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Combined Effect of Dynamic Wrist Hand Orthosis and Therapy on Hand Grip Strength in Subjects with Acute Hemiplegic Stroke

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ABSTRACT

Back ground: Stroke is a sudden loss of neurological function, with motor impairment, which can be regarded as a loss or limitation of function in muscle control or a limitation of hand movement through, insufficient muscle strength and inadequate muscle tone. The affected hand motion can result in a diminished ability to perform daily functional activities.
Objective: The study was evaluated the effect of dynamic wrist hand orthosis in acute hemiplegic stroke patient, which will increase the hand grip strength and over all hand function in affected hand.
Methods:30 hemiplegic stroke patients were participated in the study according to inclusion criteria. The subjects were divided into two groups; Group1 Dynamic wrist hand orthosis with therapeutic intervention and Group 2: only therapeutic intervention was given. In both group base line data and pre-test data was collected. Grip strength of affected hand was measured by hand held Camry dynamometer and hand fine motor skill test was conducted by box and block test. After 6 week the post test data was collected.
Results: There was a significant difference of grip strength and hand fine motor skill (performed by box and block test) was found in group 1 patients when compared with the only therapeutic group 2.
Conclusion: The dynamic wrist hand orthosis is an effective prescription in increasing hand grip strength and fine motor skill for that the acute hemiplegic stroke patients and they can easily perform daily activities.

Keywords: Acute hemiplegic stroke, Dynamic wrist hand orthosis, Grip strength, Camry hand held dynamometer, Box and block test.

INTRODUCTION

Cerebrovascular accident (stroke) is the sudden loss of neurological function caused by an interruption of the of blood flow to brain. [1] The estimated adjusted prevalence rate of stroke range is 84-262/100,000 in rural and 334-424/100,000 in urban areas. The incidence rate is 119-145/100,000 based on the recent population based studies in 2011.[2]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.[3] In particular, muscular weakness and spasticity of the upper extremities, imbalance, hypertonia, and dysesthesia can cause a loss of motor control in the upper extremities.[4] and limit activities of daily living (ADLs.[5]Therefore, by reducing upper extremity damage, it is possible to facilitate independent ADLs in stroke patients. The decrease in hand motor function is a troublesome problem, obligating stroke patients to re learn functional activities.[6]

Therefore, the reconstruction of hand function, accompanied by a recovery of their quality of life, is a desired outcome for stroke patients. Traditional therapy approaches such as passive range of motion, manual handling, weight bearing and tone reduction strategies to address moderate to severe upper extremity hemi paresis have not been shown efficacious with respect to distal recovery.[8,9]Others treatment likes bilateral training, constraint-induced movement therapy, high- intensity therapy, repetitive task training, and splinting.[7] Recovery of hand and grip strength occurs according to the Brunnstrom recovery stage (BRS),that depend upon the treatment of affected side.

Next to traditional treatment methods for patients with a moderate to severe arm-hand paresis, training incorporating assistive devices, like robot-assisted therapy with electrical stimulation or dynamic orthoses fitted to the affected arm-hand to facilitate participation in task-oriented training, are emerging.[10-12] studies into the effectiveness of interventions featuring combinations of task-oriented training methods and assistive devices for the most severely affected group of sub-acute stroke patients are still scarce, and the effectiveness of many assistive devices in stroke rehabilitation is still equivocal.[13,14] However, modest results as to the use of dynamic hand orthoses combined with task-oriented training in moderately to severely affected stroke patients have been reported. Stroke patients who are able to regain wrist and finger extension have sufficient residual voluntary movement ability to work independently with these types of orthoses.[15]

