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Effectiveness of Neuro-Muscular Electrical Stimulations (NMES) in reducing Subluxation of the Shoulder after Stroke: Randomized controlled experimental study

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ABSTRACT

Background: Shoulder subluxation in stroke is one of the most common and challenging squeals. Shoulder subluxation limits the patient's daily activities, and it may lead to permanent disability. NMES (NeuroMuscular Electrical Stimulation) had been studied widely on shoulder subluxation with controversial results, but no evidence is reported of its effectiveness in shoulder subluxation. As NMES helps in producing strong contraction and thereby helps in improving the strength of the muscles and as it also helps in learning to contract appropriate muscles, this study was made to examine the Effectiveness of Electrical Stimulations in reducing Subluxation of the Shoulder after Stroke.

Method: Study design, A Randomized control experimental design of 30 subjects. Subjects were randomly assigned into two groups, experimental (NMES group) and control (Non-NMES group) with 15 subjects in each group. Outcome measures were taken before and after the intervention on both the groups by using 'Pain Estimation Scale' (PES),-Subluxation Grading' by X-rays (AP view) and upper arm section of 'Motor Assessment Scale'(MAS). Experimental group electrodes were placed over posterior deltoid and supraspinatus. Treatment time was 30 mints two times a day for five days in a week and six weeks.

Results: Comparison of electrical stimulation with non-electrical stimulation was done by considering the differences of pre and post treatments in both groups and significance is observed by using independent sample t-test. Statistical analysis proved that there was significant ($p<0.05$) improvement using NMES compared to NON-NMES in all the three parameters.

Conclusion: Electrical stimulation has shown significant improvement in reducing shoulder subluxation, pain and increased motor recovery of the arm in stroke patients compared to the patient's given non-electrical stimulation training.

Keywords: Stroke, Shoulder Subluxation, Neuro-Muscular Electrical Stimulation (NMES), Motor Assessment Scale.

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INTRODUCTION

Stroke is defined as a rapidly developing clinical sign of focal disturbance of cerebral functions, lasting more than 24hrs (or) leading to death with no appropriate cause, other than that of vascular origin [1].

Stroke is the 3rd primary cause of death throughout the worldwide; this stroke incidence has been quoted as 0.002% of population per annum and about 0.004% of people aged 45-84 years. In India, the prevalence of Cerebro Vascular disease was found to be 13/100,000 per year in a study conducted at Vellore in 1967-1977 and 33/100,000 per year a study conducted at Rohtak. WHO study in 1990 quoted incidence mortality due to stroke in India to be 73/100,000 per year [2].

One of the most physical problems for clients with hemiplegia is the shoulder pain, subluxation, loss of muscular activity and loss of functional use. Significant proportions of a stroke patient who attend rehabilitation clinics present an inferior sub luxation of humeral joints and are reported to be present in 70 to 80%, and it causes so many complications likePain, Motor Impairment, Activity Limitation and Decrease in Quality ofLife [4].

Stability is achieved through rotator cuff-a musculo tendinous sleeve which maintains the humeral head in the glenoid fossa, while at the same time allowing shoulder mobility. Subluxation has been proposed as a contributing factor in the development of shoulder pain, activity limitation and quality of life [4]. Treatment of hemiplegic limb in the upright position with various supportive aids is still controversial. No doubt appropriately chosen shoulder supports can correct the subluxation to varying degrees with regards to the motor function of the affected extremity.

Literature has identified supports, strapping and neuromuscular electrical stimulations are the management of inferior subluxation. The methods with the best supporting evidence for realigning the subluxed GH joint are the Triangular sling, Harrison's hemi sling and the Rolyan humeral cuff are used in a standing position. Apart from this NeuroMuscular Electrical Stimulations (NMES) plays a vital role in reducing the subluxation of the shoulder [10-13].

NMES used to strengthen the weakened muscles in studies have used following parameters like frequency of 30 to 85pps, symmetrical pulse current, pulse duration of 200 – 700 microseconds and the electrode placed over the supraspinatus and posterior deltoid (Especially the weaken muscles for the GH subluxation). At least ten contraction sorupto 1hour per day, 3-5 times per week, 4-8 weeks of treatment has beenused [14,15].

NMESmusclestrengtheningmethodisbasedonthemuscle-overloadprinciple;itindicates that recruitment order of motor units with NMES first is least resistance pathway which for the muscle results inthe recruitment of large diameter of the fibers (Type II fibers) [14].

