



Neuro Developmental Techniques with Functional Electrical Stimulation reduces shoulder dysfunction in young stroke population : A quasi-experimental novel rehabilitative approach

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ABSTRACT

Stroke is the third-largest common cause of death and is the leading cause of adult impairment. Shoulder subluxation is a common complication after a stroke and has always been a challenge, making the motor and functional recovery more complicated. Sixty-nine per cent of people affect with an arm in stroke, and the critical aim of stroke therapy is to recover their arm function. Motor impairments such as flaccidity and spasticity may make a patient functionally dependent on another person for their ADL, particularly in the upper extremity for a long time. Also, these motor impairments can address other problems such as subluxation of the shoulder and pain. To evaluate the effect of NDT along with FES in the management of shoulder dysfunction following stroke. A quasi-experimental study involved 70 consecutive subjects age (30-60 years) affected by stroke recruited in the study. They are divided into two groups Group A (experimental group, N=35) and Group B (control group, N=35). Group A received NDT along with FES, and Group B received NDT treatment. Treatment was given five days a week for six weeks. The analysis of the study showed a statistically significant difference in shoulder pain, and subluxation in the experimental group (Group A) compared to the control group (Group B). FES is effective in reducing shoulder pain and subluxation early after stroke. Hence NDT along with FES is more effective than NDT alone.



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INTRODUCTION

Stroke is a severe and debilitating international healthcare issue. Stroke is the result of diseases involving a cerebrovascular system that shows symptoms and neurological signs. Stroke frequency is around 105 to 152 per 100,000. The incidence in India is 119 to 145/100,000 and in the USA is around 610,000 of these subjects were first attacks, and 185,000 were regularly attacked. Prevalence of India is 44.29 to 559/100,000 persons and of the US is approximate translates to ≈ 5 million people. The shoulder joint work synchronously to make full joint movement pain-free. Any disordering in this organised activity triggers joint discomfort and control. (Benjamin *et al.*, 2018; Davies,

2000) Pain can be caused by trauma to the underlying tissue; these injuries are caused by altered scapulohumeral rhythm, decreased external rotation of the humerus, loss of accessory gliding action of the Humerus head (Kamalakaran et al., 2017; Vafadar et al., 2015).

Among 80% of the stroke, the patient has pain and subluxation of the shoulder. Commonly, the shoulder subluxation was inferior in hemiplegia due to gravitational forces, and the weight of the reliant arm pulls the humeral head down due to weakness in the muscles of Supraspinatus and Posterior deltoid (Faghri et al., 1994; Mishra et al., 2020; Sahu and Naqvi, 2020).

Author Zorowitz et al. (1996) notes that the limitation of external rotation in subjects with hemiplegia primarily responsible for pain in the shoulder.

NDT is widely used for the treatment stroke. Most methods, i.e. handling techniques, weight-bearing exercises, positions are to be used by a therapist to allow the patient to use both sides of the body and to prevent negative sensory input that influences the muscle tone. RIP is used by physical NDT therapists to reduce spasticity and improve synergic movement.

Treatment begins with the therapies of inhibition that neutralises the influence of spastic muscles. As tone is normalised NDT, physiotherapist uses facilitation techniques and relearn the normal patterns of movement (Hafsteinsdóttir et al., 2007; Lewandowska et al., 2018).

FES (Functional Electrical Stimulation) was a well-known intervention in motor rehabilitation which is used to stimulate a group of muscles followed by joint movement. Primarily those muscles are stimulated in the hemiplegic shoulder which is mainly helpful in retaining the humeral head in glenoid fossa which is supraspinatus and posterior-deltoid and thus prevent subluxation.

It is of 10 and 50 HZ frequency, which tends to activate the motor point rather than muscle fibres. This is an integral aspect of neurological recovery (Eraifej et al., 2017).

MATERIALS AND METHODS

This is a Quasi-experimental study in which patients from the Outpatient Department of Neuro physiotherapy, Ravi Nair Physiotherapy College, Sawangi (Meghe), Wardha have taken The sample size of this study is 70 and is based on population-based sample size formula and is divided into two groups, group A (N=35) and group B (N=35), i.e. 35 subjects in each group by convenience sampling method. Study

duration was of 18 months.

