Effect of EMG biofeedback plus stimulation in the functional recovery of hemiplegic hand

Eva Snehlata Kujur

Sr. O.T, National Institute for the Orthopaedically handicapped
B.T.Road, Bon Hooghly, Kolkata-700 090

Introduction

Rehabilitation of the upper extremity in patients who have sustained a stroke poses a major challenge to therapists. In a review of studies on upper extremity recovery , Gowland stated that only 4% to 9% of patients regained normal function , 23% to 43% regained some useful function and 16% to 28% did not have return of any voluntary movement in upper limb[1] .Different treatment strategies for the rehabilitation of hemiplegic patients are available today , such as conventional exercise programs ,PNF, muscle strengthening and physical conditioning programs , neurophysiologic approaches and functional electrical stimulation .Most of these studies have reported that EMG biofeedback can help to achieve improvements even in the chronic state[2].

Feedback is an engineering term defined as a method of controlling a system by re-inserting into it the results of past performance (Moon 1978).Among the most expressive therapeutic advances, those relating to spasticity control need to be acknowledged[3]. Dimitrijevic and Soroker 1994 studied electrical stimulation effects through a wire–mesh glove on upper extremities of hemiplegic patients .The preliminary results indicated beneficial effects such as decrease in muscle hypertonia and facilitation of hand–isolated movements

Relatively little attention has been paid to the potential of effect of EMG Biofeedback + Stimulation in the functional recovery of hemiplegic hand Hence this study was carried out to see the effectiveness of EMG Biofeedback +Stimulation for the functional recovery of hemiplegic hand.

Reprints Requests: Eva Snehlata Kujur
Sr. O.T, National Institute for the Orthopaedically Handicapped, B.T. Road ,Bon Hooghly, Kolkata-700 090

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Purpose

The purpose of this study was to determine whether there is conclusive evidence regarding the use of EMG Biofeedback + stimulation for improvement in upper extremity function in stroke patients.

Hypothesis

There will be Functional recovery of hemiplegic hand and an increase in the joint range of motion for wrist extension after the application of EMG Biofeedback +Stimulation.

Null hypothesis

There will not be any increase in the functional recovery of hemiplegic hand and an increase in the joint range of motion of wrist extension after the

application of EMG Biofeedback +Stimulation.

Inclusion criteria

1) Inability to perform voluntary motion in the upper extremity following stroke & significant room for improvement in one muscle group.

2) Relatively uncomplicated history.

3) Workable amount of cooperation and attention.

4) No significant visual and auditory deficits.

5) Significant motivation.

Exclusion criteria

1) Flask hemiplegia., 2) Dementia., 3) Deformity of upper limb., 4) Any incidence of receptive aphasia., 5) Any cardiac problem.

Related Literature

Upper extremity hemiparesis is a prominent impairment following stroke and has a significant impact on activities of daily living and quality of life .recovery of upper extremity function is most rapid during the first months after stroke

.However, even 3 months after stroke only 20% of stroke survivors have normal upper extremity function. Accordingly, the majority of stroke survivors report that impaired upper extremity function is a major problem and this is associated with low level of subjective well being[4]. The loss of function in the limb of stroke survivors is the result of lack of inhibition from the higher centers. Some studies (Alfieri,1982:Kraft etal,1992) analyzing FES denoted relief of plasticity and opening of the hemiplegics hand , believing that this fact is due to the mechanism of reciprocal inhibition of the fingers flexion muscles, at the moment when the extensor muscles in hemiplegic patients are stimulated[5] .

There is growing evidence that electrical stimulation has a positive effect on upper extremity motor recovery following stroke. Therefore electrical stimulation might be a adjunct in the rehabilitation of patients with stroke[4]. Emg –biofeedback is not a system of treatment in itself, but a technique that can be incorporated into many treatment programmes.

Biofeedback is a specialized form of feedback that provides information directly to a patient about internal biological mechanisms via a sophisticated electronic device. To quote John Basmanjian (the " Father" of EMG Biofeedback), biofeedback is the technique of using equipment (usually electronic) to reveal to human beings some of their internal physiological events ,normal and abnormal, in the form of visual auditory signal in order to teach them to manipulate these otherwise involuntary or unfelt events by manipulating the displayed signals[6].

Feedback may facilitate plastic changes within the central nervous system. Mechanisms that might be invoked include one or more of the following elimination of active inhibitory influences, unmasking of existing pathways to sub serve functions, development of new movement strategies , transfer of function to intact neural structures , use of alternative pathways or sprouting of collateral axons to form new synapses[7].

What is the mechanism of EMG-biofeedback?

A nerve impulse arriving at the neuromuscular junction triggers a wave of depolarization In the muscle fiber membranes .The sum of muscle fiber action potentials from all fiber making up a motor unit is called a motor unit action potential (MUAP) .With increasing contraction in a normal muscle, more motor units are recruited and the firing rate of each unit increases .With increasing contraction in a normal muscle, more motor units are recruited and the firing rate of each unit increases. The increase in motor unit action potential can be detected through surface electrodes over the muscle [3].

