International Journal of Health Sciences and Research
Volume 14; Issue: 4; April 2024
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Investigating the Impact of Neurophysiological Approach with Modified Splint Design on Grip and Hand Function in Stroke Population: A Pilot Study

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DOI: https://doi.org/10.52403/ijhsr.20240451

ABSTRACT

BACKGROUND: Spasticity of hand after stroke is a major limitation or major cause for the development of contractures which hinders daily activities and affects overall quality of life. Hand splints are most commonly prescribed to reduce spasticity and prevent contractures. Splinting has both biomechanical and neurophysiological benefits, biomechanical stretches include changes in the muscles and ligaments and other connective tissues and neurophysiological benefits include the reduction of the spasticity by doing modifications by inhibiting and facilitating the tone and suppress the reflexive contraction of the muscles. There has been a neurophysiological modification for flexors of the fingers and extensors of the wrist have been used in the splinting but still their combined effect is not clear. In this study modified splint design has been used with neurophysiological approach to evaluate the effect of the splint on function and grip strength in people with stroke.
Aim: This study aimed to evaluate the impact of modified wrist hand orthosis with neurophysiological approach on function and grip strength in people with stroke.
Method: In this study the sample of five subjects has been taken and they were included as per the inclusion and exclusion criteria and the consent was taken. After this the modified wrist hand orthosis was designed and fabricated for the patients of stroke with the neurophysiological principles, and pre-test data was taken which included function using a Duruöz hand index and grip strength using a Jamar dynamometer and then splint is given for 15 days to the patients and after this post test data was taken and data analysis was done using SPSS Software using paired t test.
Result: The modified Wrist hand orthosis has improved the hand function the pre-test data was with a mean of 18 ± 7.2 and the post-test value comes with a mean of 16 ± 0.8 with the t-value 5.79 and the value was significant at p=0.00 and grip strength of the patient with stroke improves. As earlier pre-test data have 13.34 ± 5.54 and post-test 14.74 ± 5.55 with t value 6.14 and p value < 0.05.
Discussion and conclusion: This study showed improved results in the grip strength and function of the hand as the modified splint design includes a neurophysiological approach that is hard cone which has an inhibitory effect on flexor muscles because this modification places deep tendon pressure on the wrist and finger-flexor insertions at the base of the palm. The finger abduction facilitates the extensor tone and inhibits the extensor tone. In this study,

we investigated the effect of modified wrist hand orthosis made up of orfit sheet on a patient with stroke and its effects on grip strength and function and concluded that it is effective in improving hand function and grip strength. Further, the research can be conducted with a larger sample size and increased intervention period.

Keywords: Stroke, neurophysiological approach, Hand function, Grip strength

INTRODUCTION

A stroke is the sudden loss of neurological function caused by interrupting the blood flow to the brain [1]. Stroke prevalence is predicted to be between 84 - 262/100,000 in rural areas and 334 -424/100,000 in urban areas. According to recent population-based research conducted in 2011, the incidence rate ranges from 119 to 145 per 100, 000 [2]. Stroke is very common in the elderly population [3]. Generally, stroke is characterized by disorders of sensory, motor, perceptive, cognitive, and language functions, as well as mobility disorders on the side of the body opposite to the stroke region [4]. Stroke survivors with more severe paresis in the upper limb muscles have a higher risk for developing spasticity in the arm, and contractures of the wrist and finger flexor muscles [5]. "A motor disorder characterized by a velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyper-excitability of the stretch reflex as one component of the upper motor neuron syndrome" is how Lance defines spasticity [6]. Approximately 60-70% of all stroke patients will have upper limb paresis with approximately half of those having 'severe' paresis, and the other half having 'mild' paresis [7]. Upper limb spasticity and contractures can cause impairment in function or have a major impact on a variety of everyday activities and sleep [8]. Reducing or returning muscle tone to normal is the goal of spasticity treatment programs to avoid further difficulties. Muscle contracture, fibrosis, calcification, and shortening occur if spasticity is not addressed. Options for treatment include bracing and stretches. Because of splinting or stretching, the muscles stay extended, which can alter the biomechanical characteristics of the muscle fascicles and reduce motor neuron excitability. Better motor function, less pain, and an overall enhanced quality of life for the patient and the caregiver are all possible to come by reduced spasticity [9].

Motor impairments caused by stroke affect hand function [10]. 87% of stroke patients have hand paralysis and are unable to do daily tasks on their own [11]. A study by Wissel et.al showed that 25% of patients with stroke suffer from spasticity within the first 6 weeks of the event. The most common pattern of spasticity in the upper limbs is internal rotation and adduction of the shoulder along with flexion at the elbow, wrist, and fingers [12].

