# EFFECTIVENESS OF EMG BIOFEEDBACK ON IMPROVING HAND FUNCTION IN HEMIPLEGIC STROKE PATIENTS

# EFECTUL BIOFEEDBACULUI EMG ÎN ÎMBUNĂTĂȚIREA FUNCȚIEI MÂINII LA PACIENȚII HEMIPLEGICI, DUPĂ ACCIDENT VASCULAR CEREBRAL

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**Key words:** EMG Biofeedback, Stroke, Hand function, Action Research Arm test, Voluntary control grading scale.

**Abstract.**

**Objective** The purpose of this study was to find out the effect of EMG biofeedback along with conventional physiotherapy on improving hand function in subacute stroke participants.

**Design** Prospective comparative study.

**Setting** Department of Neuro Physiotherapy, Pravara Rural Hospital (Tertiary Hospital), Loni, Tal- Rahata, Dist-Ahmednagar, Maharashtra State, India- 413 736.

**Methods:** This study was conducted between January 2011- November 2011. Thirty participants of both genders, aged between 40-65 and those who met all the eligibility criteria were included. They were divided into two equal groups, Group A Study group received EMG Biofeedback along with conventional physiotherapy and Group B Control group received only conventional physiotherapy. Intervention given over a period of 4 weeks, baseline and post values were assessed by Voluntary Control Grading Scale and Action Research Arm test.

**Results:** The results of the study revealed that there was a significant difference between both the groups on improved hand voluntary control ($p<0.01$) and improved hand function ($p<0.01$) in hemiplegic stroke participants.

**Conclusion:** The results of this study concluded that EMG Biofeedback along with conventional physiotherapy is effective on improving hand voluntary control and hand function in subacute stage stroke participants over the period of four weeks.

**Cuvinte cheie:** Biofeedback EMG, AVC, Funcția mâinii, Test al brațului pentru cercetarea acțiunii, Scală de gradare a controlului voluntar.

**Rezumat.**

**Obiectiv** Scopul acestui studiu a fost aflarea efectului biofeedback-ului EMG împreună cu kinetoterapia convențională asupra îmbunătățirii funcției mâinii la pacienții cu AVC subacut.

**Design** Studiu comparativ de prospectare

**Locație** Departamentul de neuro kinetoterapie, Spitalul Rural Pravara (Spital de gradul trei), Loni, Tal-Rahata, Dist-Ahmednagar, Maharashtra, India -413736.

**Metode:** Studiul s-a desfăşurat în perioada ianuarie 2011 – noiembrie 2011. Au fost incluşi 30 de pacienți de ambele genuri, cu vârste între 40 şi 65 de ani care au corespuns criteriilor. Aceştia au fost împărțiți în două grupuri egale. Grupul de studiu A a beneficiat de Biofeedback EMG şi de kinetoterapie convențională în timp ce Grupul de control B a beneficiat numai de kinetoterapie convențională. Intervenția s-a efectuat pe o perioadă de 4 săptămâni, iar evaluările inițială şi finală s-au efectuat cu ajutorul Scalei de gradare a controlului voluntar şi al Testului brațului pentru cercetarea acțiunii.

**Rezultate:** Rezultatele studiului au arătat o diferență semnificativă între grupuri în ceea ce priveşte îmbunătățirea controlului voluntar al mâinii ($p<0.01$) şi îmbunătățirea funcției mâinii ($p<0.01$) la pacienții hemiplegici după AVC.

**Concluzie:** Rezultatele studiului au arătat că Biofeedbackul EMG împreună cu kinetoterapia convențională este efficient în îmbunătățirea controlului voluntar al mâinii şi a funcției mâinii la pacienții cu AVC în stadiu subacut, pe o perioadă de 4 săptămâni.

