Original Article

EFFECTIVENESS OF DYNAMIC WRIST SPLINT ON DELTOID MUSCLE ACTIVITY USING FUNCTIONAL TASK PRACTICE IN POST STROKE PATIENTS

Jalaja Prakash[1], Srinivas Mondam[2], Masilamani Srinivasan[3], Anitha Kumari Abbina[4].

Lecturer, MPT Neurology[1], Lecturer, MPT (Ortho)[2], Assistant Professor, MPT[3], Asst. Professor, MPT (CT)[5].

ABSTRACT

Background: The study is to analyze the effectiveness of dynamic wrist splint on deltoid muscle activity using functional task practice along with strengthening exercises in post stroke patients. **Materials and Methods:** Experimental study with sampling size 30 patients Group A: 15 patients. Group B: 15 patients. Sampling method is convenient random sampling. Intervention period: 4 weeks. Settings: Bhagwan Mahaveer Jain Hospital, Vasanth nagar, Bangalore. The patient will be received; history will be taken; explained about the treatment session and informed written consent will be taken. Patient will be made to sit comfortably. Check for safety i.e.; with arm rest, back rest if necessary provide cushion. Dynamic wrist splint of appropriate size will be taken; checked for fitting of the splint for any compression and avoid other complications The initial muscle activity prior to treatment will be measured using EMG for deltoid. Group A: The patient will be asked to perform a given set of activities or tasks with splint. Group B: The patient will be asked to perform a given set of activities or tasks without splint Each session would last for 30 minutes and frequency of 3-4 times per week. At the end of treatment, surface EMG for deltoid is taken to check for the effectiveness of use of splint with work task during the rehabilitation program. **Results:** After 4weeks treatment period, the subjects in the group A were compared with the subjects in the group B. Group B had shown a significant difference with outcome measures when compared to group A **Conclusion:** It is evident from the results that the subjects who used the thumb abduction supinator splint showed significant level of improvement in function and increase in deltoid muscle activity when compared with subjects who did not use the splint as quantified using Fugl Meyer Scale for Upper Extremity and Surface EMG.

KEY WORDS: Stroke; Fugl Meyer Scale; Deltoid muscle activity; Dynamic wrist splint; Surface EMG.

Address for correspondence: Ms. Jalaja Prakash, Lecturer Physiotherapy, Wind field International college, Kuala Lumpur, Malaysia. Email: jalaja03@gmail.com

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INTRODUCTION

Stroke is one of the common clinical problems in this era. It is a disease of the cerebral vasculature in which a failure to supply oxygen to brain cells, which are the most susceptible to ischaemic damage, leading to their death. It is also a major cause of serious disability in the community. Its consequences are broad which include long-term physical, psychological and social problems.

World Health Organization (1989) defines "Stroke is an acute onset of neurological dysfunction due to an abnormality in cerebral circulation with resultant signs and symptoms that correspond to involvement of focal areas of the brain"[1].

Stroke is preventable diseases with known, manageable risk factors.The modifiable risk factors for stroke include hypertension, smoking, obesity, elevated serum fibrinogen levels,

Diabetes Mellitus, sedentary lifestyle, and use of contraceptives with high doses of estrogen. The non-modifiable factors include age, race, gender, and family history of stroke. (Marmot M R et al, 1992).

The prevalence of stroke in India was estimated as 203 per 100,000 population above 20 years, amounting to a total of about 1 million cases (Sethi P K et al, 2002). The frequency of middle cerebral artery stroke (MCA stroke) has been reported to be more than 80 cases per 100,000 people (Barnett et al, 1992)[2]. Stroke rehabilitation is the cornerstone of good clinical stroke care and evidence based practice continues to expand exponentially (Dr. Marion Walker et al, 2006). It is the combined and coordinated use of medical, social, educational, and vocational measures for retraining a person to his/her maximal physical, psychological, social, and vocational potential, consistent with physiologic and environmental limitations. The goal of rehabilitation is to enable an individual who has experienced stroke to reach the highest possible level of independence and be as productive as possible. Stroke survivors often have complex rehabilitation needs; progress and recovery are unique for each person. Although a majority of functional abilities may be restored soon after a stroke, recovery is an ongoing process[3] .Impaired upper extremity function is one of the most common and challenging sequelae of a cerebrovascular accident. It has been estimated that 50% to 75% of individuals who experience stroke have persistent impairment of the affected upper limb (Mindy Levin et al, 2007). Research comparing the effectiveness of various approaches is lacking. However, clearly the current motor behaviour research supports a treatment technique: Consideration of appropriate orthoses for rehabilitation and use of function based tasks.

