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Original Article

Comparative Study of Immediate and Short Term Effect of 4 Days of Scapular Stabilizing Exercises and Scapular Proprioceptive Neuromuscular Facilitation on Scapular Alignment and Functional Task in Patients with Stroke – An Experimental Study

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Abstract

Background: Stroke is the commonest neurological cause of morbidity and mortality all over the world. Alterations in scapular position and motion occur in 68–100% of patients due to changes in the tone of the upper extremity and reduced strength, leading to an altered position of the scapula. Scapular stabilizing exercises and Scapular PNF have been shown to be effective individually in improving scapular control. However, its effect on functional tasks and objective measurement has not been studied. So, the purpose of the study is to compare these two techniques to identify the better technique with respect to objective measurement and its effect on functional tasks. Methodology: An Experimental study was done in a tertiary care hospital on 18 patients according to inclusion criteria and was divided into two groups. Group A Scapular Stabilizing Exercises and Group B Scapular Proprioceptive Neuromuscular Facilitation and Intervention were given for four days, and pre and post-assessment were done by Palpation meter (PALM) and Functional tasks (lifting and lowering the cup). Results: The results showed significant improvement in both techniques, i.e., there is a decrease in the Total Height discrepancy (t = 3.4) (p 0.003) and the time taken for lifting and lowering the cup (t = 2.2) (p 0.04). Conclusion: Scapula Proprioceptive Neuromuscular Facilitation Exercises are more effective than Scapula Stabilizing Exercises and have a better short-term effect on Scapular Alignment and Functional Tasks in patients with Stroke.

Keywords: Stroke, Scapular Alignment, Scapular Proprioceptive Neuromuscular Facilitation

Introduction

Stroke is a commonest neurological cause of morbidity & mortality all over the world[1] Following Stroke, changes in the tone of the upper extremity and reduced strength ends up in an altered position of the scapula resulting in pain, subluxation, tightness and muscle weakness. [2,3]

Upper limb recovery is the main goal of post-Stroke rehabilitation due to its importance for autonomy in Activities of Daily Living (ADL).[4]

Scapular stabilizing exercises and Scapular PNF have been shown effective individually in improving scapular control.[5,6] However its effect on functional task and objective measurement is not studied. So, the aim of the study is to compare these two techniques to identify the better technique with respect to objective measurement and effect on functional task.