Those clients with neurological disorders are the most difficult to treat because of the complex nature of their multiple symptoms. The presence of weakness, flaccidity, spasticity, or a combination of these three conditions as well as dysphasia, cognitive impairment or neglect syndrome challenges the therapist to develop a creative means to efficiently and effectively rehabilitate the client through the years.

Motor control requires information from the external world as well as proprioception. In motor learning feedback and practice are considered to be the most important. Feedback can be intrinsic or extrinsic. Intrinsic feedback is the body's internal feedback mechanism which uses visual, auditory, vestibular and proprioceptive mechanisms. Extrinsic feedback is any feedback devised from any external source. The goal of biofeedback is to improve motor performance by facilitating motor learning .This concept can be effectively incorporated with a combination of stimulation and biofeedback[5].

Electrical stimulation provides effective joint positioning by eliciting activity from weakened or inactive muscle groups. Electrical stimulation has the potential to strengthen these muscles when volitional activation is present. Electrical stimulation may facilitate neuromuscular re-education as well, the stimulation provides added afferent information to the central nervous system with attention to task and attempts to volitional activation, this afferent input may contribute to neuromuscular re-education of stimulated area[8].

When the afferent nerve is stimulated, the A alpha fibers are reflex stimulated and as a result the muscle contracts. Initiation of voluntary contraction takes place through primary

activation of the small motor neurons to set up a stretch reflex and bring about activation of the alpha neurons[9].

Depending on the instrument available , an individual who receives joint position feedback seem to improvement in torque production about the treated joint , in patterned range of motion and selective range of motion. Because joint position feedback trains motion, those patients lacking active motion about an individual joint are unable to take advantage of this approach. For the latter population, neuromuscular stimulation should be incorporated with EMG biofeedback, rather than positional feedback, thereby rendering to changes in muscle activity that are insufficient to initiate joint motion[10].

Review of literature

1) Mroczek etal 1978 in his study EMG feedback and neuromuscular retraining in hemiplegia came with the following conclusions. Biofeedback is an effective training modality and vital to motor function. It was also noted to be an effective incentive to learning by virtue of its technologic and cultural attractiveness to the subject population[11].

2) Basmanjian etal in 1982 in his study assigned an integrated behavioral physical therapy treatment including EMG Biofeedback to the experimental group and a standard physical therapy program of little duration and intensity to the control group both patients showed clinically significant but the experimental group showed better results[12].

3) Honer etal performed a case study to describe the use of EMG Biofeedback training to disrupt the synergistic patterns of upper extremity in a hemiplegics patient 1yr post stroke. The finding suggested failure of EMG training to promote deviations from an upper extremity synergy pattern in an individual[13].

4) A survey by Weerdt etal 1985 on the use of biofeedback for stroke patients concluded that it can be used as an adjunct to endorse a range of other treatment technique[3].

5) Wolf etal 1983 examined the effect of EMG Biofeedback treatment protocol on qualified changes in neuromuscular measures and functional activities among the treatment of 22 cases chronic stroke patients. Its results concluded that EMG Biofeedback can be beneficial in restoring improved upper extremity function among chronic stroke patients[6].

6) Francisco etal 1998 conducted a study EMG triggered neuromusmuscualr stimulation for improving the arm function of acute stroke survivors .He concluded that there is an effective in increasing arm function[14].

7) Carraugh etal 2000, in his study chronic motor dysfunction in stroke , recovering wrist and finger extension by EMG triggered neuromuscular electrical stimulation, conclude that the instrument is a effective means for therapeutic purpose[15].

8) Armagaon etal 2003 evaluated the efficacy of biofeedback treatment in the functional recovery of hemiplegics hand .It was evident that EMG Biofeedback when used as an adjunct to therapy , resulted in improvement in upper limb of motion and muscular strength[2] .

9) Kroon etal 2004 conducted a study on relation between stimulation characteristics and clinical outcome in studies using electrical stimulation to improve motor control of the upper extremity in stroke.

The study indicates no relationship between the specific setting of stimulation, subject characteristics and clinical outcome[9].

10) Dursun etal 2004 in there study on Effects of Biofeedback treatment on gait in children with cerebral palsy ,concluded that children with cerebral palsy and dynamic equines deformity may benefit from Biofeedback treatment for ambulation[16].

Methodology

Design

The design is a different subject experimental

Setting

The study was conducted in the Occupational Therapy Department of N.I.O.H., Kolkata.

Subjects

A total of 30 subjects with mean age group of 57yrs participated in the study. Subjects were included in the study only after taking individual consent.

Instruments /Scales Used

1) Biofeedback Instrument, 2) Action Research Arm test, 3) Goniometer, 4) Brunnstrom stage of motor recovery,

Assessments

Basic information of all the patients was taken (demographic data, history, motor evaluation, evaluation of hand function, functional evaluation and ADL evaluation was recorded), for referral. Specific assessments required for the study were Brunnstrom stages of hand recovery, Goniometric measurement for active selective range of motion of wrist, and action research arm test. Subjects were also assessed for the ability to follow simple instructions by administering a part of mini mental status examination.