Two types of strokes are most common: ischemic and haemorrhagic. Infarcts in ischemic strokes are produced by inadequate or interrupted blood flow to a part of the brain, usually due to artery obstruction. Whereas in Haemorrhagic Strokes, the primary pathology is an area of bleeding causing direct damage to brain tissue. These constitute up to 10–15 % of all strokes and have a significantly higher morbidity and mortality than ischemic strokes [13].

Splinting is used to improve function, reduce pain and spasticity, compensate for protective sensation, and prevent contracture and deformity [14]. When it comes to treating spasticity, splinting is key. Different splint designs are suggested for managing spasticity as well as other indications like discomfort, edema, and contracture avoidance. A volar resting splint is used to support the wrist and hand in the flaccid limb. On the other hand, an anti-spasticity splint that provides adequate dorsiflexion of the wrist and finger extension is useful in the spastic hand [15].

Despite the variety of aims, there are only 2 basic theoretical rationales for splinting in this population. These are the biomechanical and neurophysiologic rationales [16]. Biomechanical benefits constitute stretch-associated changes in muscles and connective tissues, and neurophysiological benefits involve the reduction of spasticity by inhibiting the reflexive contraction of muscles [17]. The neurodevelopmental treatment (NDT) theory advocates the use of reflex-inhibiting patterns (RIP) to inhibit abnormal spasticity. Finger and thumb abduction is a key point of control that facilitates extensor muscle tone and inhibits flexor muscle tone [18]. In the literature searched, it has been observed that both rationales are effective for treating spasticity in the stroke, but the combined effect has not been observed till now, this study attempts to modify the splint design by combining both the effects and the effect of the modified splint has been checked on grip strength and function in the patient with stroke.

MATERIALS & METHODS

In this study the sample of 5 subjects has been taken and they were included as per the inclusion and exclusion criteria and the consent was taken. Inclusion criteria : (1) The patient referred by the doctor (2) Patient having 6 months onset of duration (3) Age between 55-65 years (4) Both males and females (5) Upper limb spasticity (MAS score>1 at wrist and elbow (6) No history of surgery (7) Subject who gave informed consent to participate in the study. Exclusion criteria: (1) Patient with any kind of cognitive deficits (2) Patient with visual and hearing impairment (3) Any other orthopaedic or neurological disorder (4) Drug use affecting muscle strength. After this the modified wrist hand orthosis was designed and fabricated for the patients of stroke with the neurophysiological principles, and pre-test data was taken which included function using a Duruöz hand index and grip strength using a Jamar dynamometer and then the splint is given for 15 days to the patients and after this post-test data was taken and data analysis was done using SPSS Software using paired t-test.

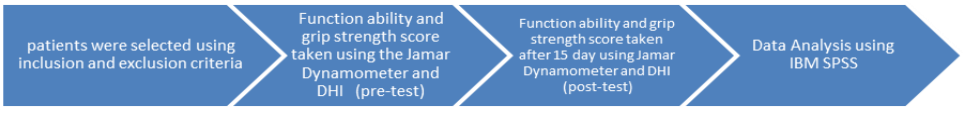


Fig 1 : Modified splint design with neurophysiological

Fig 2 : Patient wearing in splint approach

Data Analysis

The data was analyzed using IBM SPSS statistics. Descriptive statistics (mean and standard deviation) were computed and analyzed for the variables- grip strength and functional ability score. A paired t-test was used to analyse the difference between pre-test data and post test data of grip strength and functional ability score to identify changes in subjects with or without splint. A significant level of $P < 0.05$ was fixed.

RESULT

The modified Wrist hand orthosis has improves the hand function the pre-test data was with the mean of 18 ± 7.2 and post-test value comes with the mean of 16 ± 0.8 with the t-value 5.79 and p value was significant at p=0.00 and grip strength of the patient with stroke improves. As earlier pre-test data have 13.34 ± 5.54 and post-test 14.74 ± 5.55 with t value 6.14 and p value < 0.05.

Table 1: Paired T – test Result of Grip strength.

Grip Test	Mean ± S.D.	T - value	P – value
Pre – test	13.34 ± 5.54	5.79	0
Post – test	14.74 ± 5.55		