Upper extremity orthoses are devices applied externally to restore or improve functional and structural characteristics of the musculoskeletal and nervous systems[4]. Function based tasks are used to increase the patient's interest and active participation during interventions. This will also engage the patient for longer periods of time, providing opportunities for repetition and therefore for increased retention of functional gains as these are based on daily activities of the patient which in turn proves beneficial for the patient. During rehabilitation using functional tasks, a person learns to perform a variety of skill. Through functional training, the patients gain skills required for self care and mobility in the home and community. By maximizing their functional skills, they can enhance their capacity to perform socially defined roles and tasks. Several studies have proved that dynamic orthoses for lower extremity along with strengthening exercises showed improvement in strength, functional ability and balance in stroke patients[5]. It has also shown increased motor unit recruitment which was recorded in EMG. Studies have also proved that strengthening exercises are beneficial in stroke patients[6]. The use of appropriate orthoses reduces contractures; avoid unnecessary movement thereby enhancing better quality of movement and also prevents muscle wasting. The hand and finger coordination in stroke patients with hemiplegia required for skilled function is dependent on the ability to move selectively shoulder girdle required for the task. Based on Brunnstrom stages of motor recovery, from Stage 3, the spasticity in the arm can be reduced by proximal and distal inhibition and active movements can be facilitated, more isolated control of voluntary movement of the hand and finger is obtained[6]. It was noted that the proximal parts of the upper limb obtained more voluntary stability than the distal response, this being in keeping with proximodistal direction of ontogenic development (Toshiaki et al, 1990).

Studies have shown significant increase in deltoid muscle activity as it is one of the main muscle during flexion and abduction. The deltoid generates about 50% of the muscular force for elevation of the arm in abduction or flexion[7]. The contribution of deltoid increases with increased abduction. It has also been proved that deltoid is more resistant to fatigue in the range of motion through 45Ú to 90Ú of abduction. The role of a physiotherapist in rehabilitating a stroke patient with upper extremity involvement continues to be a challenging task and the studies regarding the use of upper extremity orthoses in rehabilitation is limited[8].

MATERIAL AND METHODS

An Interventional study was done on post stroke patients to analyze the effectiveness of dynamic wrist splint on deltoid muscle activity. A total number of thirty post stroke patients were selected by convenient sampling and samples were allocated into two groups A and B. Each group consists of 15 subjects. The subjects were in the age group of 50 to 65 years and both gender were included in the study. The measurement tool used in the study was Fugl Meyer Assessment of Physical Performance of Upper Extremity and Surface Electromyography (EMG). The study was conducted at Bhagwan Mahaveer Jain Hospital, Vasanthnagar, Bangalore. Subjects were diagnosed as stroke by the neurophysician with confirmation of MRI. After selecting the samples, test procedures were explained to the subjects, and then written informed consent was collected from the subjects to participate in the study. Inclusion criteria: MCA patients with confirmation of MRI, Brunnstrom grading of arm and hand: 4, patient should be able to do at least 90Ú shoulder flexion and elbow extension, age group: 50-65 years, both gender patients, patient should be co-operative. Exclusion criteria: Uncooperative and unstable patients, any peripheral nerve injuries, any neurosurgical patients, any musculoskeletal deformities and injuries with causes other than stroke, any joint restriction – range of motion less than 90Ú shoulder flexion, soft tissue tightness. Materials used for the study: Assessment chart, chair with back rest and arm rest, thumb abduction supinator splint, peg board, reflex hammer, goniometer , stop watch, EMG apparatus, cylindrical object. EMG is used clinically for diagnosis of neurological and neuromuscular problems, in gait laboratories and biofeedback. The EMG used in this study is Surface EMG with use of four channels for recording of deltoid muscle activity and the electrode placements were according to the International Standards of Electrode Placements. The recording electrode was placed over the deltoid muscle. The reference electrode was placed 2-3 cm below the recording electrode. The ground electrode was placed near recording electrode. An additional ground electrode was used to avoid artefacts. Electrode conductive jelly and surgical micropore plaster were used. The parameters used in this study - Amplitude and Voluntary maximal contraction[8].

Figure 1: EMG Equipment

Procedure: Patients who were diagnosed by neurophysician as stroke and those who fulfilled the selection criteria were divided into two groups (A & B) on the basis of convenient sampling. Demographic data of all the patients were collected i.e. age and gender. Patients were explained about the study and the purpose of the study in their own language. Informed consent was taken from the patients before the conduct of the study. There were 15 patients in each of the two groups. Group A performed the peg board and grasp activities without splint along with strengthening exercises. Group B performed the peg board and grasp activities with splint along with strengthening exercises. Fugl Meyer Assessment of Physical Performance for Upper Extremity was marked for each patient before starting the interventions. Surface EMG (sEMG) was used to record the deltoid muscle activity by making them to grasp a cylindrical object and abduct the arm, while maximal voluntary contraction and amplitude were recorded before the intervention as pre test measures.

