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A Study to Find out the Effect of Scapular Stabilization Exercises on Shoulder ROM and Functional Outcome in Diabetic Patients with Stage 2 Adhesive Capsulitis of The Shoulder Joint - An Interventional Study

Anuj Hiralal Gulwani

Assistant Professor, SKUM College of Physiotherapy, Ahmedabad- 380054

ABSTRACT

Introduction: The incidence of adhesive capsulitis is two to four times higher in diabetics than in the general population. There are very few studies done to find out the effect of scapular stabilization exercises on shoulder Range Of Motion (ROM) and functional outcome in frozen shoulder patients and no study is showing the effect of scapular stabilization exercises on shoulder ROM and functional outcome in diabetic frozen shoulder patients with stage 2 adhesive capsulitis. So, the purpose of this study is to find out the effect of scapular stabilization exercises on shoulder ROM and functional outcome in diabetic patients with stage 2 adhesive capsulitis of the shoulder joint.

Method: 30 Diabetic frozen shoulder subjects with stage 2 adhesive capsulitis, age group 40-65 years were selected by inclusion and exclusion criteria. After taking informed, written consent subjects were divided into two groups. Group-A received conventional physiotherapy and Group-B received scapular stabilizing exercises along with conventional physiotherapy. Pre & post intervention (at the end of 12th session) shoulder active ROM & Shoulder pain and disability index were measured.

Result: Data were analyzed by SPSS version 20. Wilcoxon signed-rank test for pre-treatment and post treatment comparison and Mann-Whitney U test for between groups comparison of active shoulder range of motion & functional ability (on SPADI) were applied. The result showed significant difference between the two groups.

Conclusion: Scapular stabilization exercises are helpful for improving shoulder ROM and functional ability in diabetic patients with stage 2 adhesive capsulitis along with conventional physiotherapy.

Keywords: Scapular stabilization exercises, Diabetic frozen shoulder, Shoulder pain and disability index, Active shoulder range of motion

INTRODUCTION

The shoulder is a unique anatomical structure with an extraordinary Range Of Motion (ROM) that allows us to interact with our environment. [1] Adhesive capsulitis is characterized by the gradual onset of severe shoulder pain with the progressive limitation of active and passive glenohumeral range of motion. [2] The more common terms that are synonymous to adhesive capsulitis of the shoulder are periarthritis shoulder, frozen shoulder, stiff and painful shoulder. [3] The term "frozen shoulder" was first introduced by Codman in 1934. Long before Codman, in 1872, the same condition had already been labeled "peri-arthritis" by Duplay. In 1945, Naviesar coined the term "adhesive capsulitis". [4] Codman described frozen shoulder as a condition characterized by a slow onset of pain felt near the insertion of the deltoid, with inability to sleep on the

affected side and restriction in both active and passive elevation and external rotation, yet with a normal radiographic appearance. [5]

Prevalence rate of frozen shoulder is 2% in the general population. It affects persons older than 40 years of age more commonly, and 70% of patients presenting with a frozen shoulder are women. [6] 20 to 30% patients develop the condition bilaterally. [7] The incidence of adhesive capsulitis is two to four times higher in diabetics than in the general population. The prevalence of diabetes in patients with adhesive capsulitis was 38.6%, whereby the total prevalence of a diabetic condition in patients with adhesive capsulitis was 71.5%. [8]

The risk factors for frozen shoulder are diabetes, history of shoulder trauma, cervical radiculopathy, post-operative immobilization. [2] Other comorbid factors include hyperthyroidism, hypothyroidism, hypoadrenalism, Parkinson's disease, cardiac disease, pulmonary disease, stroke, and even surgical procedures that do not affect the shoulder such as cardiac surgery, cardiac catheterization, neurosurgery, and radical neck dissection. [1]

The pathophysiological process is believed to involve synovial inflammation and fibrosis of the shoulder joint capsule. [6] Gradually the capsule thickens and results in the shoulder becoming stiffer and more painful. [2] Between the articular surfaces, there grows abnormal tissue that causes restriction of joint motion. In addition to this, there may be lack of synovial fluid that provides lubrication to shoulder joint during intra-articular movements. [9]