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**Introduction**

A stroke, previously known medically as a cerebrovascular accident (CVA), is the rapidly developing loss of brain function(s) due to disturbance in the blood supply to the brain [1]. As a result, the affected area of the brain is unable to function, which might result in an inability to move one or more limbs on one side of the body, and various neurological dysfunction like inability to understand or formulate speech.[2] because of that voluntary control of movement is impaired. According to WHO stroke is the "acute onset of neurological dysfunction due to abnormality in cerebral circulation with resultant signs and symptoms that corresponds to involvement of focal area of brain lasting more than 24 hrs".[3]

Stroke is the third leading cause of the death in the western countries and the most common cause of adult disability[4]; of the survivors about 50% will have a significant long term disability[5]. According to W.H.O (16 Nov. 2011) in India incidence of stroke was 130/ 100000 individuals every year[6]. The Middle cerebral artery (MCA) is by far the largest cerebral artery and is the vessel most commonly affected by cerebrovascular accident (CVA). The MCA supplies most of the outer convex brain surface, nearly all the basal ganglia, and the internal capsules[7]. Middle cerebral arterial territory was the most commonly affected (38.9%) followed by posterior cerebral artery13%, brainstem 13%, anterior cerebral artery in 11.1%, multiple vessel territory 9.3%, small vessel infarcts in 8.4% [8].

Complete occlusion or blockage, of the middle cerebral artery leads to paralysis of the entire opposite side of the face and body. Partial occlusion can affect only some areas example paralysis of only arm or paralysis of the arm and leg, with sparing the face.[9,10,11,12] Risk factors for stroke include old age, hypertension (70%), previous stroke or transient ischemic attack (TIA)(10%), diabetes(15% and 49%), high cholesterol(15%), cigarette smoking(9%). High blood pressure is the most important modifiable risk factor of stroke.[2, 13]

Motor deficits are characterized by paralysis (hemiplegia) or weakness (hemiparesis), typically on the side of the body opposite the side of the lesion. Initially flaccid paralysis is present in acute stage and after that in subacute stage muscles goes in spasticity[14]. According to Bobath concept there are three stages of stroke. Acute stage, subacute stage and chronic stage. Acute stage is prolonged up to 0-2 week, subacute stage is up to 2 years and chronic stage is more than 2 years.[15]

In acute stage wrist muscles are in flaccid state so there is total loss of voluntary movement and immobility which can result in loss of range of motion of wrist flexors. Paralysis of the wrist extensors has a weakening effect upon the flexing ability of the fingers. Paralysis of the finger extensors does not interfere with the interphalangeal joints, so the function is performed by the interossei and lumbricals but if it is in immobile then the contractures of these intrinsic muscles lead to hyperextension of this joints as well as flexion contracture of the metacarpophalangeal joint[16].

Traditionally the techniques which is used for improving hand function includes proprioceptive neuromuscular facilitation technique[17], Task oriented exercises programs, Electrical Muscle Stimulation[18]. Recently EMG biofeedback has introduced for improving hand function. As a comprehensive definition, biofeedback is a group of therapeutic procedures that use electronic or electromechanical instruments to properly measure, process & feedback to patients in the form of auditory or abnormal neuromuscular & autonomic activity"[19]. EMG biofeedback has been used to improve motor function in patient following stroke. This technique allows participants to alter motor unit activity based on augmented audio & visual feedback information. Training can focus on voluntary inhibition of spastic muscles (e.g. reducing firing frequency of spastic finger flexors) or on increasing kinesthetic awareness & recruitment of motor units in weak hypoactive muscles (e.g. wrist/ forearm extensor muscles).Reported benefits include improvements in range of motion, voluntary control & function[20-24].

**Methods**

A total of forty five stroke participants aged between 40 to 65 years were screened for the study out of which thirty participants were eligible based upon the inclusion and exclusion criteria and those agreed to participate in the study. Two of these participants were dropped out of the study as they lost follow-up. Study group had 14 participants where as Control group had 14 participants**.** Criteria's for inclusion in this study were participants who had first ever M.C.A stroke, participants selected after two weeks of stroke and who had voluntary control grade 1-3 according to Hand Voluntary Control Scale. Participants were excluded who had any other musculoskeletal, cardiac vascular related conditions, cardiac pacemaker, impaired cognitive function (Mini Mental Scale), sensory loss over the hemiplegic hand.