Figure 2: Electrode placement

Group A: The patients were asked about the activities they had participated, prior to the stroke and they were made to carry out those activities like grooming, dressing, writing etc. The procedure was explained to the patients to help them understand the purpose of the intervention. The session started with practicing a simple task related to their activities of daily living and made them to repeat those activities followed by a rest period for about 10 minutes to prevent fatigue. Each task was sub divided into movements that progressed in complexity to minimize failure or frustration. They were encouraged to keep an activity log that described all tasks performed by the patient with the paretic limb. At the end of every week it was reviewed with the patient to obtain the effectiveness of the intervention. The patients were made to perform the pegboard activities by removing the blocks from the board and replacing them in the board. This activity lasted for 10 -15 minutes using a stop watch. As a variation, different shapes and sizes of the blocks were used. The patients were made to perform the grasp activities by reaching for a ball on the table, holding for 2-3 seconds using a stop watch and replacing it on the table. The task later progressed to reaching for a cup and bringing it towards them, cylindrical objects and other objects like keys and eraser. The task was made complex by making the patient place the object on various marked points on the table, exchanging between the affected and unaffected limb. These activities lasted for 10-15 minutes using a stop watch. Strengthening exercises for upper extremity were given. Each session lasted for an hour along with strengthening exercises, frequency - 3 times per week, duration - 4 weeks[9].

Group B: The patients were made to wear the splint and checked for the comfort and were made to perform the pegboard and grasp activities along with strengthening exercises as given for the group A patients. Each task was sub divided into movements that progressed in complexity to minimize failure or frustration. Each session lasted for an hour along with strengthening exercises, frequency- 3 times per week, duration - 4 weeks.

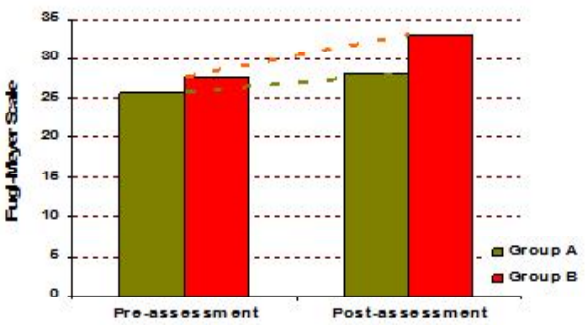
At the end of four weeks, the post-test measures of Fugl-Meyer Score of Upper Extremity were used to assess impairment, and surface EMG(sEMG) for deltoid muscle activity was recorded and compared with the pre-test measures to obtain the effects of the intervention[10].

RESULTS

The Statistical software namely SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 has been used for the analysis of the data. Table 1: The pre-intervention assessment score of FMS in Group A is 25.67 with a standard deviation of 3.29, ranging from 20-32. The post-intervention assessment score has increased to 28.07 with a standard deviation of 3.52, ranging from 21-34.The percentage change is 9.34%. P value is less than 0.001 which is significant. In Group B, the pre-intervention assessment score of FMS is 27.67 with a standard deviation of 3.52, ranging from 19-35.

Table 1: Evaluation of effectiveness based on Fugl-Meyer Scale between two groups

Fugl-Meyer Scale (FMS)	Group A	Group B	Significance
Pre-assessment	25.67±3.29 (20-32)	27.67±3.52 (19-35)	t=1.608; p=0.119
Post-assessment	28.07±3.52 (21-34)	33.13±3.94 (23-40)	t=3.715; p=0.001**
% Change	9.34%	19.73%	-
Significance	t=9.431; p<0.001**	t=17.833; p<0.001**	-



The post-intervention assessment score has increased to 33.13 with a standard deviation of 3.94, ranging from 23-40. Percentage change is 19.73%. P value is less than 0.001 which is significant.

Table 2: The pre-intervention value of EMG in Group A is 76.93 with a standard deviation of 6.92, ranging from 69-94. The post-intervention value has increased to 168.47 with a standard deviation of 20.32, ranging from 112-195.The percentage change is 118.99%. P value is less than 0.001 which is significant. In Group B, the pre-intervention value of EMG is 81.53 with a standard deviation of 12.35, ranging from 45-95. The post-intervention assessment score has increased to 209.00 with a standard deviation of 20.49, ranging from 176-251.The percentage change is 156.35%. P value is less than 0.001 which is significant.