Dynamic orthosis has 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. A dynamic splint includes outrigger; springs; elastic strings and individual finger belt. An outrigger is a projection from the splint base which is used by the therapist to position the mobilizing force of the splint to the patient's limb to allow tissue re modelling and improve hand function.[16] with respect to static splint dynamic splint is superior as it provides more benefits such as reduction of spasticity; allowing comfortable stretch; increasing compliance and motivation; reduction of joint pain, prevention of oedema repositioning fingers into extension positions and increasing brain plasticity.[17] A commercial splinting system called Saeboflex orthosis was developed and designed to permit quick training inopening and closing the affected hand. [17]

The mechanical efficiency and comfort of a dynamic splint can be increased by decreasing its tension levels.[18] Perpendicular traction and acceptable tension can be adjusted based on the feedback from the patient as it is adjusted to the hand. The amount of tension on the springs depends on patient's condition. If the aim is to improve grip strength or to learn to release objects, then more resistive springs are required; whereas to promote voluntary deactivation of hand flexors with increased hand extension activity; less resistive springs are used.[18] Very a smaller number of articles are available on effect of orthotic management of affected hand with stroke population. So, the study was conducted to determine the effectiveness of dynamic wrist hand orthosis with some therapeutic intervention in stroke patient to improve the grip strength of affected hemiplegic hand. Previous researches in regard to stroke and orthotic management for upper limb was inconsistent. The aim was to quantify and compare the different configurations of orthosis in the treatment of upper limb with stroke survivor for successful rehabilitation.

MATERIALS & METHODS

A clinical prospective study was conducted in department of prosthetics and orthotics, Swami Vivekananda national institute of rehabilitation training and research, Olatpur

Cuttack, Odisha. A total number of 30 subjects with acute hemiplegic stroke was selected according to Convenience Sampling. The inclusion criteria were both male and female, with age from 30-65,[20] affected by 1st stroke and within 6 month of stroke, Brunnstrom recovery stages 4-5, finally patients who could perform at least some active (10dgree shoulder flexion/abduction,10-degree elbow flexion/extension,30-degree IP joint movement. Subjects were introduced about the procedure and purpose of the study and they participated in the study at signing the consent form. Then the demographic data of the subject were taken. The demographic data like age, sex, height, affected side was taken.

The patients were divided into 2 groups. Group -1 (N=15) was given with dynamic wrist hand orthosis and traditional therapy and Group –2 (N=15) only treated with therapy. In group - 1 orthotic measurement and casting was taken for the fabrication of the dynamic wrist hand orthosis. Casting was taken in patient sitting position and elbow was flexed 90 degree and wrist and hand in functional position. Casting was important to make the exact replica of the hand and the cast covered the volar surface of palm, wrist, and proximal 1/3rd of the forearm. Positive mold modified at the time of modification, and by using 3 mm polypropylene molding was done. Proximal trim line was 1/3rd of the proximal forearm and distal trim line was proximal to the palmer crease so that the finger movement was not restricted and also allow the thumb movement. Trial was taken over patient. Out trigger bar and finger sleeves was attached according to biomechanical principle, elastic rubber band was used and each sleeve are 90degree to out trigger extension bar. In addition to the requisite 90° angle of approach to the length of the segment being mobilized, it is also important that the mobilizing force be perpendicular to the joint axis of rotation to ensure that equal tension is placed on both of the joint's collateral ligaments. After preparing the dynamic wrist hand orthosis pre data was taken. Patient was advised to do therapy for 6 weeks combined with dynamic wrist hand orthosis. After 6-week post data was collected. In group -2, only therapeutic intervention was given for 6 week and according to that pretest and post test data was collected.

Fig:1Dynamic wrist hand orthosis with outrigger

Fig:2Patient wearing the splint

PROCEDURE OF MEASUREMENT OF GRIP STRENGTH

Grip strength was measured by using hand held dynamometer (Camry). Grip strength was measured by averaging 3 attempts of maximal isometric strength with a grip dynamometer set at the second smallest setting. Participants were seated with their forearm supported on a table, shoulder positioned in neutral, and elbow at 90◦ flexion. Grip strength in people after chronic stroke has high reliability (ICC >0.86) and correlates well with tests of

upper extremity function min rest period was given in between each trial. [17,20]
Like that the box and block test score was also conducted before and after the intervention. The B&B test quantifies hand function by counting the number of 2.5-cm (1-in) blocks an individual can transfer over a partition dividing 2 sides of a box in a 1-minute time period. In a population with upper extremity paresis, the B&B test has been found to be reliable (ICC = 0.96).

