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Original Article

EFFECTIVENESS OF FUNCTIONAL MUSCLE STIMULATION IN IMPROVING MOTOR CONTROL AROUND SHOULDER IN PATIENTS WITH HEMIPLEGIA

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ABSTRACT

Background: The effect of electrical stimulation on motor outcomes around shoulder in acute hemiplegia is elusive. We tested the effect of stimulation of specific muscles around shoulder on motor outcome in shoulder in patient with hemiplegia.
Methods: 32 first time hemiplegic patient of stroke origin were randomly allocated to control and experimental group. Experimental group received electrical stimulation apart from exercises given to both the groups for 2 weeks. Deltoid, infraspinatus and upper trapezius were stimulated, along with attempt to contract the muscles. Stroke Rehabilitation Assessment of Movement (STREAM) upper components and manual muscle testing were used for evaluation of outcome. Wilcoxon sign rank test and chi-square tests were used for statistics.
Results: Experimental group demonstrated greater recovery compared to control group. In both groups trapezius muscle work showed improvement in large number of patients followed by deltoid. STREAM score changes were seen a more number of patients in experimental group than control group.
Conclusion: Electrical stimulation can be considered as an adjunct to exercises around shoulder in early stroke rehabilitation
KEYWORDS: Electrical stimulation, Hemiplegia, Rehabilitation.

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INTRODUCTION

Electrical stimulation is one of the therapies in neuro rehabilitation. Electrical stimulation has been used commonly for reduction of spasticity [1,2], facilitating muscle contraction[3,4,5] in upper limb rehabilitation after stroke. The stimulation was generally focused on forearm muscles [1,6,7] and few studies were on stimulation of muscles around the shoulder [8,9]. Earlier studies had methodological differences in the parameters of stimulation; muscles stimulated [10] and strength of stimulus - motor level to sensory level [11]. As majority of the studies are done on chronic stroke patients with some control in their upper extremity, the results cannot be generalized to acute patients with absence of control in extremities. Though majority of the studies concluded that electrical stimulation had positive effect on motor outcome, Church et.al concluded that it can impede the neural plasticity or result in abnormal neural plasticity [8].

In acute stroke patients absence of sense of muscle contraction may hamper their motor learning. The sense of effort produced by the muscle contraction is an integral feedback for any movement [12]. Sensation from the muscle contraction with joint sense guides through the movement as well as helps in learning the movement. As stroke patients will have minimal or absence of muscle contraction in the acute stage, their sense of muscle contraction will be reduced or absent. This may reduce their effort to cooperate during a therapy session to facilitate the muscle contraction/movement. Providing a near normal sensory input for a movement will assist in better motor learning [13]. We felt that making the muscle to contract with electrical stimulation along with the patient's effort will provide sense of muscle contraction, thus improving the of motor learning. Considering the dearth studies on effect of electrical stimulation on muscles around shoulder and models of neural recovery supporting early proximal recovery, we choose to stimulate muscles around the shoulder. We tested effect of electrical stimulation with portable electrical stimulator, given to specific muscles around the shoulder in improving motor control around shoulder in acute hemiplegic patient.

METHODS

All patients with first time hemiplegia due to non-traumatic vascular origin within a week of onset, in the age range of 30 to 70 years with a good comprehension referred for rehabilitation were screened for inclusion. Patients with absence of control in their upper extremity measured by STREAM upper limb component (score 0) and manual muscle testing (Grade 0) were considered for inclusion. Patients with previous history of stroke, brain stem infarcts, orthopedic and neurological conditions affecting the upper limb recovery, presence of sensory deficits were excluded. The nature and purpose of study was explained to patients before recruiting them in the study. Informed consent was taken from every subject. Ethical committee clearance was obtained from the Institutional ethics committee.

Thirty two subjects with mean age of 55.87 years (SD 12.6) were included in the study. They were randomized into control and experimental group by block randomization. Both the groups received exercises based on motor relearning program and neruo developmental therapy including facilitation of isolated muscle contractions and task oriented facilitation of movements. Isolated muscle contractions of upper fibers of trapezius (scapular elevation in sitting), external rotators of glenohumeral joint (external rotation in of arm in contralateral sidelying position) and deltoid (shoulder abduction to 90 degrees in supine) were facilitated with tapping on the muscle belly as a part of training. Reaching activities involving assisted picking of a glass from table, touching hand of the therapist at different positions, touching the patient's head were given as a part of task specific training.

The experimental group in addition to common training sessions received electrical stimulation to upper fibers of trapezius, infraspinatus and deltoid. The stimulation was given with portable electrical stimulator (Technomed Ltd) delivering intermittent direct current with 1 millisecond pulse width and 40 Hz frequency (surged faradic type of current). Three contractions (surges) were given per minute with intensity to produce strong muscle contraction using two carbonized rubber electrodes and saline as a conducting medium. Patient was asked to perform the movement along with the current. Fifteen contractions were given to each muscle in each session, and one session per day was given. The upper fibers of trapezius were stimulated with patient in sitting with instruction to shrug the shoulder. Deltoid was stimulated with patient in supine lying asking for abduction of shoulder. Infraspinatus was stimulated with patient in contra lateral side lying. Patient was asked to externally rotate the shoulder to bring the hand away from the bed. Patients were instructed regarding the movement to be performed and to inform difficulty in tolerating the intensity of current. At the end of every five contractions skin was checked for abnormal reactions like excessive erythema. At the end of two weeks of training manual muscle testing was performed for stimulated muscles. STREAM was scored for paretic upper limb.