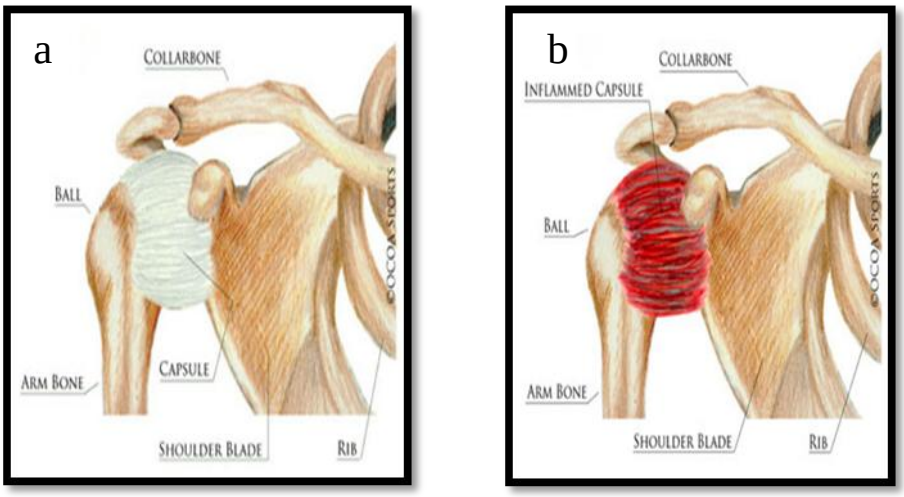

Figure 1(a) and (b): Normal and inflamed shoulder joint capsule

Pain associated with adhesive capsulitis can cause a limitation or selective immobilization of the painful shoulder. Prolonged immobilization of a joint has been shown to cause several detrimental changes. [1]

Clinical feature includes, [10]

- Night pain and disturbed sleep during acute flares
- Pain on motion and often at rest during acute flares
- Mobility: decreased joint play and ROM, usually limiting external rotation and abduction with some limitation of internal rotation and elevation in flexion
- Posture: possible faulty postural compensations with protracted and anteriorly tipped scapula, rounded shoulders, and elevated and protected shoulder
- Decreased arm swing during gait
- Muscle performance: general muscle weakness and poor endurance in the

glenohumeral muscles with overuse of the scapular muscles leading to pain in the trapezius and posterior cervical muscles

- Guarded shoulder motions with substitute scapular motions.

The pain is located over the antero- lateral aspect of the joint and radiates to the anterior aspect of the upper arm and occasionally to the flexor aspect of forearm. Discomfort is worse at night and interferes with sleep. Tenderness is generalized above the humeral head and over the bicipital groove. [11]

Adhesive capsulitis is classified into two categories: [1]

(1) Primary, which is insidious and idiopathic,

(2) Secondary, this is generally due to trauma or subsequent immobilization.

Possible causes of secondary adhesive capsulitis are of systemic, extrinsic, or intrinsic nature. Systemic causes include diabetes mellitus, thyroid dysfunction, and hypoadrenalism. Extrinsic causes include cardiopulmonary conditions, cervical spine diseases, and stroke, Parkinson's disease, and humerus fractures. Possible intrinsic factors are rotator cuff pathologies, biceps tendinitis, calcific tendinitis, and acromio-clavicular joint arthritis. Likewise, the presence of recent surgery, immobilization, and trauma has also been associated with the development of secondary adhesive capsulitis. [12]

Adhesive capsulitis is typically characterized as having three overlapping phases. [12], [13], [14]

Phase 1: Freezing stage

It is characterized by progressive stiffening and loss of motion in the shoulder with increasing pain on movement, which may be worse at night. It is usually referred to as the painful phase. Patients may not present during this stage because they think that eventually the pain will resolve if self-treated. [1]

This phase lasts between 2 to 9 months.

Phase 2: Frozen stage

There is a gradual decrease in pain but stiffness remains and there is considerable restriction in the range of movement. It is usually referred to as the stiffening phase.

This phase lasts between 4–12 months.

Phase 3: Thawing stage

There is an improvement in range of movement. It is usually referred to as the resolution phase.

This phase lasts between 12-42 months.