**Outcome measures**

The outcome measures used in this study were Action research Arm Test and Voluntary control Grading Scale. It assesses a participant's ability to handle objects differing in size, weight and shape. The ARAT consists of 19 items grouped into four subscales: grasp, grip, pinch, and gross movement. Each subscale constitutes a hierarchical Guttmann scale, which means that all items are ordered according to ascending difficulty. In the ARAT, if the participants succeed in completing the most difficult item in a subscale thus suggest he/she will succeeded in the easier items for that same subscale. Similarly, failure on an item suggests the participant will be unable to complete the remaining more challenging items in the subscale.[25]

The voluntary control of hand was measured with the help of the voluntary control grading scale.

**Procedure**

The study received approval from Ethical Committee of Pravara Institute of Medical Sciences Deemed University, Loni 413736, Maharashtra, India. Participants were screened and based on the selection criteria they were included in the study. Those willing to participate were briefed about the nature of the study and effect of the intervention in the language best understood by them and the treatment was demonstrated to them and Written Informed Consent was obtained. All participants were given pre training for EMG biofeedback that how it feels after electrode placement. Explained the all procedure to the participants then randomly selected the participants for both Group A & Group B group. Study group received EMG Biofeedback along with conventional physiotherapy management. One electrode placed over the Extensor

Digitorum communis and Extensor Carpi muscle belly & another one place over the origin of the muscle. Asked the participants to do the wrist extension by giving visual feedback and at the same time asked to achieve the goal or asked to take the points which shown over the screen & it was for 20 min. Total treatment duration 40 minutes,1session / day,5 session / week, total duration 4 weeks. Control group received squeeze ball exercise, putty exercise, cable wrist curl exercise, wrist circles exercise, finger ladder, cable roller exercise for 40 min / day. 5 days in a week for 4 weeks.

