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Original Research Article

A COMPARATIVE STUDY OF EFFECTIVENESS BETWEEN ELECTRICAL - STIMULATION AND SPLINTING TECHNIQUES USED ALONG WITH NEURODEVELOPMENTAL TREATMENT FOR IMPROVING HAND FUNCTION IN HEMIPLEGIC PATIENTS

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ABSTRACT

Background: Neuromuscular Electrical Stimulation (NMES), splinting and Neurodevelopmental Therapy techniques are frequently used by the physiotherapist as an intervention for patients with stroke (Cerebrovascular accident)with limited or impaired functional ability, ROM and pain. Hence the present study was done to compare the effectiveness between NMES and splinting, both administered along with NDT for improving hand function in hemiplegic patients.

Materials and Methods: Out of 30 subjects who were diagnosed as having sub acute stroke and who showed a typical restriction of functional ability, ROM and pain of hand, 15 were administered NMES along with NDT for 4weeks and the other 15 were administered splinting along with NDT for 4weeks. Analysis was based on the improvement of the motor function of hand using ARAT Score.

Results: The improvement in functional outcome showed a mean of 15.133 with t-value 18.824 in Group A (NMES along with NDT) and a mean of 18.0000 with t-value 31.632 in Group B (splinting along with NDT); comparison showed to be highly significant with p=0.007. The result indicates that both NMES and Splinting with NDT are effective in improving motor function of hand in patients with stroke, however, Splinting with NDT seems to be better compared to NMES with NDT.

Conclusion: In conclusion the treatment programme consisting of Splinting with NDT may be more effective in improving motor and functional recovery of hemiplegics than NMES with NDT

KEY WORDS: Hemiplegia, motor recovery, electrical stimulation.

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INTRODUCTION

Stroke is a focal neurological disorder of abrupt development due to a pathological process in cerebral blood vessels lasting more than 24 hours. The clinical manifestation of brain infarction lead to weakness of one side of body (hemiparesis) [1] especially in distal musculature viz. intrinsics of hand. Gradually weakness occurs in forearm, arm and then shoulder in that order. The deep tendon reflexes are lost and hypotonia sets in [2].

The cerebrovascular event causing stroke may be ischaemia or hemorrhage which deprives the tissue of oxygen and nutrition. The risk factors include Hypertension, Diabetes Mellitus and Heart diseases. In hemorrhagic stroke there is abnormal bleeding into the extra vascular areas of the brain secondary to aneurysm or trauma, leading to increased intracranial pressure with injury to the brain tissue and

restriction of distal blood flow [3].

Immediately post stroke with resulting hemiplegia there is a state of loss of tone of the affected side limb musculature which may last for weeks or months, followed by the gradual development of a fixed synergy pattern within limb with increase in tonic stretch reflex and exaggerated tendon jerks in particular muscle group termed as spasticity [4].

The rate of recovery to normal tone in affected limb after this phase depends upon the site and type of lesion and on the type and mode of rehabilitation administered to the affected limb.[5] Middle cerebral artery stroke leads to drastic effect on movement and power of upper limb more than that of the lower limb. Spontaneous motor recovery occurs within initial 2 to 3 months after stroke i.e. the first voluntary movements noted 6 to 33 days after onset [2].

Recovery at first is that of a synergy pattern, followed by voluntary control of movement. The intent of therapy or rehabilitation is the return from involuntary synergy on stimulus to voluntary control. Return of meaningful voluntary control of hand function varies from 20% to 40% of patients having total recovery to remainder having no functional recovery [2]. Spasticity has devastating effects on the individual's life style and ADL activities. Also the deformed limb may further lead to emotional and social trauma [6].

In sub acute stage of completed stroke there is a decrease in size of cortical representation area of affected limb [2]. This leads to abnormal prolonged movements due to the altered and impaired firing rates [7]. During this period, motor recovery is believed to be enhanced by different techniques such as NDT, sensory integration and utilization of evolving synergies [8].

The NDT approach is directed towards goal of retraining normal functional patterns of movement in adult stroke which include activation of postural responses along with re-education of muscles in the hemiplegic arm and leg for weight bearing and non weight bearing activities. ROM and Stretching Exercises are initial component of any spasticity treatment programme [9].