Table 2: Evaluation of effectiveness based on EMG between two groups

EMG	Group A	Group B	Significance
Pre-assessment	76.93±6.92 (69-94)	81.53±12.35 (45-95)	t=1.259; p=0.219
Post-assessment	168.47±20.32 (112-195)	209.00±20.49 (176-251)	t=5.440; p<0.001**
% Change	118.99%	156.35%	-
Significance	t=19.373; p<0.001**	t=30.246; p<0.001**	-

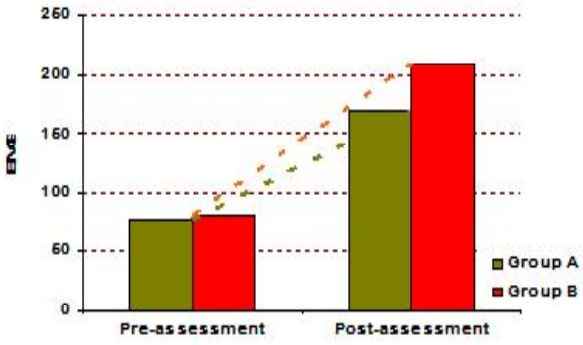
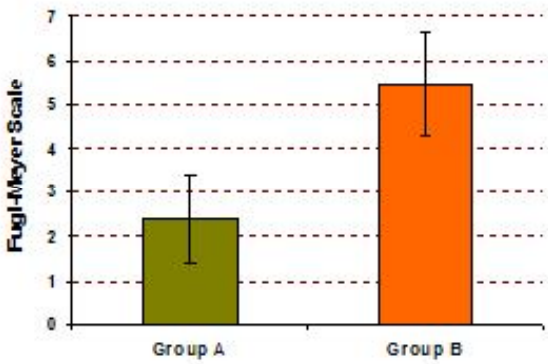
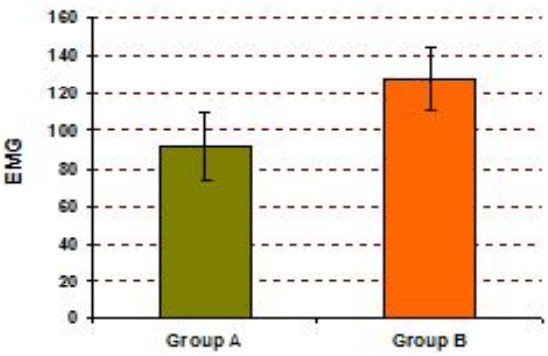


Table 3 shows that the outcome (difference of pre and post) of FMS for Group A is 2.40, with a standard deviation of 0.99, ranging from1-5. Group B shows 5.47 with a standard deviation of 1.19, ranging from 4-7. P-value is less than 0.001 which is significant. The Outcome (difference of pre and post) of EMG for Group A is 91.53 with a standard deviation of 18.29, ranging from 43-122. Group II shows 127.47 with a standard deviation of 16.32, ranging from 100-157. P-value is less than 0.001 which is significant.

Table 3: Evaluation of effectiveness based on Outcome (difference of pre and post)

Outcome		Group A	Group B	Significance	Effect size
Fugl-Meyer (FMS)	Scale	2.40±0.99 (1-5)	5.47±1.19 (4-7)	t=7.697; p<0.001**	2.73
EMG		91.53±18.29 (43-122)	127.47±16.32 (100-157)	t=5.676; p<0.001**	2.02





DISCUSSION

The possible reason could be that the splint held the subjects' thumb in abduction and wrist in slight extension and helped in grasp and release termination time. It prevented excessive pronation of the forearm thereby maintaining the functional position desired for the given activity. The elbow support helped in maintaining the elbow in extension. On a physiological level, the cause could be the priming of the motor cortex and appropriate activation of the neuromotor pathways leading to a greater amount of cortical reorganization and improved functional outcome[11].

CONCLUSION

It is evident from the results that the subjects who used the thumb abduction supinator splint showed significant level of improvement in function and increase in deltoid muscle activity when compared with subjects who did not use the splint as quantified using Fugl Meyer Scale for Upper Extremity and Surface EMG (sEMG)[12]. Although both the groups showed significant improvement, the subjects in Group B (with splint) showed greater improvement when their outcome (difference of pre test and post test) was compared with Group A (without splint). The alternate hypothesis is accepted which states that "There is significant difference following the use of dynamic wrist splint on deltoid muscle activity".Hence this study can be concluded that dynamic wrist splint has more effect on improving upper extremity function in subjects with stroke and hence can be used in clinical set ups.

Limitations: The sample size was small. The study duration was short. The duration of stroke was not considered. This could have also affected the overall outcome.

Recommendations for further studies: Can be done with a larger sample size. The effect of intensity of training and length of time actually spent in training can be considered. Effect of dominant hand and non dominant hand can be studied.

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