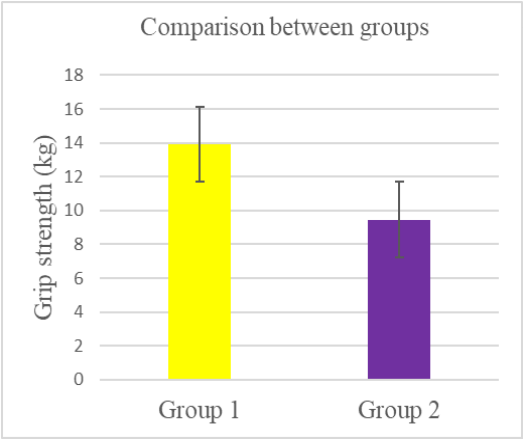
FIG:3 Measurement of grip strength with Camry hand held dynamometer

STATISTICAL ANALYSIS

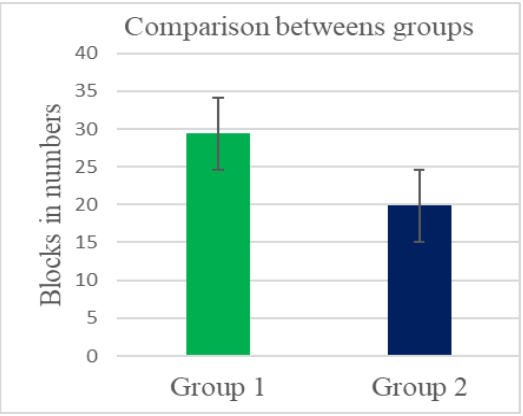
The outcome variables used for analysis were grip strength and hand function test. SPSS statistical software version 23.0 was utilized for data analysis. Pair t –test was used firstly to analyze the difference between grip strength and box and block test before and after the intervention of dynamic wrist hand orthosis and therapy in group (1) and in group (2) also pair t test analyzes the difference in both the variables before and after the therapeutic intervention. An independent t test was used to analyze the post test data of grip strength and box and block test in both groups. The level of P<0.05 was considered the statistically significance.

RESULT

The mean increase in grip strength after the use of dynamic wrist hand orthosis was 29.6% (p value<.000 and t value=8.065). A mean increase of 73.6% (p value<.000 and t value=16.374) in box and block test recorded after use of dynamic wrist hand orthosis in the group 1.
The mean increase in grip strength due dynamic hand splint and therapy was 13.907±4.916(p value -.009 and t value 2.791) and in group 2 was 9.458±3.732 (p value0.010 and t value 2.791).This accounted for 46% improvement in compared to group-2.The mean increase in box and block test due to combined dynamic wrist hand orthosis and therapy was 29.400±3.581(p valve -.000 and t value 5.102)and in group 2 19.866±6.289(p value .000and t value 5.102). This accounted for 47.9% improvement in compared to group-2.



