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[BOOK REVIEW]

Patterns of Scapula Stabilization Exercises for Improving Upper Extremity Function and Scapular Alignment in Patients with Stroke: A Systematic Review

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ABSTRACT:

Background - Scapula stabilizing exercises used for improving shoulder function in patients with stroke has been reported in literature. However there is diversity in pattern of these exercises which makes it difficult to choose specific exercise and its impact on upper extremity function and scapular malalignment cannot be estimated appropriately. Hence it was aimed toexplore different patterns of Scapular Stabilizing Exercises and its effect on scapular malalignment and upper limb function.

Methods- Four databases (PubMed, Google Scholar, Cochrane, Science Direct) were searched to identify eligible studies using the keywords Scapula stabilizing exercise, Stroke. Only Randomized controlled trial studies published in last 10 years (2010-2020) were included in this review.

Results- Thorough search identified six studies conducted on patients with sub-acute and chronic stroke. Scapular stabilising exercises were described in different positions supine lying, sitting with different movements being performed patients. Its effect on upper extremity function is measured with specific outcome measures. However its effect on scapular malalignment is not measured.

Conclusion – There is diversity in the description of exercises though a common terminology as 'Scapular Stabilizing Exercise' is used in all research studies. In addition, the effect of these exercises on scapular malalignment is not assessed in any of the studies included in the current review.

Keywords: Scapula Stabilizing Exercises, Stroke, Scapula Malalignment.

Introduction

The incidence rate of stroke in Low Middle Income Countries has increased from 56/100,000person-years during 1970 -1979 to 117/100,000 individuals - years during 2002-2008, according to a global systematic review of population-based stroke study.[(1)]Upper limb dysfunction has been the primary impairment in patients with stroke.[(2)] There is usually muscle weakness and imbalance and poor voluntary control and body malalignment. It may lead to diminished ability of affected arm.[(3)] An affected arm can change scapular orientation, as scapular stabilizers are often impaired by muscle weakness. Such weakness will increase motor impairment in upper extremities.[(3)] Neurological and functional recovery is active, task oriented and intensive during sub-acute phase of stroke so during this phase rehabilitation is crucial.[(2)] Weakness in upper limb is often severe in most distal regions. Although proximal muscles and joints may be least affected, purposeful movement requiring precise control of the proximal segments is slow, inaccurate, and poorly coordinated. The distal region of upper extremity is capable of comfortable, coordinated movement, despite immobility of the proximal region of upper extremity. Stroke survivors commonly have an impaired shoulder joint complex, because paretic muscles do not overcome the weight of the arm. Problems secondary to neuromuscular problems, such as shoulder subluxation and pain,

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suppress functioning of the upper extremity.[4]

In order to ensure that the humerus head can be properly maintained at the joint and center for the ability of the musculoskeletal system to maintain balance when movement or control disturbances occur, and scapula can be fixed in a neutral position of the thorax, the scapula stabilization exercises have been designed.[5] For ideal upper extremity function, the function to control position and movement of the scapula is essential.[6] Controlled movement of scapula and proper posture are important for upper extremity function, and scapular stabilization exercise is used to correct movement dysfunction related to dynamic control of incorrect scapular position and provides stability to the entire scapula.[7]

Various studies have investigated the effects of active, repetitive, and functional activities in post-stroke patients on upper extremity function. The studies used constraint induced movement therapy, robot-assisted movement, and electromyography-trigged neuromuscular electrical stimulation.[8-10] However, these therapeutic approaches mainly focus on fine motor skills in distal extremities, not gross motor skills in proximal extremities, even they have been reported to provide benefits for chronic stroke patients, the necessary elements for correct scapular movement, which is often linked to proper initiation and recruitment, are impaired in stroke patients.[4]

However there are few studies in which Scapular stabilizing exercises is used as an intervention. Scapular Stabilizing Exercises helps to improve shoulder ROM, firing rate, and synchrony at level of motor neuron by neural adaptation. It was concluded that scapular stability exercises are more effective in improving paretic upper extremity function in stroke patients.[11] However, there is considerable uncertainty concerning the effectiveness of scapula stabilizing exercises in restoring normal scapular kinematics and upper limb function including activities of daily living.

So the purpose of this systematic review is to study the pattern of Scapular Stabilizing Exercises described in each research article and to investigate the efficacy of scapular stabilizing exercises in improving upper limb function and activities of daily living in patients with stroke. Objectives of review are, different tools used for measuring scapular malalignment and various outcome measures used for the assessment of upper limb function and activities of daily living.