If once the muscle is paralyzed, then following functional and structural changes occurs mainly: Loss of voluntary and reflex activity atrophy, degeneration, and fibrosis, decreased synchronization of motor unit firing rate. To maintain all these muscle properties and strengthening of muscles, NMES is one of the methods that have been used [16]. Hence the study aims to evaluate and examine the "Effectiveness of Electrical Stimulations in reducing subluxation of the shoulder after stroke."

MATERIALS & METHODS

Study Design

The Source of the data was collected at College of Physiotherapy,SVIMS,Tirupati. The total number of subjects are 15 in control (Non-NMES) and 15 in experimental groups (NEMS) including both males and females of age group 35 to 60 years. The subjects were randomly divided into two groups and participants were provided with informed consent according to the criteria of the study. The inclusion criteria for the study werePatients who had a clinical diagnosis of stroke(sub-acute) with no previous Pathology of the shoulder joint on the paretic side. The patient with CVA must have a significant motor deficit of Upper Limb with a grade of <=2on Brainstorm voluntary controlgrading. The patient should have adequate communication ability to cope with verbal rating score for thepain. Subjects who are having Grade I and Grade II subluxation of the shoulder in Van Landenberg and Hogangrading [4,5].

The Exclusive Criteria for the study with the subject were, all dislocations and subluxation other than inferior and any previous history of shoulder syndromes and fractures are omitted. There were no patients with cardiac pacemakers, medically unstable, other neurological conditions and women of child bearing age[9].

Methodology

Before starting the treatment, the outcome measures were measured through pain estimating scale (PES),grading of shoulder subluxation by X-ray,AP View independent position and upper arm section of motor assessment scale (MAS) were taken from both the control and experimental group. Total treatment time is one hour per day,3-5 times per week up to six weeks. Both the groups were given conventional treatment based on the status of the condition for 30 minutes which included positioning. The patients were given different types of slings (Bobath roll, Rolyan Humeral Cuff Sling, Cavalier shoulder support, and Arm Slings) and self-assisted movements, strapping,etc. [11].

Procedure

For the experimental group subjects were in sitting position with the back-rest armchair and placed the shoulder in optimal length. The Carbon electrodes with gel were placed over the posterior deltoid and supraspinatus.A medium frequency neuromuscular stimulator (Myomed 932, Electrical MuscleSimulator) was used to provide the electrical stimulation during treatment [10,17].

The stimulus parameters used during treatment were [14,16]the waveform of either Symmetrical or Asymmetrical biphasic pulse current with 200 to 700 microseconds pulse duration, frequency of 30 to 85 PPS, amplitude depends on the patient's maximum ramp-up time 1.5 seconds, ramp down time 1 to 2 seconds and duty cycle 1:3 and 1:15 with on times up to 10 seconds. Treatment time was 30 minutes, two times per day for five days a week up to six weeks. If once to produce a full sustained, tetanic contraction of a muscle (No fasciculation's observed on visual inspections) with visual (or Palpable evidence of superior glide of the humeral head). Once this was achieved the stimulus intensity was increased further to maximum subject tolerance. (Maximum tolerance was the maximum amount of discomfort under the electrode sites that subject could tolerate during the NMES) [10,17].

In one hour, practice 30minutes conventional therapy followed by 30 minutes electrical stimulations, in each method the duration is divided into three block times each block 10 minutes with 2 minutes rest period in between each block time. After six weeks the outcome measures pain estimating scale shoulder joint X-Ray AP view independent position, Motor assessment scale was taken from both the control and experimentalgroups.

Outcome Measures

Clinical Method for Assessing Shoulder Subluxation

Palpation (PALP) of the shoulder was used to evaluate the space separating the acromial process and the humeral head. The investigated palpated these anatomical structures bilaterally and evaluate the distance separating the two in terms of the possible number of fingers that could be inserted. Half a finger was the level of precision disclosed. For the anthropometric (ANTH) evaluation, the distance separating the acromial angle and the lateral epicondyle of the humerus was measured bilaterally using a sliding caliper calibrated in the millimeters [19].

Radiological method(X-RAY) for assessing shoulder subluxation[4,7]

Shoulder subluxation was evaluated by a single AP radiograph taken of the affected joint. Two ways were used for assessing the X-rays. One method was a categorization of subluxation 0 to 4.

The method used was that described by Van Langenberghe and Hogan. The two dashed lines shown are the line connected the most superior and inferior margins of the glenoid fossa and the line bisecting it.

Pain Estimation Scale[4,6,8]

The pain was assessed by measuring the client assigns a numerical rating to a pain, staying within defined limits that indicate (most commonly between 1 and 10).