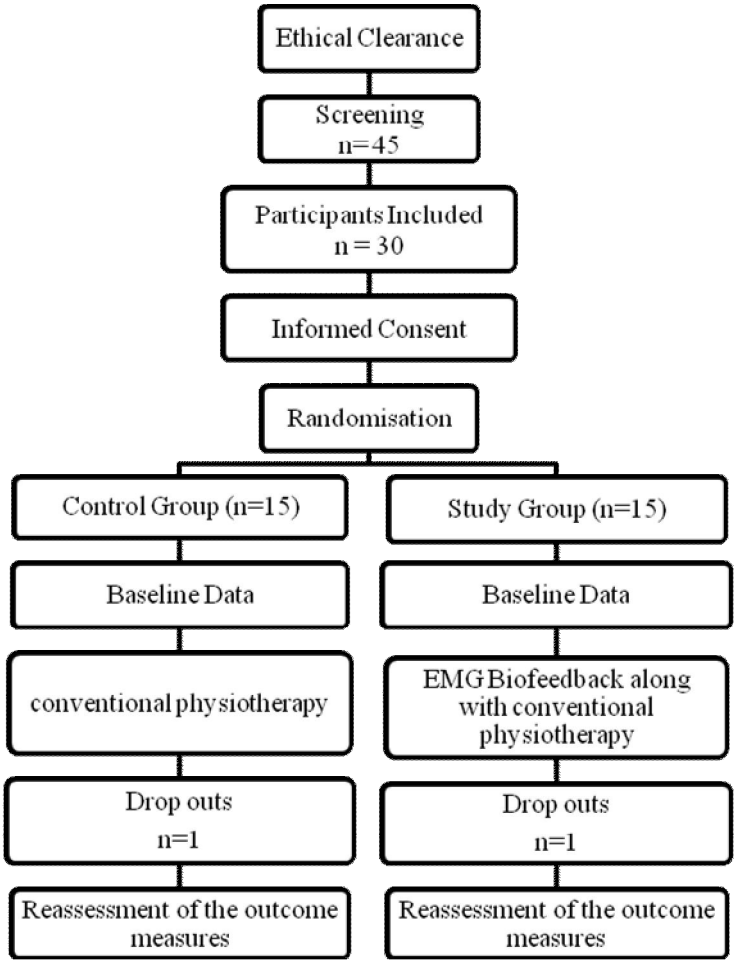


**Figure 1 Flow diagram showing the procedure used in the study**

**Fig.2**

**Fig.3**

**Results**

Statistical analysis was done by Graph Pad In Stat software using various statistical measures such a mean, standard deviation (SD) and tests of significance such as unpaired‘t’ test. The results were concluded to be statistically significant with $p < 0.05$ and highly significant with $p < 0.01$. Unpaired‘t’ test was used to compare differences between the two groups i.e. the study group and the control group. No significant difference in baseline characteristics (Table 1). The results of this study were analyzed in terms of hand function and voluntary control indicated by improvement in ARA test and Voluntary control grading scale and comparison was made

between the first,2nd week and after 4th week readings. The study results showed that EMG Biofeedback along with conventional physiotherapy are more effective than only conventional physiotherapy on improving hand function in hemiplegic participants as measured by Action Research Arm test and Voluntary control grading scale.

**Table 1: Demographic profile and clinical data of participants of both the groups**

| | Group A (Study Group) | Group B (Control Group) | 'p' value |
|---|---|---|---|
| Age (years) | 52.93±5.91 | 55.26±4.23 | 0.22 |
| Gender (M/F) | 12(80%) /3(20%) | 10(66.6%)/5(33.3%) | - |
| Duration after stroke (days) | 2.466±0.516 | 2.866±0.833 | 0.125 |
| Side of hemiplegia Rt/Lt | 8 (53.3%) / 7(46.6%) | 9(60%) / 6(40%) | - |

**Table: 2 Shows difference between pre and post mean values of Action Research Arm test of group A and group B.**

| Action Research Arm Test | Group A | Group B | 't' value | 'p' value | Results |
|---|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | | | |
| After 2nd week | 2.357±1.277 | 1.285±2.268 | 1.540 | 0.135 | Not significant |
| After 4th week | 5.857±3.159 | 1.714±2.268 | 3.986 | 0.05 | Extremely significant |

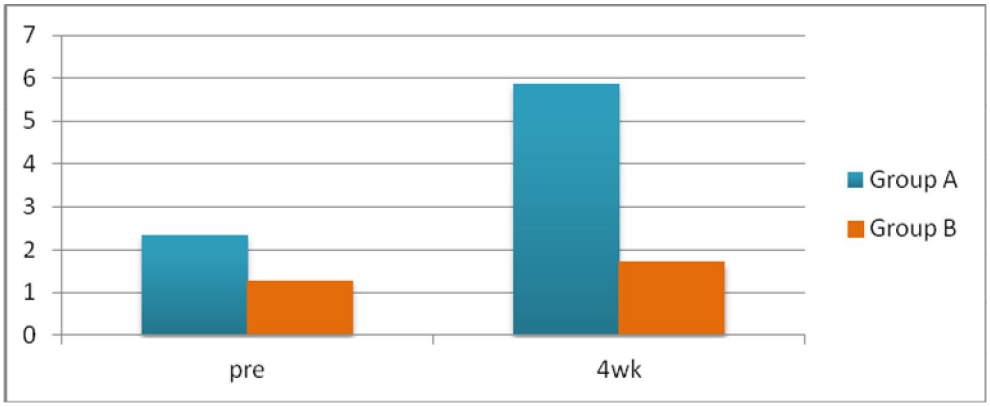


**Fig 4 Graph showing pre and post values of Action Research Arm Test of group A and group B.**

**Table: 3 shows difference between Pre and post mean values of voluntary control grading scale of both group A and group B**

| Voluntary control grading scale | Group A | Group B | 't' value | 'p' value | Results |
|---|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | | | |
| After 2nd week | 0.571±0.513 | 0.571±0.513 | 0.000 | 0.999 | Not significant |
| After 4th week | 2±0.679 | 1±0.554 | 4.266 | 0.02 | Extremely significant |