Methodology: A Systematic search was undertaken in four commonly used search engines (PubMed, Google Scholar, Science Direct, Cochrane library) for the research articles published during the period June 2010 to June 2021. The search strategy comprised of the following terms: Scapula stabilizing exercises, Acute, subacute stroke, Upper extremity function, scapular malalignment and it followed the recommendations of the Cochrane handbook for systematic reviews of intervention and reported in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P). Selection criteria for randomized controlled trial - Only RCTs published in English language investigating patterns of scapula stabilizing exercises for improving upper limb function were included. The Exclusion criteria were case study, observational studies and experimental studies including one group.

Results-

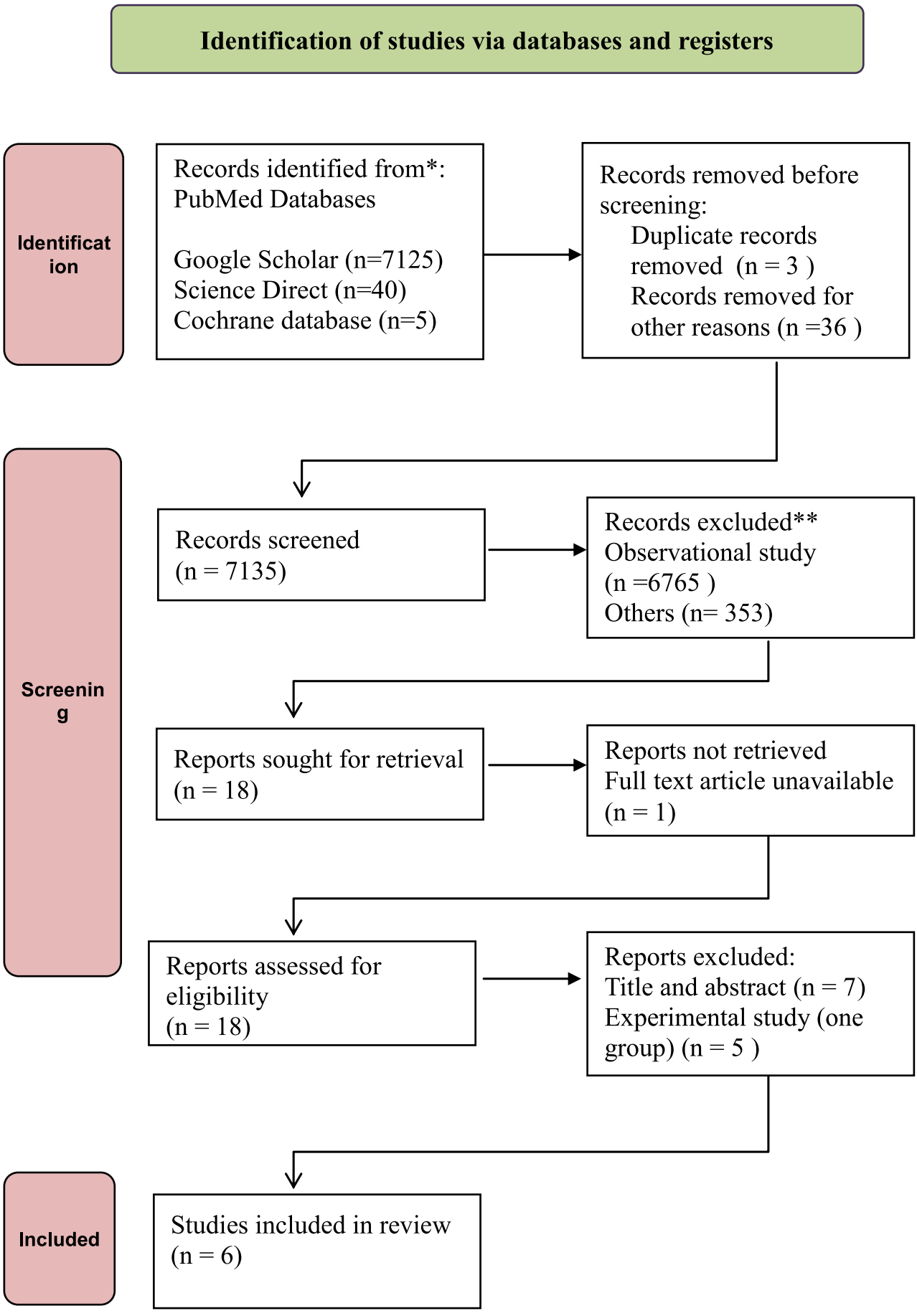
Thorough search identified six studies conducted on patients with sub-acute and chronic stroke. Scapular stabilising exercises were described in different positions supine lying, sitting with different movements being performed patients. Its effect on upper extremity function is measured with specific outcome measures. However its effect on scapular malalignment is not measured.