Because it provides a numerical range of scores, this tool is valuable for statistical analysis purpose. However, whereas some clients find assessing a numerical rating to their pain intensity easy and clients with impaired abstract thinking may have difficulty like that encountered with the visual analog scale.

Motor assessment scale [1-3]

This scale was directly published in the Measurement in Neurological Rehabilitation by the Derrick T. Wabe – Revermead Rehabilitation center Oxford. With references Carr et al. (1985): Poole and Whitney (1988); Loewen and Anderson (1988)

RESULTS

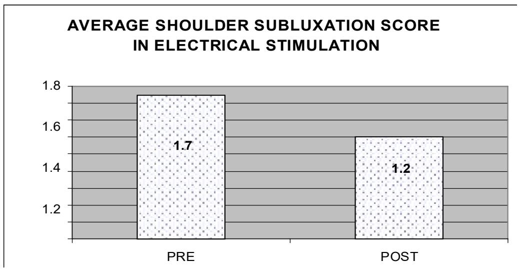
STATISTICAL ANALYSIS: The data were analyzed using mean and standard deviation by using the SPPS software, the normality was tested using paired T-test.

Table 1: Comparison of Pre and Post results of electrical stimulation group

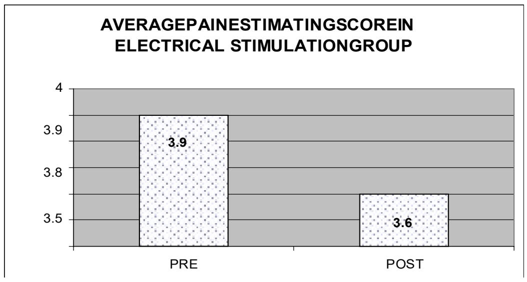
Parameter	Evaluation	Mean	S. D	T	DF	P
Shoulder subluxation (In Grading)	Pre	1.7	0.4577	0.0030	14	0.000*
	Post	1.2	0.4140			
Pain estimating scale (In cms)	Pre	3.9	2.0862	0.6482	14	0.000*
	Post	3.6	1.4040			
Motor assessment scale	Pre	1.9	0.9904	0.2045	14	0.000*
	Post	2.4	1.1212			

Represents significant at $p < 0.05$

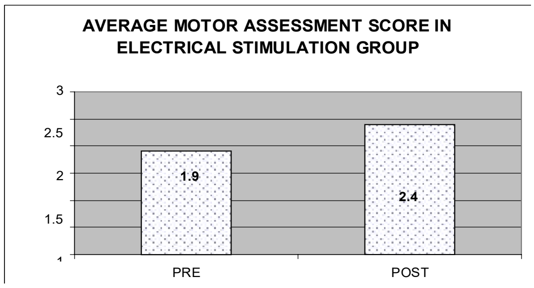
Table1 shows comparisons of pre and post results of experimental (Electrical Stimulation group) were observed in three parameters (Shoulder Sub Luxation Grading, Pain Estimating Scale, Motor assessment scale) with a standard deviation of 0.003 on shoulder subluxation o.682 on pain estimating and 0.2045 on motor assessment scale. The results were found highly significant. Below the graphical bar,the diagram represents reducing of shoulder subluxation, pain, and increasing motor assessment by using electrical stimulation.



Graph1.1: Shoulder Sub-luxation in Experimental Group



Graph 1.2: Pain Estimation Score in Experimental Group



Graph 1.3: Motor Assessment in Experimental Group

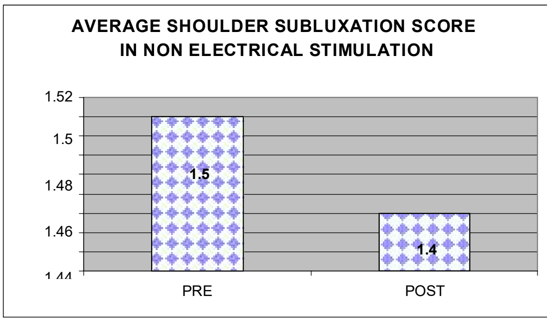
Table 2: Comparison of Pre and Post results of non-electrical stimulation group

Parameter	Evaluation	Mean	S. D	T	DF	P
Shoulder subluxation (In Grading)	Pre	1.5	0.5163	0.2728	14	0.000*
	Post	1.4	0.5070			
Pain estimating scale (In cms)	Pre	3.1	0.7432	0.3249	14	0.000*
	Post	3.0	0.8451			
Motor assessment scale	Pre	2.2	0.8618	0.3342	14	0.000*
	Post	2.6	1.0141			