In stage II and III adhesive capsulitis ROM are restricted in the capsular pattern i.e. external rotation is most limited, followed by limitation in abduction and internal rotation respectively. [14], [15]

The diagnosis of adhesive capsulitis may be suggested by a careful history and physical examination. Loss of active and passive motion is present; the loss of external rotation with the arm at the patient's side is a hallmark of this condition. The loss of passive external rotation is the single most important finding on physical examination and helps to differentiate the diagnosis from a rotator cuff problem because problems of the rotator cuff generally do not result in a loss of passive external rotation. [16]

Diabetes is not a single entity but a group of conditions characterized due to an absolute or relative lack of insulin and has many causes, though commonest are 'type-2' and 'type-1' diabetes. [17]

Diabetics have a higher incidence of frozen shoulder, probably because poor circulation leads to abnormal collagen repair and degenerative changes. The theory is that platelet derived growth factor is released from abnormal or ischemic blood vessels, which will then act as a stimulus to local myofibroblast proliferation. What follows has been proposed that micro vascular disease, abnormalities of collagen repair and predisposition to infection may link diabetes with frozen shoulder. [8]

The scapula performs 3 major roles in the production of smooth, coordinated movement about the shoulder girdle. These roles are interrelated to maintain the

glenohumeral relationship and provide a stable base for muscular function. [18]

The first role of the scapula is the maintenance of dynamic stability with controlled mobility at the glenohumeral joint. In order to maintain itself as the stable platform for glenohumeral function, the scapula must move in a coordinated fashion with the moving humerus, so that the humeral head is constrained within the glenoid throughout the full range of shoulder motion. [18]

The second role the scapula plays is as a base for muscle attachment. The muscles that stabilize the scapula attach to the medial border of the scapula, thereby controlling its position. This musculature controls scapular motion mainly through synergistic co contractions and force couples, which are paired muscles that control the movement or position of a joint or a body part. [18]

The third role of the scapula is best represented as the link in the proximal-to-distal transfer of energy that allows for the most appropriate shoulder positioning for optimal function. [14, 18-20] the scapula is pivotal in transforming the large forces and high energy from the major sources for force and energy-the legs and trunk-to the actual delivery mechanism of the energy and force-the arms and hands. [18]

The main pathology is in the capsule of glenohumeral joint and there will be thickness of capsule and synovium of the inferior axillary recess. Even though due to capsular tightness there will be tightness of pectoralis major, latissimus dorsi and teres major muscles will occur lead to stretch weakness of middle and lower trapezius, rhomboids minor and major muscles. This muscular instability produced protracted shoulder girdle and increased scapulothoracic joint motion which alters Glenohumeral (GH) mechanics leads to additional stress to capsule, rotator cuff muscles and sub acromial bursa. [19] The GH to scapulothoracic ratio in abduction motion was found to be 5:4 after 30 degree of abduction. [20]

The Shoulder Pain And Disability Index (SPADI) is a self-administered questionnaire that consists of two dimensions, one for pain and the other for functional activities, and requires *5* to 10 minutes for a patient to complete. The pain dimension consists of five questions regarding the severity of an individual's pain. Functional activities are assessed with eight questions designed to measure the degree of difficulty an individual has with various Activities of Daily Leaving (ADL) that require upper-extremity use. Patients place a mark on a 10-cm visual analog scale for each question. Verbal anchors for the pain dimension are "no pain at all" and "worst pain imaginable," and those for the functional activities are "no difficulty" and "so difficult it required help." The scores from both dimensions are averaged to derive a total score. [21] Staples et al (2010) concluded that the Shoulder Pain And Disability Index (SPADI) is superior responsiveness when compared to the Disability of Arm, Shoulder and Hand (DASH) in patient with adhesive capsulitis. [21]

Goniometry refers to the measurement of angles, in particular the measurement of angles created at human joints by the bones of the body. The universal goniometer is the instrument most commonly used to measure joint position and motion in the clinical setting. The body of a universal goniometer resembles a protractor and may form a half circle or a full circle. The scales of a half circle goniometer read from 0˚ to 180˚ and from 180˚ to 0˚. [22] One arm is stationary and the other arm is moving around its axis or fulcrum of the protractor. The reliability of goniometry is 0.98 and validity is 0.97-0.98. [23]

METHODOLOGY

- **Study design:** An Interventional study.
- **Study setting:** Shri K.K. Sheth Physiotherapy College, Rajkot.
- **Source of data:** Various physiotherapy centers in Rajkot.

- **Sampling technique:** Purposive sampling
- **Sample size:** 30 subjects (group A – 15 subjects) (group B – 15 subjects)
- **Study duration**: 2 weeks (6 times/week)
- **Method of data collection:** Total 30 subjects with diabetes and having stage – 2 of adhesive capsulitis with age group of 40 to 65 years were selected for the study that fulfilled the inclusion and exclusion criteria. The details and purpose of the study were explained to all the subjects and written consent was taken from them.