Conclusion –

There is diversity in the description of exercises though a common terminology as 'Scapular Stabilizing Exercise' is used in all research studies. In addition, the effect of these exercises on scapular malalignment is not assessed in any of the studies included in the current review.

Keywords:

Scapula Stabilizing Exercises, Stroke, Scapula Malalignment.


Identification of studies via databases and registers
Identification
Records identified from*:
PubMed Databases
Google Scholar (n=7125)
Science Direct (n=40)
Cochrane database (n=5)
Records removed before screening:
Duplicate records removed (n = 3)
Records removed for other reasons (n =36)
Screening
Records screened
(n = 7135)
Records excluded**
Observational study
(n =6765)
Others (n= 353)
Reports sought for retrieval
(n = 18)
Reports not retrieved
Full text article unavailable
(n = 1)
Reports assessed for eligibility
(n = 18)
Reports excluded:
Title and abstract (n = 7)
Experimental study (one group) (n = 5)
Included
Studies included in review
(n = 6)

Data Extraction:

Analysis of data through various Electronic Data base was done and searched by PB. The Title and Abstract of all the retrieved results were then screened for eligibility by PB & SG. The Screening process was aimed at narrowing down the volume of articles by rejecting the studies that are not relevant or appropriate according to previously stated criteria, Full text version of all relevant articles were evaluated by PB and SG.

Data Analysis:

The selected studies in terms of specific study design, no. of subjects included, procedure and intervention performed, outcome measures and results used in the study, conclusion, limitations and future scope were analyzed.

Analysis of study design helped to confirm specific type of Randomized controlled trial. Details of participants suggested the stage of stroke whether subacute or chronic. Procedure and intervention of each study revealed the patients undergoing following treatment. Outcome measures description indicated quality of tool along with its psychometric properties. Result of study produced a direction to understand the effectiveness of each intervention in given study.

Risk of Bias Assessment:

Studies were evaluated with the PEDro scale. The PEDro scale includes following components: 1) Eligibility criteria 2).random allocation to groups 3)Allocation concealment, 4)groups similar at baseline 5) blinding of all subjects 6)blinding of all therapists 7) Blinding of all assessors 8) measures of one key outcome measures 9) all subjects for whom outcome measures were available were treated 10)Results of between group Statistical comparisons ,11) point measures and measures of variability for one key outcome measures. The final study of each score study is presented in Table 1.The methodologic quality varied between 6-8 out of 11 on the PEDro scale. According to the PEDro classification, all of the studies showed 'Good 'quality. Studies lost the points on blinding of patients, therapists and assessor .Also the allocation concealment was not done. Most studies scored good in randomization and one key outcome measures results. Only one study reported blinding of the assessor.

Study	Components											PEDr score (11)	Quality
	1	2	3	4	5	6	7	8	9	10	11		
1. Dae-Jung Yang	1	1	-	1	-	-	-	1	1	1	1	7	Good
2. Dr. Avanee Vajaret.al	1	1	-	-	-	-	-	1	1	1	1	6	Good
3. Kim JO, Lee J et.al	1	1	-	1	-	-	1	1	1	1	1	8	Good
4. Larissa Dhar1,et.al	1	1	-	1	-	-	-	1	1	1	1	7	Good
5. Sung-Ryoung Ma et.al	1	1	-	1	-	-	-	1	1	1	1	7	Good
6. Young Youl You et.al	1	1	-	1	-	-	-	1	1	1	1	7	Good

The Outcome measures used in the studies for investigating the effect of scapular stabilizing exercises are Ultrasonography, Motor assessment scale, Manual Function Test, Modified Barthel Index, Visual analog scale, Modified Ashworth Scale, Timed Up and Go test, Functional Gait Assessment, Fugl Meyer Assessment Scale and Electromyogram.