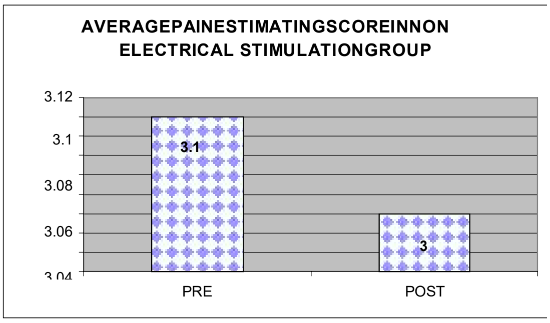
Represents significant at $p < 0.05$

Table 2 shows the comparison of pre and post treatment to non-electrical stimulation (Conventional group) were observed in three parameters. The results were with a standard deviation of 0.2778 on shoulder subluxation, 0.3249 on pain estimation scale 0.3342 on motor assessment scale. The results were found highly significant of P <0.05.

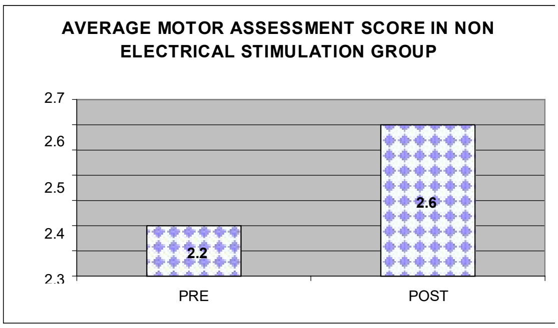
For showing significant change, we have made a graphical representation using a bar diagram for three parameters (pre and post treatment) for non-electrical stimulation group.



Graph2.1: ShoulderSubluxationinNon-Experimental Group



Graph 2.2: Pain Estimation Score inNon-Experimental Group



Graph 2.3: Motor Assessment in Non-Experimental Group

Table 3: Comparision ofElectrical and Non-Electrical stimulation group

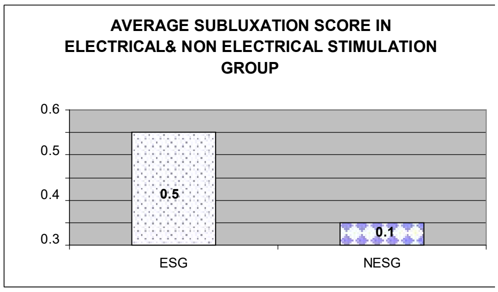
Parameter	**Evaluation**	**Mean**	**S. D**	T-value	DF	p-value
Shoulder subluxation (In Grading)	Electrical stimulation group	0.5	0.0437	0.2698	13	0.000*
	Non-electrical Stimulation group	0.1	0.0093			
Pain estimate scale (In cms)	Electrical stimulation group	0.3	0.6822	0.6241	13	0.000*
	Non-electrical stimulation group	0.1	0.1019			
Motor assessment scale	Electrical stimulation group	-0.5	0.1308	0.1297	13	0.000*
	Non-electrical stimulation group	-0.4	0.1523			

Represents significant at $p < 0.05$

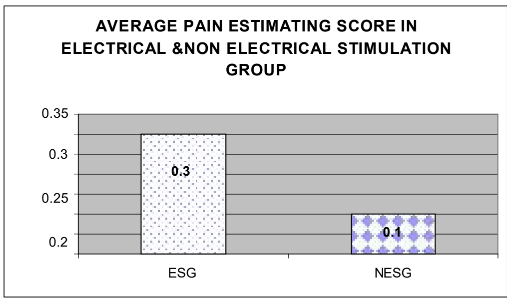
Table3 Comparisonof electrical stimulation with non-electrical stimulation group was made by considering the difference between pre and post treatment in both groups, and the significance was observed by using simple independent T-test. The results were found significant (P<0.05) between 2 groups in 3 parameters.

For showing the significant changes, we have made a graphical representation using a bar diagram for three parameters for electrical and non-electrical stimulation group.