The basis of facilitation and re-education programme in neurologically involved patients is bombardment of CNS with sensory information [10]. A considerable number of studies support the concept that electrical stimulation of healthy muscle , increased strength without requiring voluntary effort by the subjects [11]. Electrical stimulation has also been successfully used to prevent atrophy during joint immobilization and hence can be incorporated into almost any traditional facilitation technique to further enhance patient's control [12].

Splinting of affected side upper limb post stroke proved to be of great help in reducing the contractures as well as in bringing down the effects of spasticity at a later stage. A resting hand splint may be used to prevent joint deformities post contracture and also to decrease tone in spastic hand [13].

MATERIALS AND METHODS

Sampling method: 30 subjects, diagnosed with middle cerebral artery stroke were randomly allocated as per their availability, irrelevant of sex.

Inclusion criteria: Subjects with hemiplegia following an MCA stroke diagnosed by a certified medical practioner, age group between 40 years to 60 years, spasticity level of grade 3 or less as per Modified Ashworth Scale.

Exclusion criteria: Any other neurological disorder, orthopaedic problem which may hinder hand function improvement, non-dominant side affected.

Collection of Data: 30 subjects included were allocated randomly into 2 groups, Group A and Group B each consisting of 15 subjects. The Group A subjects received NMES and NDT exercises. Group B subjects received splinting and NDT exercises. The total duration of the study was 4 weeks. Upper-extremity motor function was assessed on the first sitting before treatment and at end of 4 weeks by using Action Research Arm Test.

Sampling: Subjects those who were referred to the outpatient department of Shree Devi College of physiotherapy Mangalore, Karnataka, India.

1. Subjects those who are referred to the outpatient department of Govt. District Wenlock hospital Mangalore.

2. Subjects referred from Mallikatta Neuro Center, Mallikatta, Mangalore.

Tools Used for the study were 1. Action Research Arm Test Measure (ARAT), 2. Custom made volar static splint, 3. Portable Electric Stimulator.

PROCEDURE: All the subjects were screened on the day one of the treatment according to the general neurological assessment format. Modified Ashworth Scale was used for grading spasticity level. Hand function was graded by using the Action Research Arm Test scoring . All the subjects belonging to both the groups were asked to sign the consent form at their wish also the technique of stimulation was demonstrated to them by self stimulation before the commencement of the sessions.

NMES administered to group A: NMES of the subject's affected hand was carried out by making the patient sit on a chair with his/her and resting on a table by side. The position of shoulder was abducted and forearm in prone position with elbow flexed to about 90 degrees, wrist joint in either neutral or slightly extended position. Two surface electrodes were placed over the extensor aspect of the forearm. Stimulation of the extensors will be carried out for 1 hour/ day. A biphasic wave form with amplitude ranging between 0 to 60 mA, pulse width of 300 m.sec, frequency of 25 to 50 hz & with an intermittent rest period set to 4 seconds after each pulse was selected.

Splinting for subjects belonging to group B: Subjects belonging to this group were made to wear custom made, static, volar cockup splint on the affected hand for 8 hours a day, so that the wrist stays in at least 45 degree of extension.

NDT administered to both the groups: Clasping the affected hand with the unaffected hand & moving the affected limb in overhead position so that the affected side elbow remains extended.

1. Holding the effected side hand with the normal hand from side to side.

2. Weight bearing on affected side hand with the elbow kept in extension. Holding a stick in both hands at a distance & performing shoulder overhead movements & side to side movements. (Shoulder flexion, horizontal abduction & adduction, elbow extended).

3. Holding stick in affected hand & performing rotation of forearm (supination & pronation of forearm) .

4. Subjects made to do weight bearing on fore limbs (Quadruped position) & made to do front & back rocking.

5. In lying down position patient made to take his effected side hand above his head.

6. The wrist & finger flexors of the affected side hand were stretched towards wrist extension in the pain free range.

RESULTS

The statistical analysis was done for both groups based on the readings that were taken from day 1 till day 28th and were given the terms **pre** for 1st day for both the Groups and **post** for 28th day.

Table 1: Pre-Post comparison in GROUP A (NMES along with NDT).