Results:

Study Characteristics: For interpretation of the results regarding the study population, duration, intervention, follow up period and main results of the studies are summarized in the table 2 and table 3

Table no. 2 – Summary of Randomized controlled studies(arranged in chronological order)

Study	Design and participants	Treatment	Outcome measures	Results and conclusions
Young Youl You, Jin Gang Heret.al.[12] (2014)	1) n= 41 2) 6months or more< 2 yrs	**Group A** – 30 min traditional exercise- normal development therapy **Group B** – 30 min stretching- Shoulder abduction at 45˚, stretching of shoulder at 90˚, reaching towards the ground with elbow extension. **Group C** – 15 min stretching + 15 min stabilizations exercise	1) Thickness of biceps tendon – Ultrasonography (mm) 2) Motor assessment scale	Combine stretching and stabilization more effective in spastic shoulder dysfunction in hemiplegia.
Dae-Jung Yang, Yo-Han Uhmet.al[15] (2015)	1) n=30 2) 6 months - <1 yr	**Group A** – Biofeedback scapular stabilization exercise - attaching the Myo-Ex recording electrode of the E-LINK system intervention training tasks with external rotation, horizontal abduction and flexion . **Group B**- Task –oriented training 20 tasks for eg :-using a sprayer, inserting and removing cards from the wallet, dusting, opening and closing the door.	1)Electromyo gram– to check muscle activity 2) Fugl –Meyer Assessment scale 3) Manual function test	Biofeedback scapular stabilization exercise is effective than task-oriented training in facilitating muscle activation and functional capacity of upper limb.
Kim JO, Lee J et.al [23] (2017)	1)Randomized controlled trial 2) n=17 3) ≥6 months	**Group A** – physical therapy and scapular stabilization exercise. **Group B** – simple scapular exercise .Both groups- 30 min per session 3 sessions / week for a period of 8 wks	1) Timed Up and Go test (TUG)(sec) 2) Functional Gait Assessment (FGA) 3) Manualfunction test (MFT)	Scapular stabilization exercise during standing on a paretic side for 8 weeks had an effect on hand function and gait ability of hemiplegic patients after stroke.
Sung-Ryoung Ma, Byung-Il Yang[25] (2018)	1) n=30 2) ≥6 months	**Group A** - Scapula setting intervention- Strengthening exercises of scapular bone stabilization muscles (trapezius, serratus anterior, rhomboid major, minor) **Group B** – General physical therapy with balance training. Both interventions given 30 mins in a day and 3 times in week for 4 wks	1) Modified Barthel Index(MBI) 2) Timed up and go (TUG) test (sec)	Scapula setting intervention effective in improving gait for stroke patients.
Dr. AvaneeVajaret.al [11] (2019)	1)Comparative study 2) n=30 3) Sub-acute(3-6 months)	**Group A**-Scapular PNF& conventional therapy **Group B**- Blackburn exercise & conventional treatment in prone position with 6 holds. for a period of 10 repetitions for, 5days per week up to 4 weeks for both the groups.	1) Fugl Meyer Assessment 2) Manual Function test	Scapular stability exercises are more effective in improving paretic upper extremity function in stroke patients
LarissaDhar, S.Anita Devi et.al[14] (2021)	1)Comparative study 2) n=30 3) Duration 2-3 months	**Group A** – stabilization exercises- shoulder joint - 90° and elbow at 120° and protracted the scapula for 10 seconds shoulder external rotation with upper limb abduction of 45 degree, elbow flexion of 90 degree ,and performed internal rotation and external rotation 10 second hold, 10 second rest with 10 repetitions 5 days/week for 3 months **Group B** - PNF - hold relax technique in diagonal pattern of anterior elevation and posterior depression	1) Visual Analog scale 2) Modified Ashworth Scale .	PNF Stretching technique is better than Stabilization techniques in improving pain and spastic shoulder in chronic stroke patients.

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Table No. 3 Summary of Result of each Study