❖ **Selection criteria:**

❑ **Inclusion Criteria:**

- Age group between 40-65 years.
- Both male and female gender.
- Subjects having diabetes and diagnosed as adhesive capsulitis of shoulder.
- Subjects having phase – 2 stage of adhesive capsulitis.
- Subjects who are not on painkillers.

❑ **Exclusion Criteria:**

- Any neurological disorder.
- Subjects who have been operated previously for shoulder or neck.
- Severe psychiatric illness.
- Any other musculoskeletal disorder
- Any bone disease, tumors or infection.
- Pregnancy.
- Traumatic injuries of upper limb and cervical spine.

❖ **Materials used in the study**

1. Treatment table.
2. Pillow.
3. Consent form
4. Pen & paper.
5. Record or data collection sheet.
6. Shoulder Pain And Disability Index (SPADI)
7. Universal goniometer.
8. Vestibular ball.
9. Towel.
10. Cable or band

Figure 2 (a): Materials used for the study

Figure 2 (b): Materials used for the study

❖ **Procedure:**

- The proposed title and procedure had been approved by ethical committee members.
- Subjects of both the gender were selected from physiotherapy centers in Rajkot. The selection of subject was done by purposive sampling. All the subjects were explained about the purpose and the test procedures involved in the study before their enrolment in the study. Written consent was taken from subjects who fulfilled both the criteria and were willing to participate in the study.
- A total number of 30 patients were selected in study by giving

consideration to inclusion and exclusion criteria.

- The subjects were randomly assigned into two groups namely group A (Control group) and group B (Experimental group).
- Baseline measurements were taken for all the patients for functional ability (on SPADI) & active shoulder ROM prior to beginning of the study as well as at the end of 12th session.

❑ **Measurement procedure:**

1. Method for measurement of active shoulder range of motion: [22]

Flexion:

Position of the patient: The subjects were in supine position, with the knees flexed to flatten the lumbar spine. The shoulder was positioned in 0 degrees of abduction, adduction and rotation. The forearm was positioned in 0 degrees of supination and pronation.

Goniometer Alignment:

1. Centre the fulcrum of the Goniometer close to the acromial process.
2. Align the proximal arm with the midaxillary line to thorax.
3. Align the distal arm with the lateral midline of the humerus, using the lateral epicondyle of the humerus for references.

Extension:

Position of the patient: The subjects were in prone position with the head facing away from the shoulder being tested. No pillow was used under the head. The shoulder was positioned in 0 degrees of abduction and rotation. The elbow was positioned in slight flexion. The forearm was positioned in 0 degree of supination and pronation.

Goniometer Alignment:

1. Centre the fulcrum of the Goniometer close to the acromial process.
2. Align the proximal arm with the midaxillary line of the thorax.
3. Align the distal arm with the lateral midline of the humerus, using the lateral epicondyle of the humerus for reference.

Abduction:

Position of the patient: The subjects were in supine position. The shoulder was positioned in 0 degrees of flexion and extension and full lateral rotation so that the palm of the hand faces anteriorly.

Goniometer Alignment:

1. Centre the fulcrum of the Goniometer close to the anterior aspect of the acromial process.
2. Align the proximal arm so that it was parallel to the midline of the anterior aspect of the sternum.
3. At the end of the ROM, align the distal arm with the medial midline of the humerus.

Adduction:

The testing position, stabilization and alignment were the same as for the shoulder abduction.

Medial (internal) Rotation:

Position of the patient: The subjects were in supine position, with the arm being tested in 90 degrees of shoulder abduction. The forearm was perpendicular to the supporting surface and was in 0 degrees of supination and pronation. The full length of the humerus rests on the supporting surface. The elbow was not supported. A pad was placed under the humerus.

Goniometer Alignment:

1. Centre the fulcrum of the Goniometer over the olecranon process.
2. Align the proximal arm so that it was either parallel to or perpendicular to the floor.
3. Align the distal arm with the ulna, using the olecranon process and ulnar styloid for reference.

Lateral (External) Rotation:

The testing position and Goniometer alignment were the same as for the shoulder medial rotation.

2. Shoulder pain and disability index (SPADI): [21]

The shoulder pain and disability index (SPADI) consists of 13 items in two subscales: pain (5 items) and disability (8 items). The pain dimension consists of five

questions and the functional activities are assessed with eight questions. Patients place a mark on a 10-cm visual analog scale for each question. Verbal anchors for the pain dimension are "no pain at all" and "worst pain imaginable," and those for the functional activities are "no difficulty" and "so difficult it required help." The scores from both dimensions were averaged to derive a total score.