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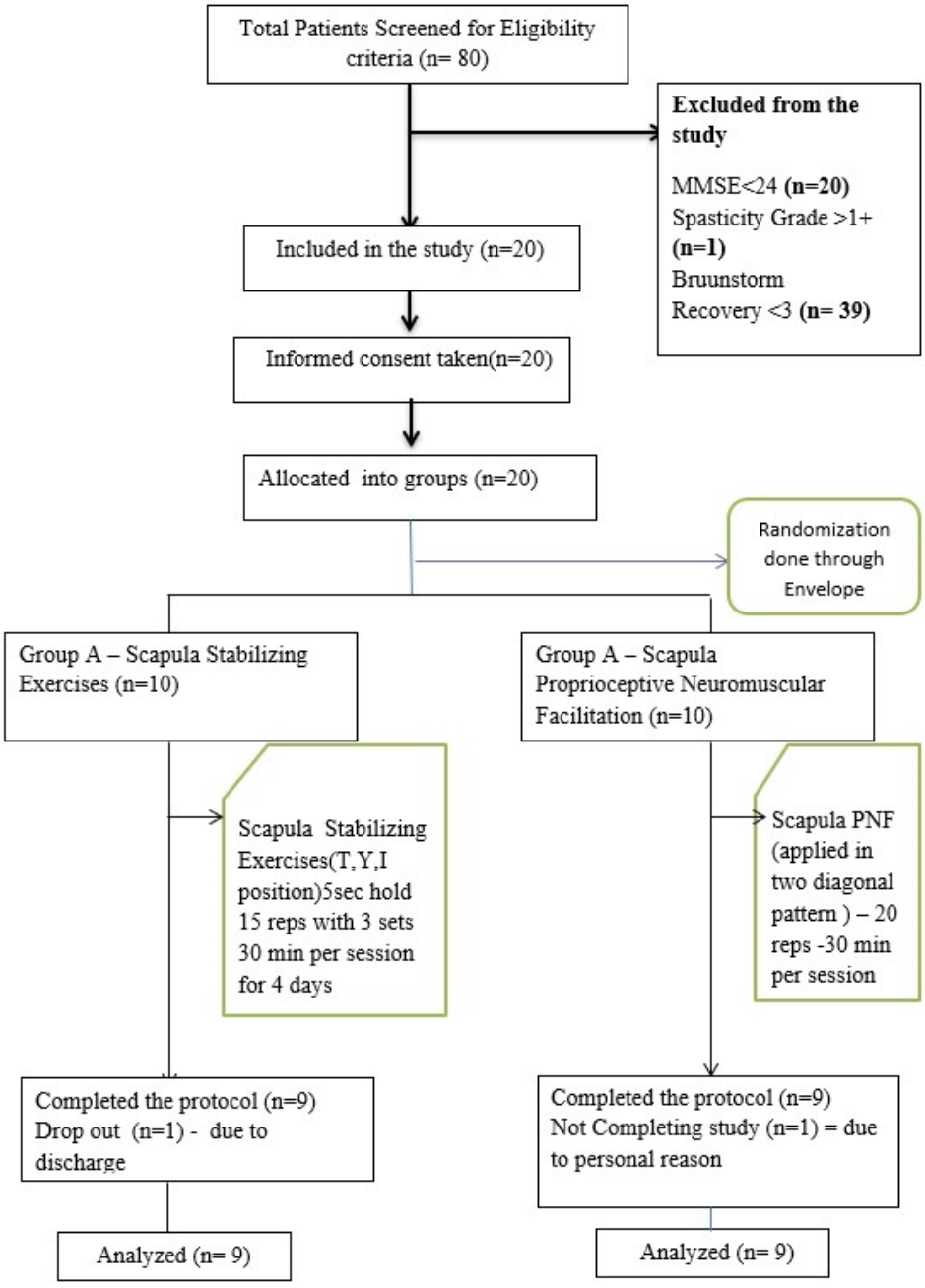
Materials and Methods

An Experimental Study was conducted in tertiary care hospital 20 patients diagnosed with Stroke were recruited as per the inclusion and exclusion criteria. Ethical clearance was obtained from the Institutional Ethical Committee of Physiotherapy College and the trial was registered on the clinical trial registry maintained by the government of India Sample size was statistically calculated by Open Epi- formula and purposive sampling technique was used. Written informed consent was explained and undersigned by the patients who were included in the study. The participants were selected based on the following inclusion criteria.

Patients diagnosed with Stroke, patients with spasticity Grade 0 to Grade 1+ in the upper extremity, Brunstorm recovery Stage ≥3 for Hand, patients with Static and Dynamic balance in sitting (Balance Assessment, patients with MMSE Score > 24. Patients with shoulder subluxation, undergone any recent surgery related to the shoulder joint, any musculoskeletal injuries such as fractures, dislocation or any soft tissue injuries on the affected side or non-affected side [7]and Neurological conditions other than Stroke were excluded.

Participants after their enrollment were then randomly allocated into 2 groups by allocation method i.e. Envelope method by Random Generate no. and Blinding was done for the assessment of outcome measures before and after an intervention. Scapula Stabilizing Exercises and



FLOW DIAGRAM FOR SUBJECT ASSIGNMENT IN THE STUDY

Scapula PNF were given to Group A and Group B respectively. Scapula Alignment with the help of a Palpation meter (PALM) and Functional task in terms of Lifting and lowering the cup was taken at baseline and for four consecutive days.

A Palpation meter (PALM, St. Paul, MN, USA) is used to measure the distance and inclination between two bony landmarks of the body.[8,9] Participants testing position was in a sitting position with hip and knee 90° of flexion and with shoulders exposed on a seat with short back support. The hands are kept on the same side thigh to prevent the shoulder girdle elevation.