GROUP A (ARAT)	MEAN	SD	t	p
Pre	3.933	2.914	18.824	0
Post	19.066	3.863		

Table 1: shows the Pre-Post comparison of ARAT Score in GROUP A. The mean of pre-treatment ARAT score mean in GROUP A is 15.133 SD ± 2.914, and mean of post treatment ARAT score is 19.066 SD ±3.863. Thus there was a mean improvement of 15.133 in the ARAT score value, pre-post treatment. The t value of this GROUP A pre-post treatment was 18.824 with p=0.000 sig.

Table 2: Pre-Post comparison in GROUP B (Splinting along with NDT).

GROUP B (ARAT)	MEAN	SD	MEAN IMPROVEMENT	t	p	RESULT
Pre	3.33	2.093	18	31.632	0	P <0.05 Sig.
Post	21.33	2.35				

Table 2 shows the Pre-Post comparison of ARAT Score in GROUP B. The mean of pre-treatment ARAT score in GROUP B is 3.3333 SD ± 2.093, and mean of post treatment ARAT score is 21.33 SD ±2.350. Thus there was a mean improvement of 18.00 in the pre-post treatment ARAT score values. The t value of this GROUP B pre-post treatment was 31.632 with p=0.000 sig.

Table 3: Comparison between GROUP A and GROUP B.

GROUP (ARAT)	MEAN IMPROVEMENT	t	P	RESULT
GROUP A	15.133	2.91	0.007	P<0.05 Sig.
GROUP B	18			

Table 3 shows the mean difference between the pre-post ARAT score in GROUP A and GROUP B. The mean improvement in GROUP A is 15.133 and GROUP B is 18.00. Thus there is a mean improvement of 2.867, t value 2.910, p value 0.007(<0.05) sig.

DISCUSSION

The present study suggests that both NMES as well as splinting along with NDT are effective in improving upper extremity motor recovery of stroke survivors.

The inter group comparison of ARAT scores in both group at first sit pre and 20th sit post were carried out by using students paired t-test. For GROUP A 1st sit pre showed a mean of 3.933, SD ± 2.914 and 20th sit post showed a mean of 19.066, SD± 3.863. In GROUP B 1st sit pre showed a mean of 3.33, SD± 2.093 and 20th sit post showed a mean of 21.33, SD± 2.350. Thus the result indicated improvement in both the groups. GROUP A had a mean improvement of 15.133 and GROUP B showed a mean improvement of 18.000.

The intra group comparisons, of ARAT score using paired t-test. GROUP A had t-value = 18.824 (p=0.000sig) and GROUP B had t-value= 31.632 (p=0.0000sig). Comparison between pre and post treatment scores were done for both the groups. The findings of the students unpaired t-test suggested that Splinting with NDT demonstrated significant improvement over NMES with NDT in ARAT score with t-value=2.910 (p=0.007sig).

The study documents the effects of NMES on the motor recovery as reflected by the ARAT scores. The study suggests that active repetitive exercise induced by NMES enhances the motor recovery after stroke when administered along with NDT. The study also documents the effects of Splinting on the recovery of the motor function due to marked increase in spasticity and increased tone post stroke due to abnormal synergy pattern. This is consistent with the findings of some studies which state that prolonged splinting post stroke has a beneficial effect on recovery of motor function.

It has been hypothesized that longitudinal muscle growth occurs in response to the average position in which a muscle is held. After an earlier trial of hand splinting for stroke patients, and found that splinting was ineffective, we speculated that hand splints that administered greater stretch at the wrist might be beneficial. The results on the outcome measure post treatment have shown that splinting the wrist in either a neutral or an extended position did produce statistically significant and clinically important effects in adults after stroke.

The pre-post treatment changes in the ARAT scores correlate with the findings of a study which states, that consistent use of splint in hemiplegic patients shows increased spontaneous use of hand [14]. Thus, this study supports the conclusion of one of the study which suggested that immobilizing hand splint may be used as an integrative treatment of post stroke upper-limb spasticity [15].

The strengths of this study are that it used a concealed, random allocation to both the intervention groups, blinded assessment of outcomes, used valid outcome measures, specified primary outcomes, and analyzed data by intention to treat. Therefore, the results should be generalizable to the stroke population undergoing rehabilitation.

CONCLUSION

The subjects in GROUP B, who received Splinting along with NDT showed better improvement in motor and functional recovery of paretic arm than GROUP A, who received NMES along with NDT.

Conflicts of interest: **None**

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