CONVENTIONAL TREATMENT (FOR BOTH THE GROUPS) was given in form of shoulder active assisted exercises, passive stretching, and home exercises for 6 days in a week for 2 weeks. Total treatment duration was approximately 30-40 minutes for both the groups.

Patients in group B (n=15) received 12 (6times\week) sessions of scapular stabilizing exercises along with conventional physiotherapy. [24]

SCAPULAR STABILIZING EXERCISES included

- Scapular clock exercises (figure 4.2 to 4.5).
- Towel slide.
- Lawnmower exercise (figure 4.6(a) and 4.6(b)).
- Ball stabilization exercise (figure 4.7).
- Serratus anterior punch (figure 4.8).

All the 5 exercises were given for 10 repetitions each, 6 days a week for 2 weeks.

Figure 3 (a) Scapular clock exercise at 12 o'clock position(This exercise will facilitate scapular elevation)

Figure 3 (b) Scapular clock exercise at 3'clock position (This exercise will facilitate scapular protraction)

Figure 3 (c) Scapular clock exercise at 6'clock position: This exercise will facilitate scapular depression.

Figure 3 (d) Scapular clock exercise at 9'clock position: This exercise will facilitate scapular retraction

Figure 3 (e) Lawnmover exercise: starting position. This exercise simulates pulling the starter cord of a lawnmower. Both the knees are bent and weight is in the hand for resistance

Figure 3 (f) End position of lawnmower exercise. Here facilitation of motion by having the patient pulls using large amounts of trunk rotation and lower extremity extension to guide shoulder motion.

Figure 3 (g) Ball stabilization exercise. In this exercise the patient stood near a wall with the affected hand on the ball. Instruction to the patient to prevent the ball from moving as perturbations was applied in various directions.

Figure 3 (h) Serratus anterior punch. In this exercise subject is asked to perform a serratus anterior punch with holding the thera-band, which is used for the resistance

❖ Results and statistical analysis:

- All statistical analysis was done by SPSS statistics version 20.0 for windows software. Microsoft excel was used to calculate mean and to generate graphs and tables.
- Statistical test: Means were calculated as a measure of central tendency for active shoulder range of motion and functional ability on SPADI respectively and Standard Deviation (SD) was calculated as a measure of dispersion. Pre-treatment and post treatment data of active shoulder range of motion and SPADI was analyzed by Wilcoxon signed rank test and comparison between two groups of active shoulder range of motion and SPADI was analyzed by Mann-Whitney U test (Wilcoxon sum rank test).
- Level of significance (p value) was set to 0.05.

- Thirty subjects were randomly divided into two groups: -

Group A conventional treatment (n=15) and Group B conventional treatment with scapular stabilization exercises (n=15).

- Outcome measures, ROM and SPADI for functional ability were taken before and after completion of 12 sessions of treatment (6 times/ week).

Table 1: Age Group distribution of both groups

Age group(Years)	Group A	Group B	Total
40-45	1	1	2
46-50	2	4	6
51-55	4	3	7
56-60	3	3	6
61-65	5	4	9

Interpretation: The above table shows the number of subjects in Group A and Group B.

Table 2: Mean (in years) and SD of age

Group	N	Mean (Years)	SD
Group A	15	56.93	6.397
Group B	15	54.80	6.84

Interpretation: The above table shows the mean age of subjects for Group A i.e.

56.93+6.397(SD) years and for Group B i.e. 54.80+6.84(SD) years taken for the study.

Table 3: Gender Distribution of all patients

Gender	Group A	Group B
Female	7	6
Male	8	9

Interpretation: The above table shows the number of female and male in Group A and Group B.

- Wilcoxon signed rank test was used for pre-treatment and post treatment comparison of active shoulder ROM of Group A and Group B.