Design	Intervention	Results						
Young You l You, Jin Gang Her et.al[12]	**Group A –** 30 min traditional exercise - normal development therapy **Group B –** 30 min stretching- **Group C –** 15 min stretching + 15 min stabilizations exercise –			**AUS**			**MAS**	
		Group A	Pre	7.61±0.70			1.64 ± 0.63	
			4 wks	7.28±0.57			2.07 ± 0.61	
			8 wks	5.19±0.92			2.50 ± 0.51	
		Group B	Pre	7.57±0.85			1.54 ± 0.66	
			4 wks	7.29±0.84			2.08 ± 0.49	
			8 wks	5.48±0.49			2.85 ± 0.55	
		Group C	Pre	7.38±0.87			1.50 ± 0.51	
			4 wks	7.08±0.74			2.00 ± 0.55	
			8 wks	5.63±0.57			3.36 ± 0.84	
Dae-Jung Yang,et.al	**Group A –** Biofeedback scapular stabilization exercise - attaching the Myo-Ex recording electrode of the E-LINK system –. **Group B-** Task –oriented training 20 tasks			**LT**	**DM**	**SA**	**FMA**	**MFT**
		Group A	Pre	37.62±1.68	41.50±2.4	34.25±1.4	33.25±1.9	16.8±1.60
			Post	42.00±2.00	44.37±1.8	37.62±1.6	37.12±1.8	22.37±2.5
		Group B	Pre	36.87±1.95	41.12±2.4	33.37±1.5	32.37±1.7	18.37±1.9
			Post	39.25±1.48	42.75±2.9	35.37±1.5	35.00±2.3	21.25±2.1
Kim JO, Lee J[23]	**Group** A– Physical therapy and scapular stabilization exercise G**roup B –** simple scapular exercise Both groups – conventional therapy 30 min for 4 wks.			TUG	FGA	MFT		
		Group A	**Pre**	24.01±7.90		16.00±6.0	9.67±9.40	
			Post	21.43±6.87		17.33±6.7	11.00±8.83	
			Follow up	18.95±5.95		19.78±6.9	12.56±8.50	
		Group B	**Pre**	26.67±11.6		15.00±7.3	14.13±10.41	
			Post	25.73±11.0		16.13±6.6	14.38±10.15	
			Follow up	24.95±10.0		16.38±6.8	14.75±10.44	

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• Sung-Ryoung Maet.al [25]	**Group A -** Scapula setting intervention- **Group B –** General physical therapy with balance training.			TUG		MBI
		Group A	**Pre**	28.46±3.49		75.67±4.62
			Post	26.32±3.20		75.93±4.69
		Group B	**Pre**	28.46±3.49		75.67±4.62
			Post	26.32±3.20		75.93±4.69
		Inter group	**Post settinng**	2.14±1.37		0.26±0.45
			Post physical ex	1.15±1.20		0.66±1.39
Dr. AvaneeVajar, et.al [15	**Group A-**Scapular PNF& conventional therapy**Group B-** Blackburn exercise & conventional treatment				FMA	MFT
		Group A Control Group		Pre	25.2±4.7	9.6±2.6
				Post	42.3±4.9	15.5±3.3
		Group B		Pre	30.±6.63	14.33±3.6
				Post	48.33±4.7	21.33±3.3
		Inter group		Post PNF	42.333	15.53
				POST BB	48.333±5.646	21.33±4.415
Larissa Dhar1, et.al.[14]	**Group A –**Stabilization exercises **Group B -** PNF - conventional treatment				VAS	MAS
		Group A		Pre	7.20±1.373	2.40±0.986
				Post	3.33±1.175	1.0±7.37
		Group B		Pre	7.20±1.373	2.93±0.799
				Post	3.33±1.17	1.53±0.64

Discussion:

This systematic review focus on effect of scapular stabilizing exercises on upper limb function and activities of daily living. There are studies which show better improvement in upper limb function and its effects on activities of daily living. For upper limb function Manual Function test was most commonly used outcome measure in the study.

In the current systematic review, with upper limb function and activity of daily living they also considered Pain, Spasticity, and Gait as their secondary outcome measures.

Although the name for Scapula stabilizing exercises is same the position of the patient, the treatment technique is given different in the articles included in this systematic review.

Patterns of scapula stabilization exercises

You YY et al.[12] and Kim J et al [23] stated that for the stabilization exercise, the participants were in sitting position. The subjects were asked to hold the resistance band in hands with shoulder abduction of 0–60° in scapular plane with elbow flexed in 90°& shoulder in neutral rotation. They were asked to punch forward from shoulder flexion of 0–60 in sagittal plane and elbow

Flexion of 90°, simultaneously extending the elbow & flexing. Next Scapular retraction with their arms by their sides with elbow flexion of 90° and the shoulder in neutral rotation performed pinching the scapula. Lastly they performed shoulder external rotation with arm abducted 45° in scapular plane, elbow flexed to 90°, moving through an arc from 30° of internal rotation to 30° of external rotation.[13]

Larissa Dhar et.al investigated that for stabilizing exercise, the patient seated on chair with feet flat on floor. The therapist stood behind the patient placing hand on scapula and axillary area. The patients were ask to hold the shoulder flexion at 90° and the elbow flexion at 120° and protract the scapula for 10 seconds, and then returned to the starting position. Then perform shoulder external rotation with abduction of 45 ˚ and elbow flexion at 90˚ internal rotation and external rotation for 10 secs hold 10 sec rest with 10 repititions. [14]

Dr. AvaneeVajar et al. for scapular stability exercise stated for which patients were prone lying position and asked to perform Black burn exercise with 6 holds.[11] Yang DJ et al. stated scapula stabilization external rotation exercise, flexion , horizontal abduction, and extension exercise based on the study of Cools10 [7]. Also they used this exercise by using Myo-Ex of the E-LINK system (Biometrics Inc, United Kingdom) [15].