Inclusion criteria were male or female with the subjects of age group 35-60 years, subjects diagnosed with dysfunction of the shoulder following a stroke, stroke duration, not more than two months, able to talk, subjects with spasticity on Modified Ashworth scale 1 and 1+ and subjects with static sitting balance. The patients with fracture of the upper limb, preexisting shoulder pathologies such as previous subluxation, frozen shoulder, subjects having impaired cognition, visuoperceptual impairment and non-cooperative subjects were excluded from the study.

Procedure

Ethical approval was obtained from the institutional ethical committee of our university with Ref.No.DMIMS(DU)/IEC/2018-19/7198. The consent form was taken from all the participants recruited in the study.

Total 70 referred male and female volunteers post-stroke persons having a mean age 35- 60 years have been included in the study as per Figure 1. Patients were assessed according to inclusion criteria, and they were able to perform the task on Fugl-Meyer Assessment of the Upper Extremity (FMA-UE).

All the patients were divided into two groups, i.e. group A (experimental group, n=35) and group B (control group, n=35). Patients of group A and group B were assessed on all outcome measures pre and post-treatment. That included Numerical Rating Scale (NRS), sulcus sign grading and Fugl Meyer scale of the upper extremity.

In Fugl Meyer Assessment scale of the upper extremity, motor domain assessed the capability of patients to move an upper extremity and other domain assessed sensation, pain and ROM which were rated the items according to the finding of patients.

It has a high test-retest reliability on stroke patients. Treatment was given to each of the patients for five days a week and six weeks.

Sulcus Sign grade Assessment

The patients included in this study were assessed for subluxation on sulcus sign grading while assessing the patient was in a comfortable sitting position, and the hands-on the side of the body was hanging. The therapist stands on the affected side, grasps his/her hand and pulls it inferior so that the degree of translation was measured and graded accordingly.

Group A: (Experimental group)

This group consist of 35 subjects (N=35) of both gender, and they received NDT along with Functional

electrical stimulator. In NDT patients received the following treatment.

NDT

Mobilisation of Shoulder Girdle

In Supine Position

As per Figure 2 arm is in extended and external rotation, the therapist supports the patient's arm with the elbow. The therapist takes the shoulder girdle forward, downward, and upward, but has to prevent backwardness that emphasises scapula retraction.

In Side-Lying

As per Figure 3 the patient has to lie down inside lying and shoulder girdle is then brought forward without any trouble.

Weightbearing Exercise

The therapist has to support the subject under the axilla in a sitting position on the edge bed and raise shoulder girdle, also grasping and supporting his arm in abduction and lateral rotation. Then ask the patient to move in the therapist's direction, and then return to the mid-position.

Movement Control of Arm

The therapist grasps the patient's hand with an extended wrist and fingers and abducts the thumb. Ask the patient to force it against the hand of the therapist.

The therapist must then hold his elbow in extension and ask the patient to move his hand sideways and downwards gradually. Then the patient must move the arm forward diagonally, till external rotation is maintained.

Clasped Hand Exercises

1. Elevation of both the arm by clasping it together
2. Alternately elevation and placing that clasped hands on the head
3. Then Move that clasped hand to the mouth.
4. Then ask the patient to raise his arm so that the palm faces upward and then forward.
5. Make the patient stand with arms raised against the wall.

Flexor Spasticity Inhibition with Stimulation of Extension

As per Figure 4 the therapist must grip the patient's wrist in extension. The arm must both extend backwards. Then have to push and pull slowly that will activate the active extension.

Home Exercise Program

Functional Electrical Stimulator(FES)

"Bionics Chattanooga (complex technology)" FES which was used it has stimulator and a two pair of electrodes as shown in Figure 5.

As per Figure 6 the posterior deltoid muscle was placed with two electrodes, and the two electrodes were placed on the supraspinatus muscle. 40Hz was set to produce a tetanised muscle contraction. The intensity was set to get the elevation of the shoulder with some abduction and extension.

When performance improved, FES duration (muscle contraction and relaxation ratio) was gradually increased. 40 Hz of current are given for 25 min with 8 Sec of contraction and 8 Sec of relaxation. Over six weeks, the FES session was held five days per week.

Group B: (Control group)

This group consist of 35 subjects (N=35) of both gender, and they will receive NDT treatment. In NDT, they will receive Mobilisation of the shoulder girdle, weight-bearing exercises, Movement control of the arm, inhibition exercises and home exercise program as described above.

This will last for 30 min for each patient. One dropped out at the mid of the study due to some personal issue (Bertabobath, 1990).