Table 4: Mean and SD of pre-treatment and post treatment active shoulder ROM of Group A

ROM		Mean	SD
Flexion	Pre treatment	127.33	15.22
	Post treatment	135.33	15.17
Extension	Pre treatment	37.00	8.41
	Post treatment	42.33	9.61
Abduction	Pre treatment	86.33	19.04
	Post treatment	94.00	17.13
Internal rotation	Pre treatment	54.67	14.70
	Post treatment	62.00	13.73
External rotation	Pre treatment	38.00	12.36
	Post treatment	44.67	11.87

Interpretation:

- ✓ The above table shows the mean value of pre ROM of flexion i.e. 127.33 ± 15.22 (SD) and post ROM of flexion i.e.135.33 ± 15.17 (SD) of group A is shown.
- ✓ The mean value of pre ROM of extension i.e. 37.00 ± 8.41 (SD) and post ROM of extension i.e. 42.33 ± 9.61 (SD) of group A is shown.
- ✓ The mean value of pre ROM of abduction i.e. 86.33 ±19.04 (SD) and post ROM abduction i.e. 94.00 ± 17.13 (SD) of group A is shown.
- ✓ The mean value of pre ROM of internal rotation i.e. 54.67 ± 14.70 (SD) and post ROM of internal rotation i.e. 62.00 ± 13.73 (SD) of group A is shown.
- ✓ The mean value of pre ROM of external rotation i.e. 38.00 ± 12.36 (SD) and post ROM of external rotation i.e. 44.67 ± 11.87 (SD) of group A is shown.

Table 5: Comparison of pre-treatment and post treatment active shoulder ROM of Group A

ROM	Z	p	Result
Flexion	-3.482	<0.05	Significant
Extension	-3.557	<0.05	Significant
Abduction	-3.530	<0.05	Significant
Internal rotation	-3.508	<0.05	Significant
External rotation	-3.542	<0.05	Significant

Interpretation:

- ✓ The above table shows the result of Wilcoxon signed rank test.
- ✓ Result shows significant difference for pre & post ROM of flexion (Z= -3.482, $p<0.05$).
- ✓ A significant difference for pre & post ROM of extension (Z= -3.557, $p<0.05$) is seen.
- ✓ A significant difference for pre & post ROM of abduction (Z= -3.530, $p<0.05$) is seen.
- ✓ A significant difference for pre & post ROM of side Internal rotation (Z= -3.508, $p<0.05$) is seen.
- ✓ A significant difference for pre & post ROM of External rotation (Z= -3.542, $p<0.05$) is seen.

Table 6: Mean and SD of pre-treatment and post treatment active shoulder ROM of Group B

ROM		Mean	SD
Flexion	Pre treatment	124.66	14.45
	Post treatment	138.67	16.09
Extension	Pre treatment	37.00	5.61
	Post treatment	44.33	4.58
Abduction	Pre treatment	84.67	14.82
	Post treatment	98.67	13.56
Internal rotation	Pre treatment	51.33	11.72
	Post treatment	61.33	10.26
External rotation	Pre treatment	35.67	9.04
	Post treatment	44.33	9.23

Interpretation:

- ✓ The above table shows the mean value of pre ROM of flexion i.e. 124.67 ± 14.45 (SD) and post ROM of flexion i.e.138.67 ± 16.09 (SD) of group B.
- ✓ The mean value of pre ROM of extension i.e. 37.00 ± 5.61 (SD) and post ROM of extension i.e. 44.33 ± 4.58 (SD) of group B is shown.
- ✓ The mean value of pre ROM of abduction i.e. 84.67 ± 14.82 (SD) and post ROM abduction i.e. 98.67 ± 13.56 (SD) of group B is shown.

- ✓ The mean value of pre ROM of internal rotation i.e. 51.33 ± 11.72 (SD) and post ROM of internal rotation i.e. 61.33 ± 10.26 (SD) of group B is shown.
- ✓ The mean value of pre ROM of external rotation i.e. 35.67 ± 9.04 (SD) and post ROM of external rotation i.e. 44.33 ± 9.23 (SD) of group B is shown.

Table 7: Comparison of pre-treatment and post treatment active shoulder ROM of Group B

ROM	Z	p	Result
Flexion	-3.468	<0.05	Significant
Extension	-3.508	<0.05	Significant
Abduction	-3.455	<0.05	Significant
Internal rotation	-3.475	<0.05	Significant
External rotation	-3.475	<0.05	Significant

Interpretation:

- ✓ The above table shows the result of Wilcoxon signed rank test.
- ✓ Result shows significant difference for pre & post ROM of flexion (Z= -3.475, p<0.05).
- ✓ A significant difference for pre & post ROM of extension (Z= -3.508, p<0.05) is seen.
- ✓ A significant difference for pre & post ROM of abduction (Z= -3.455, p<0.05) is seen.
- ✓ A significant difference for pre & post ROM of Internal rotation (Z= -3.475, p<0.05) is seen.
- ✓ A significant difference for pre & post ROM of External rotation (Z= -3.475, p<0.05) is seen.