For Lifting and lowering the cup participants were asked to be seated on a stool. They were asked to lift the cup towards their mouth as if drinking water and lower the cup to the table at their normal pace and the time was noted after completing the task. No practice was given prior to the patient to perform the task. [10]

Intervention

For Group A - Scapula stabilization exercises - The patient was in a prone lying position and the therapist gave proper instructions before starting the treatment Keeping the arm straight and slowly lifting the arm towards the spine to form a letter (T), then lifting straight but diagonal and thumb facing upwards to form letter (Y) and lastly keeping the elbow straight and lifting the arm overhead to form a letter (I) and each exercise was asked to hold for 5 sec and 3 sets of 15 repetitions.[7]

For Group B – Scapula PNF Exercises – It was applied in two diagonals, Anterior elevation and posterior depression and Posterior elevation and anterior depression with 20 repetitions.

Patients laid on the unaffected side while the therapist was standing in a line of desired motion the therapist pulled the scapula to an elongated position and gave instructions for the desired movement.

Rhythmic initiation and repeated contractions facilitation techniques was applied in all patients.

Results

Data analysis was done using Graph Pad Instat 3. Descriptive statistics were used to analyse the demographic data of all participants. Paired t-test was used to compare pre and post-intervention mean obtained from Scapula alignment and Functional task within the groups. An unpaired t-test was used to compare the post-intervention mean difference obtained from Scapula alignment and Functional task between the groups. P value < 0.05 was considered statistically significant for the entire test.

Table no. 1 shows the Basic Characteristics of all participants.18 patients were recruited in the studies which were then divided into two groups Group A & Group B with six males and three females and seven males and two females respectively. Table no. 2 shows a within-group analysis of Group A Scapula Stabilizing Exercises pre and post-intervention. Distance between spinouts process to inferior angles decreased post-intervention. There was a statistically significant improvement in distance between two inferior angles and total Height Discrepancy also decreased post-intervention ($t=6.9$) ($p<0.05$). Upper Extremity function was measured in secs which showed a decrease over time.

Table 1. Basic Characteristics of all participants

			Group A n (%)	Group B n(%)
Sex	Male		6(62%)	67(75%)
	Female		3 (38%)	2 (25%)
Types of Stroke	Ischaemic		8(87.5%)	9 (100%)
	Hemorrhagic		1 (12.5%)	0
Affected side	Right		4(38%)	7 (75%)
	Left		5(62%)	2 (25%)
Spasticity	Grade 0	Elbow flexors	3 (38%)	5(62%)
		Wrist flexors	6(75%)	7(87.5%)
	Grade I	Elbow flexors	1(12.5%)	-
		Wrist flexors	1(12.5%)	-
	Grade I+	Elbow flexors	4(50%)	3(38%)
		Wrist flexors	1(12.5%)	1(12.5%)
Recovery stage (Brunnstorm)	Stage III		5(62%)	4(38%)
	Stage IV		4(38%)	4(50%)
	Stage V		-	1(12.5%)
	Stage VI		-	-

Table 2. Comparison of Within Group Analysis of Scapula Stabilizing Exercises on Scapular Alignment and Upper Extremity Function

Outcome measures			Mean ± SD	t value	p value	Significance
Scapular alignment	**Distance from spinous process to inferior angles**	PRE (baseline)	9.6±1.1	7.68	0.0001	Extremely Significant
		POST (day 4)	8.3±0.9			
	Deviation in degrees	PRE (baseline)	3±0.8	3.35	0.01	Significant
		POST (day 4)	2.27±0.64			
	Total discrepancy	PRE (baseline)	1.6±0.64	5.84	0.0004	Extremely Significant
		POST (day 4)	0.34±0.1			
	Distance between two inferior angles	PRE (baseline)	23.4±2.67	7.38	0.0001	Extremely Significant
		POST (day 4)	19.3±2.6			
	Height deviation degrees	PRE (baseline)	3.6±0.9	8.5	0.0001	Extremely Significant
		POST (day 4)	1.4±0.3			
	Total height discrepancy	PRE (baseline)	1.6± 0.6	6.9	0.0001	Extremely Significant
		POST (day 4)	0.5±0.25			
Upper Extremity Function	**Functional task**	PRE (baseline)	4.1±1.2	5.09	0.0001	Extremely Significant
		POST (day 4)	2.1±0.6			

Table 3. Comparison of Within Group Analysis of Scapula Proprioceptive Neuromuscular Facilitation exercises Exercises on Scapular Alignment and Upper Extremity Function