Statistical Analysis

The statistical analysis was done with by using software SPSS 22.0 version. The comparison of pre-treatment and post-treatment scores was made by using Wilcoxon Signed Rank Test, and the comparison between Group A and Group B was made by Mann Whitney U test.

RESULTS AND DISCUSSION

Here 70 subjects are taken, which are assigned into two groups; each group contain 35 subjects; they received the intended treatment and were analysed for the outcomes measures.

A significant change in the NRS, FMA and sulcus sign grading score was observed in Group A compared to Group B in this present study. (p= 0.0001)

On NRS as shown in Table 1 and Graph 1 in between-group comparison indicates a statistically significant change in group A than group B as group A receives NDT along with FES which simultaneously helps to realign the joint, reducing spasticity thus reduces pain. The combination of NDT and FES also contributes to weaker muscle facilitation and spastic muscle inhibition and helps to correct thoracic rhythm of the scapula.

Table 1: Comparison between Group A and Group B median scores on Numerical Pain Rating Scale

Group	N	Mean	Standard Deviation	Standard Error Mean	Median	IQR	z-value
Group A	35	7.02	0.82	0.13	7	6-8	18.51 P=0.0001,S
Group B	35	3.71	0.66	0.11	4	3-4	

In between-group comparison using Mann-Whitney U test shows statistically significant improvement in group A. (p=0.0001)

Table 2: Comparison between Group A and Group B median scores on Sulcus Sign Grading

Group	N	Mean	Standard Deviation	Standard Error Mean	Median	IQR	z-value
Group A	35	1.02	0.29	0.04	1	1-1	5.77 P=0.0001,S
Group B	35	0.45	0.50	0.08	0	0-1	

In between-group comparison using Mann Whitney U test shows statistically significant improvement in group A. (p=0.0001)

Table 3: Comparison of difference in Fugl Meyer Scale Score median score in Group A and Group B

		Mean	N	Standard Deviation	Standard Error Mean	Median	IQR	z-value	p-value
A	Group A	8.17	35	1.09	0.18	8	7.5-9	15.59	0.0001,S
	Group B	2.65	35	1.78	0.30	2	2-3		
	Group A	2.91	35	1.24	0.21	2	2-4	8.99	0.0001,S
	Group B	0.62	35	0.84	0.14	0	0-1		
C	Group A	5.68	35	1.89	0.31	6	4-7	13.65	0.0001,S
	Group B	1.02	35	0.70	0.11	1	1-1		
D	Group A	2.20	35	0.96	0.16	2	2-2	1.28	0.20,NS
	Group B	1.94	35	0.68	0.11	2	2-2		
Total	Group A	10.80	35	3.30	0.55	19	16-22	17.96	0.0001,S
	Group B	6.20	35	2.50	0.42	6	4-8		
H	Group A	4.22	35	2.19	0.37	5	4-5	2.52	0.014,S
	Group B	3.80	35	1.58	0.23	3	2-4		
J	Group A	4.25	35	1.40	0.23	4	4-5	5.71	0.0001,S
	Group B	4.97	35	1.38	0.30	2	1-4		
J	Group A	5.17	35	0.98	0.16	5	5-6	9.32	0.0001,S
	Group B	2.68	35	1.23	0.20	2	2-3		

In between-group comparison using Mann-Whitney U test shows significant improvement in both groups, but Group A shows more statistically significant improvement in all domains.

As per graph both group shows improvement, but group A shows statistically significant improvement.

Chantraine also indicates that FES therapy in subjects with hemiplegia substantially decreases pain in the shoulder in 5weeks (Chantraine et al., 1999).

On Sulcus sign grading, as per Table 2 and Graph 1 in between-group comparison shows a statistically significant reduction in subluxation in group A than group B, because group A received FES, which was applied to subsequent posterior deltoid and supraspinatus fibres which maintain the head of the humerus into the glenoid cavity.