- Mann-Whitney U test was used for between group comparison of active shoulder ROM of flexion, extension, abduction¸ internal & external rotation of Group A and B.

Table 8: Mean and SD of active shoulder ROM of Group A and Group B

ROM		Mean	SD
Flexion	Group A	8.00	3.68
	Group B	14.00	6.87
Extension	Group A	5.33	2.29
	Group B	7.33	3.20
Abduction	Group A	7.67	4.58
	Group B	14.00	7.12
Internal rotation	Group A	7.33	2.58
	Group B	10.00	7.56
External rotation	Group A	6.67	2.44
	Group B	8.67	4.81

Interpretation:

- ✓ The above table shows the mean value of ROM of flexion i.e. 8.00 ± 3.68 (SD) of group A and ROM of flexion i.e. 14.00 ± 6.87 (SD) of group B.
- ✓ The mean value of ROM of extension i.e. 5.33 ± 2.29 (SD) of group A and ROM of extension i.e. 7.33 ±3.20 (SD) of group B is shown.
- ✓ The mean value of ROM of abduction i.e. 7.67 ± 4.58 (SD) of group A and ROM of abduction i.e. 14.00 ±7.12 (SD) of group B is shown.
- ✓ The mean value of ROM of Internal rotation i.e. 7.33 ± 2.58 (SD) of group A and ROM of Internal rotation i.e. 10.00 ± 7.56 (SD) of group B is shown.
- ✓ The mean value of ROM of External rotation i.e. 6.67 ± 2.44 (SD) of group A and ROM of External rotation i.e. 8.67 ± 4.81 (SD) of group B is shown.

Table 9: Between group comparison of active shoulder ROM of flexion, extension, abduction, Internal & External rotation of Group A and Group B

ROM	Z	P	Result
Flexion	-2.792	<0.05	Significant
Extension	-1.834	<0.05	Significant
Abduction	-3.089	<0.05	Significant
Internal rotation	-0.487	<0.05	Significant
External rotation	-1.072	<0.05	Significant

Interpretation:

- ✓ The above table shows the result of Mann-Whitney U test.
- ✓ Result shows significant difference for pre & post ROM of flexion (Z= -2.792, p<0.05).
- ✓ A significant difference for pre & post ROM of extension (Z= -1.834, p<0.05) is seen.
- ✓ A significant difference for pre & post ROM of abduction (Z= -3.089, p<0.05) is seen.
- ✓ A significant difference for pre & post ROM of Internal rotation (Z= -0.487, p<0.05) is seen.

- ✓ A significant difference for pre & post ROM of External rotation (Z= -1.072, p<0.05) is seen.

- Wilcoxon sign rank test was used for pre-treatment and post treatment comparison of SPADI of Group A and Group B.

Table 10: Mean and SD of pre-treatment and post treatment SPADI of Group A

		Mean	SD
SPADI	Pre treatment	48.67	21.15
	Post treatment	41.13	19.39

Interpretation: The above table shows the mean of pre SPADI i.e. 48.67± 21.15 (SD) and post SPADI i.e. 41.13± 19.39 (SD) of group A.

Table 11: Comparison of pre-treatment and post treatment SPADI of Group A

	Z	P	Result
SPADI	-3.304	<0.05	Significant

Interpretation: Result shows significant difference for pre & post SPADI (Z= -3.304, p<0.05).

Table 12: Mean and SD of pre-treatment and post treatment SPADI of Group B

		Mean	SD
SPADI	Pre treatment	49.08	17.64
	Post treatment	35.47	12.59

Interpretation: The above table shows the mean of pre SPADI i.e. 49.08± 17.64 (SD) and post SPADI i.e. 35.47± 12.59 (SD) of group B.

Table 13: Comparison of pre-treatment and post treatment SPADI of Group B

	Z	p	Result
SPADI	-3.411	<0.05	Significant

Interpretation: Result shows significant difference for pre & post SPADI (Z= -3.411, p<0.05).

- Mann Whitney U test was used for between group comparison of SPADI of Group A and B.

Table 14: Mean and SD of SPADI of Group A and Group B

		Mean	SD
SPADI	Group A	7.53	3.31
	Group B	14.33	7.91

Interpretation: The above table shows the mean of SPADI i.e. 7.53± 3.31 (SD) of Group A and i.e. 14.33± 7.91 (SD) of Group B

Table 15: Between group comparison of SPADI of Group A and Group B.