Graph.1 Comparison of grip strength



Graph .2 Comparison of fine motor skill

DISCUSSION

Hemiplegia in the upper extremity is widely reported as the primary impairment in individuals after stroke. This impairment interferes with movements required for basic daily activities and household activity as well as for work related tasks. [21] Therefore, recovering voluntary movement

in the upper extremity is the most important goal in rehabilitation and for research in these fields. Various treatment approaches have been used for recovering the function of the hemiparetic upper extremity.[22] In the static hand splint motor recovery in hemiplegic hand function related to task-specific practice do not increase movement in the case of minimal distal movement in the hemiparetic upper extremity, but dynamic hand splint designed to permit quick training in opening and closing of the affected side due to spring or rubber band attachment.[19] The dynamic hand splint helps the participants to practice finger extensions by using progressively stiffer elastic-spring strength levels. The elastic force could be decreased to allow the participants to extend their hands more easily. The adjustment level of the dynamic hand splint's spring and the ability of the participants to engage in advanced training were determined by therapists according to the muscle tone and hand motion of the participants. [21]

Most of the current clinical evidence-based studies based on effect of therapeutic intervention on hand grip strength and fine motor skill tests like box and block test, action reaction arm test and some assessment scale etc. and most available studies on dynamic wrist hand orthosis on grip strength, fine motor skill development scales. So, aim of our study was to combined effect of dynamic wrist hand orthosis with therapy on grip strength and fine motor skill for improving manual dexterity. The findings of the study regarding gender distribution shows in male about 60% and 40% of the females are affected by hemiplegia in stoke. This result was supported by Peter Appelro et.al in which result shows Male stroke incidence rate was 33% higher and stroke prevalence was 41% higher than the female, with large variations between age bands and between populations. Regarding affected side in our study, 53% subjects were affected with left side and 46% subjects had right side involvement. In the current study the result was in agreement with Portegies ML et.al which showed left side is more effected. According to our research finding, the grip strength improve from 10.724±3.643 to13.907±4.916 (kg) by use of dynamic wrist hand orthosis combined with therapy after 1 month of intervention. The grip strength shows a statistically significant improvement of 29.6% after the use of dynamic wrist hand orthosis. Between groups, the mean increase in grip strength due dynamic hand splint and therapy was 13.907±4.916 (p value-.009 and t value 2.791) and in control group was 9.458±3.732 (p value0.010 and t value 2.791). This accounted for 46% improvement in compared to control group. Wen-Dien Chang and Ping-Tung Lai et al found the use of dynamic wrist hand orthosis in hemiplegic stroke significantly improve grip strength with combined with therapeutic intervention and $p<0.05$ which support our finding. Barry, J. G. et.al found significant improvement in grip strength p=.05 with saeboflex dynamic hand orthosis with home exercises programme which is supporting our research findings. But Sandy A. Ross et.al found no significant improvement in grip strength by use of saeboflex dynamic wrist hand orthosis with some therapeutic intervention. Box and block test used for measuring fine motor skill. It is used to test grasp and grip performances of similar objects. The B&B test quantifies hand function by counting the number of 2.5-cm (1-in) blocks an individual can transfer over a partition dividing 2 sides of a box in a 1-minute time period. Our finding revealed a mean difference of -12.466±9.94 in box and block test before and after intervention. 47.9% improvement was found in box and block test score when compared with to control group.

According to another study by Hye-seon Jeon et.al changes in fine motor skill was found by box and block test score, by the use of spring assisted wrist hand orthosis. Our result also suggest that use of dynamic wrist hand orthosis increases scores of box

block test significantly, within group and between the groups. [24] According to Youngkeun Woo et.al Significant improvement was found in box and block test (p= 0.03) due to use of saeboflex dynamic hand orthosis, which is in support of study. [21] Sandy A. Ross et.al found there was no significant effect in box and block test (p=0.43) with dynamic orthosis when compared to control group, which is contradict to our study. But there are some limitations in our study that small sample size, and study was conducted in one Centre, duration of use of orthosis by the subject could not be controlled exactly and thus it was difficult to generalize.

CONCLUSION

The result of this study shows that, dynamic wrist hand orthosis was more effective in improving grip strength and fine motor skill (box and block test), compare to only therapy. combined effect of orthosis and therapy is more effective. The study shows statistically and clinically significant improvement in grip strength and fine motor skill, which provides strong evidence for its clinically implication.

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Ethical Approval: Approved

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