Experimental group

Experimental group received EMG Biofeedback +Stimulaton for wrist extensors and finger extensors. Subjects were also provided with the conventional Occupational therapy.

Control group

Control group received only the conventional Occupational Therapy for 20 sessions.

Procedure

Duration of treatment

Total of 30 minutes session, 15 minutes each for wrist extensors and finger extensors with a in between phase suitable to the patients compliance to the the program.control group underwent the conventional therapy for one hour each day for 20 sessions

Treatment, Relaxation

1) Relaxed position is determined, the patient is asked to maintain the reduced EMG activity as he performs various motions with opposite extremity.

2) Conversations with the patient may be used by therapist as a measure of the patients ability to maintain the relaxed state while his attention is diverted.

3) patient is asked to maintain a relaxed state during a full passive stretch of the involved muscle.

Position

Shoulder flexion-10* to 15*, Abduction-20* to 25*

Elbow flexion-10* to 15*.,Wrist flexion - 1 (Maximum), Finger flexion - Maximum [17](Kelly)

Electrode application

Select the muscle to be monitored.

Prepare the skin site by cleaning with spirit for application of electrodes over the muscle bellies of wrist extensors the for the muscle belly for finger extensors.

Electrodes spacing is 3.5 cm to 5 cm.

Arc of motion

The wrist extensors and finger extensors were monitored only after relaxation of flexors of the wrist and the fingers .If too much flexor activity ws evident, subjects were targeted for smaller arc of motion with success in smaller range of motion, larger arc of motion was aimed.

Parameters

The parameters used for each patient were adjusted to produce the most harmonious movement possible .Width of pulse varied between 100 micro se to 200 micro sec and the frequency varied between 40 hertz to 50 hertz.A

Long ramp on time is used to avoid activating of stretch reflex in a spastic antagonist.

During the biofeedback session which was in the protocol the patient was asked to contract the wrist extensors and the finger extensors voluntarily

Results:

The data was analyzed by spss software. The results indicated an improvement in the joint range of motion of wrist extension, the control group achieved 2% improvement in range in experimental group 25% improvement was seen. Not much difference was observed on the affect on improvements in joint range of motion by the stage of recovery. The results are tabulated in table.

DEMOGRAPHIC AND CLINICAL FEATURES PF SUBJECTS		
	EXPERIMENTAL GROUP(n=15)	CONTROL GROUP (n=15)
Age/yr	57 ± 10.53	57 ± 11.27
Male /Female	13/2	10/5
Duration of stroke (months)	36/09	36/4
Stroke type,inf/hem	7/7	6/7
Side of hemiparesis(R/L)	9/5	9/4

Table 1

Table 2. Correlation of stage of recovery and we JROM

N	BRUNNSTORM STAGE OF RECOVERY	% 0F IMPROVEMENT IN JROM OF WRIST EXTENSION
30	2-3	13.6%
	3-4	14.6%
	4-5	40%

There remained a tendency for total ARAT score to be improved in the experimental group; however this difference was not statistically significant between the two groups.

P=0.24

Discussion

The hypothesis that there will be an improvement in the functional recovery of upper extremity in the stroke patients was not justified as the results were not significant at p=0.24. Studies by Lourecao etal leads to conclude that use of FES on upper extremity should be at least for 6 months, when applied twice a week. Probably the duration of treatment was not long enough; this may justify the insignificance in the recovery of upper extremity function. There was an improvement in the joint range of motion of wrist extension in both the groups but the experimental group cited better results. Feedback may facilitate plastic changes within the CNS[7] .Basmanjian etal in his study states that studies on new therapy for upper limb function in stroke patients should be done at the IIpost stroke in patients who show greatest promise. And as most patients in the study did not belong to the acute stage it may be suggested that this may be one of the reasons for the insignificance in the results[12].

There was not much difference in the wrist extension range of motion in between the stage group 2 to 3 and 3 to 4. This is supported by Armagaon etal, 2003, who in their study revealed similar results. This may be because electrical stimulation has combination of effects including those at the level of muscle and also a central effect associated with improved motor relearning. However the subjects in stage 4 to 5 achieved 40% improvement[2]. Kroon etal 2005 states although there not direct evidence electrical stimulation provokes motor activation and is associated with cutaneous , muscle and joint proprioception feedback .It may be that patients belonging to stage 4 to 5 get more muscle and joint proprioception feedback which adds to the better improvements in joint range of motion.

Conclusion

The study provides conclusive evidence regarding the use of EMG Biofeedback + stimulation for improvement in upper extremity function in stroke patients .The study did not show statistically significant differences, therefore it may be that the estimated size was small, hence future studies are recommended with a larger sample size. Studies may be conducted to see whether lesion site has any correlation to improvement in upper extremity function and joint range of motion for wrist extension as a result of the therapy[10].

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