Outcome measures			Mean ± SD	t value	p value	Significance
Scapular alignment	**Distance from spinous process to inferior angles**	PRE (baseline)	8.89±1.17	9.02	0.0001	Extremely Significant
		POST (day 4)	7.1±1			
	Deviation in degrees	PRE (baseline)	2.78±1.09	3.94	0.004	Very Significant
		POST (day 4)	1.5±0.6			
	Total discrepancy	PRE (baseline)	1.1±0.5	7.44	0.0001	Extremely Significant
		POST (day 4)	0.17±0.09			
	Distance between two inferior angles	PRE (baseline)	21.4±2.05	7.39	0.0001	Extremely Significant
		POST (day 4)	17±2			
	Height deviation degrees	PRE (baseline)	3.56±1.51	8.5	0.0001	Extremely Significant
		POST (day 4)	1±1			
	Total height discrepancy	PRE (baseline)	1.73±0.4	6.93	0.0001	Extremely Significant
		POST (day 4)	0.3±0.1			
Upper Extremity Function	**Functional task**	PRE (baseline)	4.6±2	5.09	0.0001	Extremely Significant
		POST (day 4)	2±1			

Table 4, Comparison of Between Group Analysis of Scapula Stabilizing Exercises and Scapula Proprioceptive Neuromuscular Facilitation Exercises on Scapular Alignment and Upper Extremity Function

OUTCOME MEASURES		Mean ± SD		t value	p value	RESULT
		Post Stability exercises	Post PNF			
Scapular alignment	Distance from spinous process to inferior angles	8.3±0.9	7.1± 1	2.68	0.016	Significant
	Height Deviation (from spinous to Inferior angles)	2.27±0.64	1.5 ±0.6	2.62	0.016	Significant
	Total discrepancy	0.34±0.10	0.17±0.19	4.0	0.001	Very Significant
	Distance between two inferior angles	19.3±2.6	17 ± 2	2.3	0.03	Significant
	Height deviation degrees	1.4±0.3	1 ± 1	3.78	0.01	Significant
	Total height discrepancy	0.5±0.25	0.3 ±0.1	3.40	0.003	Very Significant
Upper Extremity Function	Functional task	2.18±0.6	2 ±1	2.2	0.04	Significant

Table no. 3 shows within-group analysis of Group B Scapula Proprioceptive Neuromuscular Facilitation Exercises pre and post-intervention. Distance between the spinous process to inferior angles decreased post-intervention in Group B and there was statistically significant improvement in distance between two inferior angles. Total Height Discrepancy also decreased post-intervention ($t=6.93$) ($p<0.05$) and upper extremity time taken to lifting and lowering cup also decreased. Table no. 4 Distance between the spinous process to inferior angles decreased post-intervention but Group B shows more effective with as compared to Group A and is statistically significant with($t=2.08$) ($p<0.01$). Total Height Discrepancy also decreased post-intervention ($t=3.40$) ($p<0.003$). Upper Extremity Function improved in both groups but as compared to Group A Group B showed more significant improvement with($t=2.2$) ($p<0.04$).

Discussion

This Experimental Study focused on the comparison of immediate and short-term effects of Scapular Stabilizing Exercises and Scapular Proprioceptive Neuromuscular Facilitation on Scapular Alignment and functional task in patients with Stroke.

PNF is a therapeutic exercise approach that combined a functional diagonal pattern with neuromuscular facial techniques to generate motor responses and improve neuromuscular control and function and PNF has been reported as an effective technique to improve upper limb function in patients with Stroke. Scapular Stabilization Exercises help to improve shoulder ROM, firing rate, and synchrony at the level of motor neurons by neural adaptation.

The study demonstrated that there is a significant difference between the short-term effect of Scapular Stabilizing Exercises and Scapular Proprioceptive Neuromuscular Facilitation on Scapular Alignment and Functional task in patients with Stroke in favour of PNF.

But there was no significant difference between the immediate effect of both techniques. The present study recruited a total of 18 patients with Stroke who were divided into two groups with mean age of 46.3± 10.1in Group A and mean age of 48.6±12.4 in Group B.

Scapula Stabilizing Exercises and Scapular Alignment

In the current study, Scapular Stabilizing Exercises showed significant improvement in Scapular Alignment.