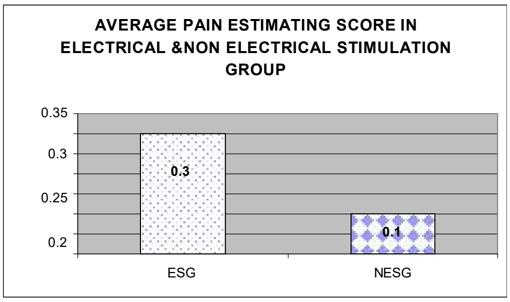
ESG= Electrical Stimulation Group NESG= Non-Electrical Stimulation Group



Graph 3.1: Shoulder Subluxation Comparison B/W ESG & Non-ESG



Graph 3.2: Pain Estimation Comparison B/W ESG & Non ESG



Graph 3.3: Motor Assessment Score Comparison B/W ESG & Non ESG

DISCUSSION

After statistical analysis, it showed that both groups could show significant changes in all three parameters. But compared to non-electrical stimulation group the electrical stimulation group showed significant improvement.

The difference may be due to voluntary muscle activity of deltoid and supraspinatus could be more compared to non-electrical stimulation. Along with electrical stimulation self-assisted movements of the shoulder also increase the strength of the shoulder muscle. Electrical stimulation reduces the pain as well. Once the pain reduces patient attempts to move the shoulder motions. The total treatment time for the experimental group is 1 hour compared to non-electrical stimulation group.

The previous study conducted by Ada L,Foongehomchay(2002) is meta-analysis to examine the effect of electrical stimulation on shoulder subluxation following stroke suggest that the earlier treatment following stroke help to prevent the development of hemiplegic shoulder subluxation, while treatment help to reduce the pain in additional conventional therapy. He proved that the use of electrical stimulation early after the stroke for the prevention of shoulder subluxation, but not late after stroke for the reduction of shoulder subluxation [11].

The current study proved that it was not only reducing the subluxation but also improves motor functions of the upper extremity.

NMES improves the strength of muscles by two methods. First is based on the principle of muscle overload, a strong muscle contraction using NMES can potentially stress the tissue beyond its typical contractor capability [18]. In the second method, NMES isused to strengthen muscle fundamentallyina different way· In NMES, the electrical current takes the pathway of least resistance, resulting in the recruitment of large diameter fibers (Type II) initially, followed by small diameter fibers (Type I) which are of highly resistant to electrical current. This potentially influences the fatigability of a muscle, as the larger diameter fibers are primarily fatigable fiber, whereas small diameter fibers are non-fatigable [14]. As aType II fibers have been shown to decrease in size with aging, these atrophied Type II fibers get weakly activated by voluntary activation, where Type I fibers recruits first. Thus, recruitment of Type II fibers with NMES is of more effective means to strengthen themuscles [14].

Due to shoulder subluxation shoulder pain causes significant problems in hemiplegia, pain occurs in the hemiplegic shoulder because of muscle imbalance with loss of joint range, and improper joint alignment and impingement of the shoulder capsule and inadequate muscle stretching. In electrical stimulation method pain has been reduced, the effect could be due to change in the shoulder alignment due to therapy and electrical stimulation it self would have resulted in pain modulation.

In the non-electrical stimulation group, strapping used to support the arm to limit the development of shoulder pain as strapping has increased joint proprioception. It would have stimulated the muscle activity around the shoulder, which had been useful in clients with flaccid paralysis [13]. Slings have been used to prevent and correct GH joint subluxation [15]. A single strap was used as hemi sling to decrease the traction force during development of tone and volitional movements, a patient with volitional movements may consider a Rolyan humeral cuff sling, bobath sling to distribute the affected limb weight to another part of the body [12].

In Non-electrical stimulation group the supports mentioned above a long with the positioning the shoulder could have played a role to prevent changes in soft tissue lengths, particularly of GH adductor and internal rotator muscles. Positioning would have corrected downward rotation of scapula; the natural passive locking mechanism of the shoulder is reestablished. Self-assisted exercises elicit muscle activity with muscle at different lengths (ex: with an arm in elevation, attempting to raise the arm from the bed). Exercises to regain active muscle contraction increase strength and control of muscles ofthe shoulder region [20].

Due to the following reasons the electrical stimulation is more effective in reducing subluxation, pain and improves motor functions compared to non-electrical stimulation. Hence, we conclude that electrical stimulation shows significant compared to non-electrical stimulation.

Recommendations:

This approach must be studied in a large number of samples to evaluate the electrical stimulation effectiveness. Along-term effect of neuromuscular electrical stimulation training on the hemiplegic arm also is evaluated. The study needs the Kinematics analysis for a displacement of the shoulder joint with electromyographic analysis of muscle activation during electrical a non- electrical stimulation training. Create awareness of about the electrical stimulations for patients with stroke.

CONCLUSION

Electrical stimulation has shown significant improvement in reducing shoulder subluxation, pain and increased motor recovery of the arminstroke patients compared to the patient's given non-electrical stimulation training.

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