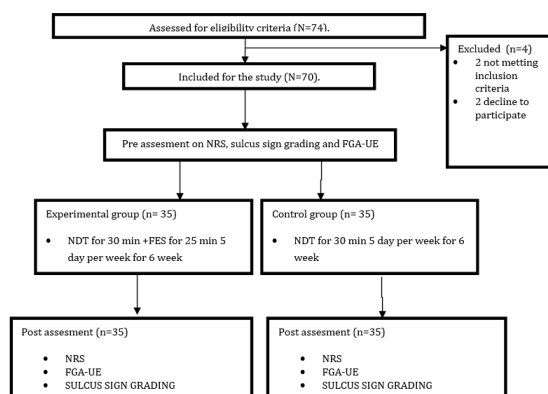


Figure 1: Flow chart



Figure 2: Shoulder Girdle Mobilization in Supine



Figure 5: Functional Electrical Stimulator



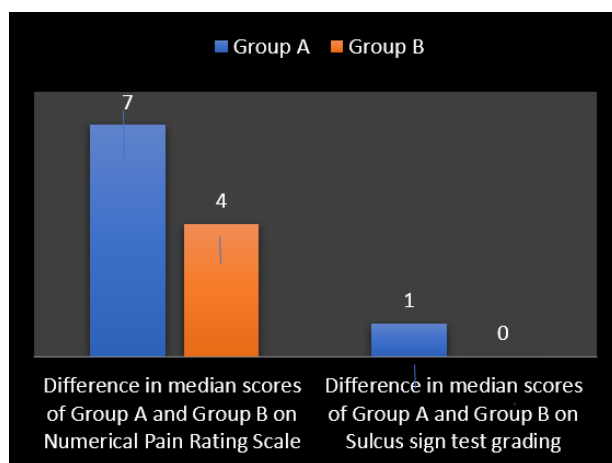
Figure 3: Shoulder Girdle Mobilization in Side Lying



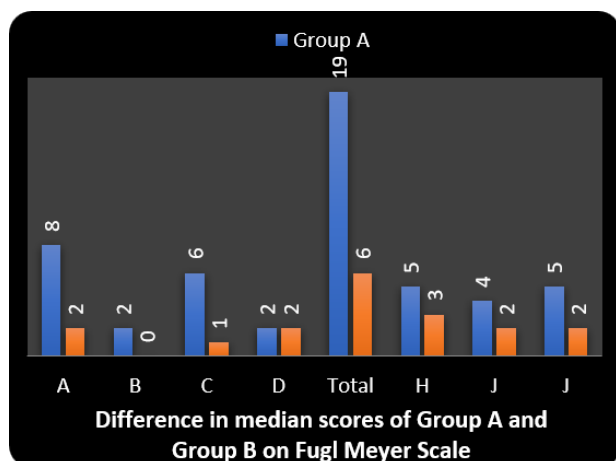
Figure 6: Movement with Stimulation



Figure 4: Gentle Push and Pull Stimulates Active Extension



Graph 1: Comparison of difference in Numerical Pain Rating Scale and Sulcus Sign Grading median score in Group A and Group B



Graph 2: Comparison of difference in Fugl Meyer Scale median score in Group A and Group B

They also are the functional stabiliser of the shoulder. This reduces inferior dislocation, lowers pain, and restores motor efficiency. In NDT scapula mobilisation also helps in re-education by promoting weaker muscles and inhibiting spastic muscles.

Jae-Hyoung Lee and Faghari et al. describe that the ES is beneficial for six weeks in hemiplegic subjects for the subluxation of the subacute shoulder than the control group (Baker and Parker, 1986; Faghri et al., 1994). Koyuncu et al. (2010) study on FES have a statistically significant decrease in the subluxation of the shoulders.

On the scale of Fugl Meyer as per Table 3 and Graph 2, there is a significant change in group A in group comparison than group B in all domains. In group A FES together with NDT assists in promoting weaker muscles, re-alignment of the joint, which reduces pain and improves motor scores. It also helps to re-educate the muscle, to enhance motor control and functional activity. In the hand domain, there is not much change, as it has a more extensive presentation on cortex takes more time to recover. As per the graph, both groups shows improvement, but group A shows statistically significant improvement.

It also has similar results, indicating that FES in combination with a rehabilitation program decreases shoulder pain, prevents shoulder subluxation over time and also decreases shoulder subluxation in patients with acute and sub-acute strokes (Karaahmet et al., 2019).

CONCLUSION

In this present study, FES shows a significant impact on motor recovery, subluxation reduction, and pain in post-stroke shoulder dysfunction. This study

indicates that early application of FES in the treatment of stroke to supraspinatus muscle and subsequent deltoid muscle may significantly decrease inferior subluxation and pain in the shoulder joint following stroke. This study also suggests that the combined effect of NDT and FES is more critical in reducing the efficiency of subluxation, pain, and motor performance than NDT itself.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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