There was improvement seen in terms of Total Discrepancy i.e. Distance between the spinous process to inferior angles and total discrepancy after 4 days of Intervention. Also, there was significant improvement seen in the distance between two inferior angles and total Height Discrepancy.

Scapular Stabilizing Exercises showed improvement in terms of Total Discrepancy and Total Height Discrepancy which were measured by a Palpation meter i.e. before treatment the Total discrepancy mean was and after 4 days of treatment the discrepancy decreased Whereas Before treatment the Total Height discrepancy mean was (1.6±0.6) and after 4 days it decreased

The data demonstrate that there was a change in Scapular position and hence there was a decrease in the discrepancy proving Scapular Stabilization Exercises.

A similar study done by author Si Eun Park et.al (2018) stated that there was an immediate effect of Stabilizing exercises in 4 days on Scapular position which was measured as the distance between the scapular medial border and spinous process of thoracic vertebrae 3, 4 using a tape measure. They stated that weakness of the Rhomboids and serratus anterior led to Scapular Alterations in the patient and as these muscles provide Scapular Stability causing retraction and adduction of the scapula and so they found that Scapular Strengthening Exercises improve function by improving the scapular position in patients with chronic Stroke.[10,12]

Scapular Stabilizing Exercises and Upper Extremity Function

In the present study, Scapular Stabilizing Exercises showed significant improvement in the Upper Extremity Function i.e. Functional Task performed by the patients (lifting and lowering the cup).

At Baseline the mean time taken for the patients to perform the task and it decreased throughout the intervention and after four days of treatment.

The scapular affects the shoulder joint playing an important role in adjusting the position. Scapula stabilizing exercises strengthen the scapular muscles which help in the stability of the scapula and the shoulder joint.

As discussed earlier, there was a decrease in the discrepancy in terms of distance between two inferior angles and the distance between the spinous process to inferior angles which suggests that there was an improvement in Scapular positions. This has a positive impact on the Shoulder joint hence improving the Upper Extremity Function.

D Bhide et.al (2018) stated that the scapular muscle plays a crucial role in proper functioning, execution of movement and proper stability of the upper extremity. Dynamic scapular muscle strengthening exercise had a significant influence on the distal segment i.e. hand by increasing grip strength. Upper extremity function is improved by improving the control ability of the muscles around the scapula before voluntary movement of the upper extremity. Through Scapula Stabilization Exercises it provides stability to the scapular muscles, by placing the scapula in the optimal position.

Scapula Proprioceptive Neuromuscular Facilitation Exercises and Scapular Alignment

In the current study, Scapula PNF Exercises showed statistically Significant improvement in terms of Total Discrepancy ($t= 7.4$) ($p<0.05$) & Total Height discrepancy ($t= 6.9$) ($p<0.05$) . The primary purpose of physiotherapeutic intervention is functional recovery. When Assessing a patient after injury, many symptoms are observed, including muscle weakness resulting in the loss of hand functionality, reduction in sensory-motor functions, hypertonicity, and reduction of coordination.[13]

Smooth Movements of the glenohumeral joints for the movements of the scapulothoracic joints are needed to move the upper extremities comfortably and these movements of Glenohumeral joints have been reported to be connected to trunk rotation and movements of the scapula [14] One of the study done by Sang Hyun Moon et.al. (2017) who stated that there are effects of PNF on Scapular Adductors muscles on scapular movements. PNF proved to be effective in improving the position of the scapula in terms of change in cm from the second cervical vertebra to the superior angle of the scapula and the seventh cervical vertebra to the inferior angle of the scapula after six weeks of treatment.[15]

These findings are similar to our present study, the data analyzed in terms of distance from the corresponding spinous process to inferior angles pretreatment mean was (8.89±1.17) cm and after 4 days of PNF pattern, the post-intervention values changed to (7.1± 1) cm which shows significant improvement.

Scapula Proprioceptive Neuromuscular Facilitation Exercises and Upper Extremity Function

In the present study, Scapular PNF Exercises showed statistically significant improvement in the Upper Extremity Function i.e. Functional Task performed by the patients (lifting and lowering the cup).