Sung-Ryoung investigated for stabilizing exercise, the patient in sitting position and identified scapular alignment by checking position of shoulder bones on both sides they corrected the posture through pelvic movement and in order to recognize the injured scapular bones they gave sensory stimulation by tactile and proprioceptive stimuli to inner lateral and medial border of scapular bone .Then the therapist supported the pectoralis major with one hand and supported the weight of scapular bone downward with the other to reposition then strengthening exercises of scapula bone stabilization muscles (for trapezius, serratus anterior Rhomboid major and minor) were given. [25]

Scapula Stabilizing Exercises and Upper Limb Function

Upper limb function was measured by Motor assessment scale, Fugl Meyer Assessment scale and Manual Function test. MFT and FMA was used in two studies together and one study used Motor assessment scale for upper limb function .It was hypothesized that Scapula stabilizing exercises primarily reeducate the stability, control around scapula, enhance the recruitment, firing rate and synchrony at level of motor neuron by enhancing neural adaptation of the hemi paretic upper limb in patients with stroke. [16]

Biofeedback scapula stabilizing exercises helps provide information about one's own movement while performing the task, and used as a positive reinforcement that leads to immediate behavior modification in next movement performance. [22] Also by improving the control ability of the muscles around the scapula before voluntary movement of the upper extremity by providing stability and positioning scapula at the optimal position through the scapula stabilization exercise. [24]

Scapula Stabilizing exercises – Pain and Spasticity

Visual analogue scale and Modified Ashworth scale was used to measure pain and spasticity respectively in one study [14]. They stated that there was significant decrease in VAS scale and Spasticity Grade after application of stabilization exercises .They reported that

scapulohumeral external rotation muscle in patients improved scapulohumeral rhythm and when a person tries to move the upper extremities range of motion is decreased, so exercise is used to correct abnormal scapular location and functional movement disorder and primarily provides stability to the entire scapula. When rotating the scapula upwards, the couple force of the trapezius, lower trapezius and serratus anterior muscles, act as stabilizer muscles and plays a vital role in scapula movement and helps in decreasing pain and spasticity of shoulder.[25]. Scapula stabilizing exercises and Thickness of biceps tendon Ultrasonagraphy was used to measure thickness of biceps tendon. It was hypothesized that the thickness, length, biomechanical characteristics, stiffness, and hysteresis of the affected tendon were increased compared with those of the unaffected tendon in stroke patients. After giving stabilizations exercises it decreased significantly due to decrease in muscle tone as a result of change in length of the spastic muscle hence improving the activity of the antagonistic muscle, and improving the activity of the tendon. [12]

Scapula Stabilizing exercises and Activities of Daily Living

Activity of daily living was measured by Modified Barthel index in one Study[25] they reported stabilization exercises given to strengthen weak stabilizers, the necessary elements which gives the scapular correct movement and hence giving proper initiation and recruitment to perform activities of daily living [1].

Scapula Stabilizing Exercises and Balance and Gait

Timed up and Go test in two studies measured for balance[23,24] and Gait was measured by Functional Gait Assessment by one study [23] reported that there was improve in Balance and Gait significantly after giving stabilizing exercise sit was hypothesized that upper body uprights the trunk while walking. Body stability through the movement of the upper body is ±1.5° of movement of the body during walking. This enhance the stability of the head and reduce improper signals from anotolith and the vestibular system.[22] With the dynamic regulation of the scapular ,stable muscles make scapula effectively positioned to obtain ideal postural control on body weight load and assumed that compensate movement was intervened through the training.

None of the authors have focused on scapular alignment as an outcome measure which is necessary component for the functioning of upper extremity as there is scapular malalignment due to weakness of scapula stabilizers which is already reported. Hence, further studies can be done to investigate effect of scapula stabilizing exercises on scapular alignment with sufficient sample size. .

Conclusion - Diversity in performance scapular stabilizing exercises across the studies and lack of assessment of scapular alignment can be the underlined component which may override the positive aspect of assessing the effect of these exercises on functional performance in patients with stroke.

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Conflict of Interest – None

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