bilateral hands.[17]
Deshkar1 et al (2014)	Management Of Tone And Hand Functions In Cerebral Palsy: Inhibitive Weight Bearing Splint As An Adjunct Modality	This study shows the fact that not only significant improvement was noted in hand, it was found that during the intervention period, the hand opening but also the use of hands was improved. Furthermore, changes were noted in the approach to grip, release, and arm.[25]

Continued.

Author	Title	Conclusion
Jackman et al (2013)	Effectiveness of hand splints in children with cerebral palsy: a systematic review with meta-analysis	Their findings indicate that upper limb orthosis may have small advantages for hands, but improvements decreased after wearing was stopped.[6]
Louwers et al (2011)	Immediate effect of a wrist and thumb brace on bimanual activities in children with hemiplegic cerebral palsy	The study indicates that the bracing of the wrist and thumb enhances instantly the spontaneous use of the affected upper limb in bimanual activities, likely because bracing allows for a more stable hand posture.[26]
Morris et al (2011)	Orthotic management of cerebral palsy: Recommendations from a consensus conference	The finding shows that dynamic thermoplastic orthosis in tasks involving grip and dexterity tend to promote better function than static orthoses.[22]
Barroso et al (2010)	Improvement of hand function in children with cerebral palsy via an orthosis that provides wrist extension and thumb abduction	The orthosis improved the range of motion, muscle strength and manual ability of the trapeziometacarpal joint.[23]
Burtner et al (2008)	Effect of Wrist Hand Splints on Grip, Pinch, Manual Dexterity, and Muscle Activation in Children with Spastic Hemiplegia: A Preliminary Study	The results indicate that children with hemiplegic CP patients may experience improved grip strength and dexterity of the motor by using dynamic splints.[5]
Ozer et al (2006)	Neuromuscular electrical stimulation and dynamic bracing for the management of upper-extremity spasticity in children with cerebral palsy	The combined use of electrical stimulation and dynamic bracing introduced in this study is a quick and efficient management tool, which may potentially minimize the need for multiple surgical procedures.[27]
Taplicky et al (2002)	The Effectiveness of Casts, Orthoses, and Splints for Children with Neurological Disorders	Studies suggest that hand splints improve grip for children with cerebral palsy, and upper extremity casts result in improved range of motion and reduced muscle tone.[28]
Carmick (1997)	Use of Neuromuscular Electrical Stimulation and a Dorsal Wrist Splint to Improve the Hand Function of a Child With Spastic Hemiparesis	The splint allowed the child to use finger and thumb opposition, grasp and release free of the "helping hands" of an adult trying to maintain wrist extension.[29]
Blcrit et al (1995)	A study of a dynamic proximal stability splint in the management of children with cerebral palsy.	The finding suggests that children were found to have increased postural stability and motions of the upper extremities while wearing the splint.[30]
Reid et al (1992)	Influences of a hand positioning device on upper-extremity control of children with cerebral palsy	There were no major differences, though the authors reported some signs of more natural muscle activation during reach and improved visual motor efficiency when splint was worn.[31]
Goodman et al (1991)	The Effects of a Short Thumb Opponens Splint on Hand Function in Cerebral Palsy: A Single-Subject Study	The results suggest that the use of a thumb opponence splint improved the underlying aspects of hand function for this child with cerebral palsy. Active range of thumb movement, grip strength, cube stacking, and performance on the Box and Block Test significantly improved after 4 weeks of splint wear.[19]
Langlois et al (1989)	Hand splints and cerebral spasticity: A review of the literature	Both clinical findings and some experimental studies indicate spasticity reduction after hand splinting.[16]
Flegle et al (1988)	Improvement in grasp skill in children with hemiplegia with the MacKinnon splint	At wearing the MacKinnon hand splint, grasp improved in all children. Changes in the child with the poorest grasp before wearing the splint were most dramatic.[18]

Up to 60 percent of this population experiences significant hand capacity related difficulties and for this reason it is critical to be successful and evidence-based in therapeutic approaches. While little empirical evidence supports the use of hand splints in children with neurological disorders, they are often commonly used in an attempt to enhance upper limb skills and functional activities.[6-11]

Hand splints are often used to help a weak or ineffective joint or muscle to enhance a person's arm or hand posture, mobility, quality of motion, and function. Within the definition of the ICF (International Classification of Functioning , Disability and Health), hand splints can be defined as an external factor (such as physical support) that influences the overall relationship of ICF domains that can influence the function and structure of a child's body, as well as activity and participation.[12,13,5]

DISCUSSION

According to ISPO (2008), both static and dynamic approaches to splinting across the wrist have been shown to support functional dexterity. In comparison, the dynamic splinting strategy, with respect to grip strength, tended to encourage a stronger grip than either the static splint or no splint treatment.[32]

Many widely used neuro rehabilitation splints are applied with the goal of inhibiting spasticity with an end result of improving performance. It obviously relies on the assumption that is a splint that inhibit spasticity and that spasticity inhibition contributes to increased activity. Spasticity was thought to increase due to the tactile stimulation of the palm surface of the hand, resulting in unwanted muscle contractions. Many therapists, based on these assumptions, recommend splinting only on the dorsal surface of the hand. Along with concerns that splinting the flexor surface of the hand would "cause" spasticity, some clinicians also assume that certain positions "break" spasticity patterns. Most therapists believe that the hand must be held neutrally with the wrist and the finger separated and extended to prevent spasticity. While splinting will minimize hyper-reflex stimulation by immobilizing the joint, this does not mean that spasticity will be reduced in the long term when the splint is removed.[21]

The splint gave the child the opportunity to learn how to functionally and independently use the grasp, release, and opposition, without anyone holding the wrist position for him.[29]

The findings suggest that children with hemiplegic CP may experience increased grip strength and fine motor dexterity when using dynamic splints. Static splints had reduced muscle activity in the forearm muscles during grip and at the completion of grip and dexterity tasks recruited more shoulder muscles than children control. Therefore, repeated use of static wrist splints can lead to muscle atrophy in the forearm muscles and increased activation of the shoulder muscles during tasks can result in fatigue and increased stress of the proximal shoulder muscles.[5]

The cutaneous input and finger adduction resistance provided by a finger spreader may generate a similar patterned response and can explain the reduced spasticity that is assumed to occur with the use of this splint. The reflex inhibiting pattern was integrated into a dorsal frame, volar finger pan design that emphasized wrist extension and extension of interphalangeal joints as well as abduction of fingers and extension of thumbs. Immediately after application a decrease in flexor tone was consistently noted. Further research confirmed results of a reduction in hypertonicity.[16]

CONCLUSION

The study indicates that the splinting of an upper limb is a unique task. Nonetheless, it's hard to imagine a child adjusting splints according to their activities. Considering the factors affecting compliance and overall treatment in CP Patient, splints should be designed with comfortable structure and suitable appearance. Starting splint regimen within earlier ages and considering the child habits and preferences along with the treatment plan and prescribed regimen for the orthosis can revolutionize the overall outcome. The ultimate effect of treatment may then be enhanced (in both physical and psychological aspects). Although further investigation in this field is required, it would seem that decisions about bracing of the wrist and hand should be taken on a case-by-case basis, meeting each patient's needs. Treatment with hand splints has insignificant adverse effects, and this common chronic disease will reduce morbidity. Conservative treatment of cerebral palsy has a beneficial effect on the upper limb skills and functional activities of the people affected.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Kumari R, Surbhi, Saharawat S. Effectiveness of hand splints on upper limb skills and functional activities in children with cerebral palsy: a review. Int J Community Med Public Health 2021;8:2614-8.