Within the group changes was tested with Willcoxon sign rank test. For between the group analyses the STREAM upper limb score was categorized as less than 2 and more than 2 (including a score of 2). MCID for STREAM upper limb component is equivalent to change of 2 points [14]. Manual muscle testing scores are divided as 0 and 1 or higher score. Chi-square test or Fisher exact test (when any count recorded less than 5) was used for between the group testing.

RESULTS

Table 1 shows the demographic data of the patient studied. The greater percentage of patients in experimental group showed change in their motor control than in control group. In STREAM scoring 85% of the patients in experimental group improved to a score two and above, whereas none showed such a change in control group. In experimental group two patients scored 5 and one patient scored 6 in STREAM upper limb components. In control group three patients scored one and other thirteen had absence of control. STREAM score change within experimental group was statistically significant ($p<0.05$) while the changes in control group did not reach statistical significance.

In experimental group strength of upper trapezius and deltoid improved in majority of the patients and change was statistically significant, however number of patients who had improvement in the external rotator strength was minimal, and the change was not statistically significant. In control group though patients improved in strength of the muscles evaluated, the change did not reach statistical significance for all the 3 muscles. In this group the upper trapezius strength change was observed in majority of the patients followed by deltoid and external rotators (Table 2). In between the group testing, experimental group has significantly greater improvement in all the variables (Table 3).

Table 1: Demographic data

	Control group (n = 16)	Experimental group (n = 16)
Age	56.6 +/-11.1	55.1+/-14.4
Male	11	12
Female	5	4
Left CVA	8	6
Right CVA	8	10

Table 2: Frequency table for muscle power at post intervention period

	Muscle power					
	0	1	2	3	4	5
Control group						
Deltoid	13	3	0	0	0	0
Infraspinatus	15	1	0	0	0	0
upper trapezius	7	6	3	0	0	0
Experimental group						
Deltoid	5	8	3	0	0	0
Infraspinatus	8	5	1	2	0	0
upper trapezius	0	3	9	4	0	0

Table 3: Frequency table for between the group differences

	Control group (n=16)	Experimental group (n=16)
STREAM UL ≥ 2	0	16*
MMT Deltoid ≥ 1	3	11*
MMT Trapezius ≥ 1	9	16*
MMT Externa rotators ≥ 1	1	8*

*significance at $p<0.05$

DISCUSSION

We found that electrical stimulation in acute stage of hemiplegia has impact on the motor outcome in upper extremity. In the presence of only few studies testing the effect of electrical stimulation in proximal part of upper extremity, the result of this study reveals that electrical stimulation will be an effective addition to therapy for improving motor control. Patients in experimental group showed improvement in movements which are not limited to muscle stimulated in the study. They showed ability to protract scapula, flex elbow, and initiate elbow extension. However majority of them improved in shoulder shrugging in sitting. These improvements can be attributed to increase in cerebral blood flow in the sensory –motor cortex revealing an increase in activity in the area during electrical stimulation [5].

Motor learning depends on the feedback received during the performance of motor task. The individual receives the feedback of every part of the movement through his proprioceptors in the joints and muscles. This type of feedback can be termed as knowledge of performance or internal feedback mechanism. In this feedback when an individual lacks muscle contraction as in case of early part of stroke, the feedback from the muscular element will be absent. Hence individual cannot feel the amount of muscle contraction and has to rely only on the joint proprioceptors. It is anticipated that electrical stimulation given along with the patient's ability to move, it will make the muscle to contract and provide the feedback of muscle contraction. This enhanced sensory input, would have benefited in development of motor control in experimental group. Merletti et al (1978) states that force production of muscle improved with the electrical stimulation [3]. We found a improvement in contractile ability of stimulated muscles in experimental group. We found study by Church et al. (2006) stating that 4 weeks stimulation to supraspinatus and posterior deltoid did not improve motor outcome in severely impaired acute stroke patients after 4-week session of treatment. It was not clear whether patient's attempted movements along with stimulation in this study [8].

In control group few patients showed change in their motor control. Trapezius activity was predominant in this group. Upper trapezius activity is a movement generally learnt by the patients easily as it is a part of flexor synergy of upper limb as well as it is a part of compensatory movement for upper limb elevation around shoulder. STREAM score change was observed among three patients only. The muscle contractions gained by these patients were predominantly flicker of contractions, not enough to perform components of STREAM upper limb.

Chae et al. (2008) states that methodological limitation found in earlier studies making interpretation of the results difficult, though they conclude a positive outcome by stimulation. Few studies were not clear regarding patients participation during stimulation, which we feel important for motor learning [8,15]. Doing muscle work along with electrical stimulation will improve chances for motor learning We considered small number of patient population studied and short therapy duration, as limitations. Size and site of lesions could have influenced the outcome, which was not considered in the study.

CONCLUSION

The results of this study suggest that electrical stimulation can be considered as an adjunct to exercises in early part of rehabilitation in improving the motor control after stroke around shoulder.

Conflicts of interest: None

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