	Z	P	Result
SPADI	-3.037	<0.05	Significant

Interpretation:

- ✓ Result shows significant difference for SPADI (Z= -3.037, p<0.05).
- ✓ These above findings suggest that there is statistically significant difference for pre-treatment and post treatment comparison for all the range of motion in Group-A and Group-B.
- ✓ There is statistically significant difference in pre-treatment and post treatment comparison of SPADI in both the groups.
- ✓ There is significant difference for between group comparisons of range of motion and SPADI as group B shows better improvement than Group A.
- ✓ Hence, experimental hypothesis was accepted and null hypothesis was rejected.

DISCUSSION

The intent of the study was to find out the effect of scapular stabilization exercises on shoulder ROM and functional outcome (SPADI) in diabetic patients with stage 2 adhesive capsulitis of the shoulder joint with a conventional physiotherapy in form of shoulder active assisted exercises, passive stretching, and home exercises for 6 days in a week for 2 weeks was same for both the groups.

In the present study, when the values of pre-treatment and post treatment SPADI and active shoulder ROM were analysed, it was statistically significant in both the groups but when comparison was done between them, there was significant difference as scapular stabilization exercises

were more effective in reducing pain and improving shoulder ROM.

In previous studies scapular alterations have been assessed in patients with frozen shoulder but treatment program was mainly focused on pain relief and improvement in ROM. [25] Fayad F *et al.* (2008) in his study of three dimensional scapular kinematics told that scapulohumeral rhythm of the affected shoulder is inversely related to severity of shoulder range of motion, increased scapular rotation is seen in frozen shoulder as a compensatory pattern. The initial 30 degrees of arm abduction were essentially the result of glenohumeral motion. From 30 degrees to full arm abduction, movement occurs at the scapulothoracic and glenohumeral joints.

While considering treatment for shoulder joint, emphasis should be on tight anterior chest wall muscles & weak scapular stabilizers. The main stabilizers are levator scapulae, rhomboids major & minor, serratus anterior & trapezzi. The glenohumeral protectors include the muscles of the rotator cuff: the supraspinatus, infraspinatus, teres minor & subscapularis. Synergistic co contraction of these muscles is necessary to anchor the scapula & guide the movement of the shoulder girdle. Fatigue or weakness of the scapular stabilizers lead to compromised scapula humeral Rhythm and resultant Shoulder dysfunction that further leads to micro trauma in shoulder muscles, capsule & ligamentous tissue.

During overhead activities, scapula must rotate upwards, tilted posteriorly & rotated externally. Weakness of the scapular stabilizers leads to imbalance of the force couples between the trapezzi, serratus anterior & rhomboids that may result in to downward rotation, anterior tilting & internal rotation of the scapula during the abduction of the arm. This fatigue induced strength deficit may result into the adverse effect on scapular position & allowing more lateral gliding of the scapula during functional activities.

The present study gives similar result as a study conducted by Yatheendra Kumar G et al., (2015) suggesting that Scapular stabilization exercises are effective in decreasing pain and increasing ROM and functional ability by restoring scapula humeral rhythm in frozen shoulder. Michel L Voight, et al., (2000) also suggested that while caring Glenohumeral (GH) joint, scapular stability is also important in adhesive capsulitis for the faster recovery.

❖ **Limitations:**

- Small sample size.
- Blinding was not done in the study.
- Home program taught to the patients was not supervised.

❖ Further recommendations:

- Study could be done with large sample size.
- Treatment can be given for longer duration with follow up.
- Study can be done with different stages of adhesive capsulitis.

❖ Clinical implication

- Results suggest that Scapular stabilization exercises along with conventional treatment are more helpful for improving shoulder ROM and functional ability in diabetic patients with stage 2 adhesive capsulitis.
- While treating any patient with shoulder pain and dysfunction, Emphasis should be on scapular stability exercises. Though the rotator cuff muscles are chief stabilizers for glenohumeral joint, but their origin is from scapula. So until they have a very stable base, they cannot work effectively.
- So each treatment protocol for any patient with shoulder dysfunction must contain exercises to strengthen the scapula.

CONCLUSION

- Scapular stabilization exercises along with conventional treatment is more helpful for improving shoulder ROM and functional ability in diabetic patients with stage 2 adhesive capsulitis.
- Hence it can be concluded that Scapular stabilization exercises should be included in the rehabilitation protocol of adhesive capsulitis in diabetic patients with stage 2 adhesive capsulitis.

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