PNF was found to be more significant showing effectiveness in Functional Outcomes i.e. Lifting and lowering the cup. Feronika et.al (2019) did a similar study on the influence of PNF on activities of daily living in patients with Stroke. And their 12 times PNF showed an increment in their daily activity which they measured by the Barthel Index.[16]

The recovery process after Stroke is distinguished for neurological restoration of brain nervous function and functional recovery. (Ability to perform functional activity). Neurological restores occur early after the Stroke. The underlying mechanism behind that is brain cell function recovery in the penumbra area around the real infarct area and diachysis recovery. Functional capability recovers with the neurological recovery capabilities that occur.[16]

PNF is more geared toward movement with diagonal and spiral patterns together with movement used in daily activities in accordance with neuroplasticity of the nerves. A similar study done by the author Poonam C.et.al (2017) done on Effect of Early PNF on Functional Outcomes in patients with Stroke showed statistically significant improvement in activities of daily living which they measured by the Barthel Index .and also stated that improvement in activities of daily living resulted in better Quality of Life.[17]

PNF works on the principle that resisting the strong muscle causes irradiation effects in surrounding weak muscles and muscles of the contralateral side [17,18] these results in the building up of tone in flaccid and weak muscles. Applications of this principle in patients generate tone and voluntary control in flaccid and weaker muscles in the extremities. Hence improving the upper extremity function.[19]

Scapular Stabilizing Exercises versus Scapular Proprioceptive Neuromuscular Facilitation Exercises

In the current study, the data demonstrates a significant difference between both the techniques but the more effective is found to be in Group B i.e. Scapular Proprioceptive Neuromuscular Facilitation Exercises. The results show that there is a statistically significant improvement between the group in terms of distance from spinous to inferior angles (with $p<0.01$) and Height deviation in degrees ($p<0.01$) resulting in a Very Significant improvement in terms of Total Discrepancy ($p<0.051$). Distance between two inferior angles was statistically significant ($p<0.03$) resulting in Total Height Discrepancy ($p<0.003$).

Upper Extremity Function in terms of Functional task also showed significant improvement ($t=2.2$) ($p<0.04$) Comparing the between-group analysis Scapula PNF exercises have been found to be more effective. One of the studies contradicts this finding showing Scapular Stability Exercises to be more effective than the Scapular PNF Exercises and stated that scapular stability exercises are more effective in improving paretic upper extremity function in Stroke patients.[7]

The mechanism behind the effectiveness of Blackburn exercises is explained by AAwadas strengthening exercises primarily reeducate the stability, control around the scapula, enhance the recruitment, firing rate and synchrony at the level of motor neurons by enhancing neural adaptation of the hemiparetic upper limb in patients with Stroke (Awad, 2015)[20]

According to the results, the data contributes to a clear understanding that in the present study, There is a significant difference between both the techniques; but PNF was found to be more effective than Scapula Stabilizing Exercises. In PNF exercises, there was strengthening and functional movement that occurred simultaneously. Structures surrounding the scapula and shoulder joint do not act efficiently after the damage caused by Stroke; restoration of functions of those Structures is of utmost importance to have a proper shoulder. This restoration is aided by various PNF techniques by normalizing tone and by improving blood circulation.

In the present study, Patients with acute and sub-acute were not differentiated as per their condition this could be one of the limitations of the study to find effectiveness at an early stage of Stroke. Future studies can be conducted to study the long-term effect in Chronic patients.

Clinical Implications

The results of the current study imply that providing isolated Scapular Exercises in chronic conditions may also bring a change in function.

Scapula PNF exercises are efficient to improve tone and Strength in the scapular muscles. They are very similar to our functional movements so they can be implemented to teach functional activities by the therapists which may also enhance the neuroplasticity.

As the Shoulder is an important component for functional stability early administration of Scapula Exercises can be started from day 1 of Rehabilitation.

Conclusion

The conclusion of the present study is that Scapula Proprioceptive Neuromuscular Facilitation Exercises is moderately more effective than Scapula Stabilizing Exercises and has better short-term effect on Scapular Alignment and Functional Task in patients with Stroke.

Declarations:

Ethics approval and consent to participate: Approved by Institutional Ethical Committee.

Consent for publication: No patient data were used in this manuscript.

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