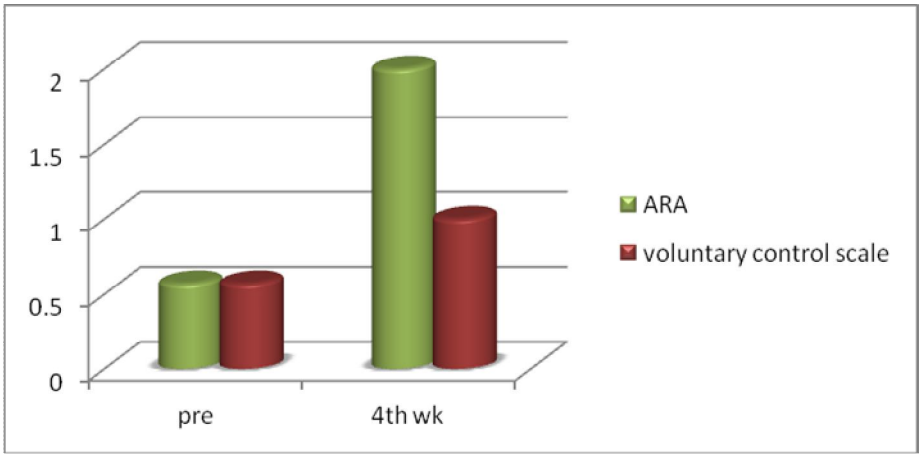


**Fig.4 Graph showing pre and post values of Voluntary Control Grading Scale of group A and group B.**

## Discussion

Study group showed greater improvement in improving hand function and voluntary control of hand in hemiplegic stroke participants. Improvement showed because of EMG Biofeedback and conventional physiotherapy which alter motor unit activity based on augmented audio & visual feedback information. Training can focus on voluntary inhibition of spastic muscles (e.g. reducing firing frequency of spastic finger flexors) or on increasing kinesthetic awareness & recruitment of motor units in weak hypoactive muscles (e.g. wrist/ forearm extensor muscles).[20-24]

Motor recovery in the arm was found to be significantly better in the study group. Therefore this study concluded that the effectiveness of the Biofeedback therapy could be attributed mainly to the repetitive stimulation of muscle activity in the arm. These results agree with those from two recent studies, [27,28]in which active repetitive motor training of hand and fingers have proven to be effective. There is growing evidence that muscle weakness rather than spasticity plays a dominant role in impairment of active voluntary movements.[29,30] Similar results were found in a favor of EMG Biofeedback in a study done by Armagan O et al (2003), conducted a study on "Electromyographic Biofeedback in the treatment of the Hemiplegic Hand" with 27 patients & concluded that the potential benefits of EMG biofeedback in conjunction with neurophysiologic rehabilitation technique to maximize the hand function in hemiplegic patients. Thus the clinical implication is the EMG Biofeedback along with conventional physiotherapy has significant effect on hand function in hemiplegic stroke participants when compared to control group. After 4$^{th}$ weeks of EMG Biofeedback session improvement was noted but at the 2$^{nd}$ weeks there was no significant effect of EMG Biofeedback along with conventional physiotherapy on hand function in hemiplegic stroke participants. A evidence from studies suggests that using EMG Biofeedback in combination with conventional physiotherapy may result in improvements in motor power beyond those of conventional physiotherapy alone. The limitations of this present study focused on only in MCA stroke participants as well as only subacute stage hemiplegic participants and ARA test and voluntary control grading scale both outcome measures were depends on the condition, the severity of disability of participants.

## Conclusion

On the basis of this study it can be concluded that EMG Biofeedback along with conventional physiotherapy can be used on improving hand function and voluntary control of hand in hemiplegic stroke participants.

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Ethical approval: Ethical Committee of Pravara Institute of Medical Sciences, Loni, Maharashtra state, India. (PMT/PIMS/RC/2011/08)

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