Graph 1: Graphic representation of Grip Strength

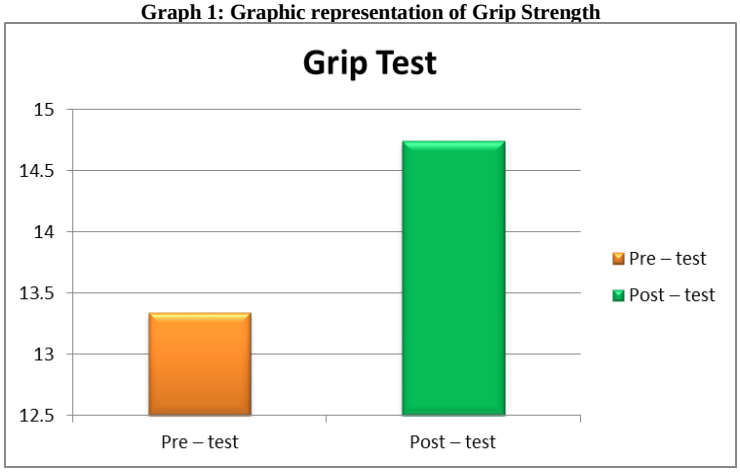
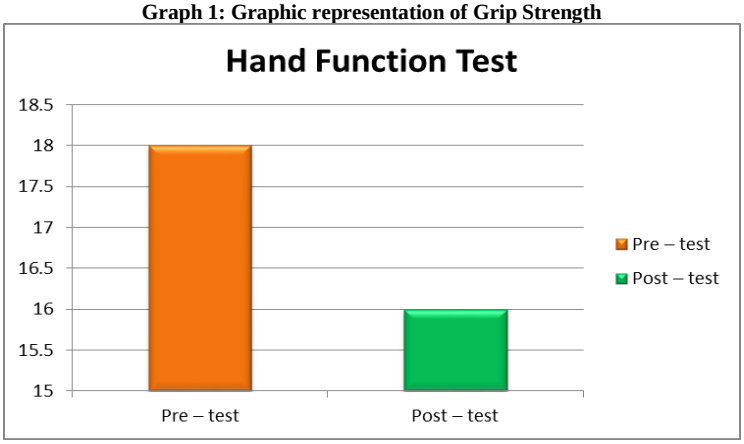


Table 2: Paired T – test Result of Hand Function Test.

Hand Function test	Mean ± S.D.	T – value	P – value
Pre – test	18 ± 7.2	5.79	0
Post – test	16 ±0.8		

Graph 1: Graphic representation of Grip Strength



DISCUSSION

This study stated improved hand function and grip strength as a result of the modified splint design with a neurophysiological approach. The post-test grip strength score mean was 14.74 ± 5.55, p - value <0.05, significantly better than the pre-test score mean of 13.34 ± 5.54, indicating a

significant improvement in grip strength. This is supported by earlier study done by Subhasmita Sahoo *et al* on Combined Effect of Dynamic Wrist Hand Orthosis and Therapy On Hand Grip Strength In Subjects With Acute Hemiplegic Stroke. Thirty people with acute hemiplegic stroke was selected to evaluated the effect of wrist hand orthosis in acute hemiplegic stroke patients, which will increase the hand grip strength and overall hand function in affected hand and concluded that there was a significant increase in grip strength after use of wrist hand orthosis (p value <0.000 and t value = 8.065) [4]. Assunta Pizzi *et al* on Application of a Volar Static Splint in Poststroke Spasticity of the Upper Limb. Forty patients were included in the study and found there was an increase in joint PROM after RIS. Daily use of RIS over an extended period is associated with reduction of spasticity and pain [19]. Wen-Dien chang and Ping-Tung Lai *et al* on New design of home-based dynamic hand splint for hemiplegic hands: a preliminary study, found the use of dynamic wrist hand orthosis in hemiplegic stroke significantly improve grip strength with combined with therapeutic intervention and $p<0.05$ [20]. This study showed the improved result in hand function with a significant improvement in post – test hand function score mean = 16 ± 0.8, p – value =0.00 as compared to pre – test score mean = 18 ± 7.2 which indicates significant improvement in hand function. This is supported by the earlier research performed by Zih-Hua Chen *et al* Functional Assessment of 3D-Printed Multifunction Assistive Hand Device for Chronic Stroke Patients concluded that the study developed a 3DP-MFHD for patients with chronic stroke. The results showed that the 3DP-MFHD enhance hand strength in context of grip force and lateral pinch force. Hand function was improved as well [21]. Yu-Sheng Yang *et al* on Effectiveness of a New 3D-Printed Dynamic Hand–Wrist Splint on Hand Motor Function and Spasticity in Chronic Stroke Patients concluded that new 3D-printed dynamic hand–wrist splint is a feasible and effective alternative modality for reducing muscle spasticity and improving hand motor function [22].

CONCLUSION

This study showed the improved results in the grip strength and function of the hand as modified splint design includes neurophysiological approach that is hard cone which has an inhibitory effect on flexor muscles because this modification places deep tendon pressure on the wrist and finger-flexor insertions at the base of the palm. The finger abduction facilitates the extensor tone and inhibits the extensor tone. In this study, we investigated that the effect of modified wrist hand orthosis made up of orfit sheet on the patient with stroke and its effects on grip strength and function and conclude that it is effective in improving hand function and grip strength. Further, the research can be conducted with the larger sample size and increased intervention period.

Declaration by Authors

Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Yashika Kumar, Ankit Kumar Ray. Investigating the impact of neurophysiological approach with modified splint design on grip and hand function in stroke population: a pilot study. *Int J Health Sci Res.* 2024; 14(4):388-393. DOI: *https://doi.org/10.52403/ijhsr.20240451*

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