

How to Cite:

Razaq, H. B., Basharat, A., Sheikh, S. A., Zehra, R. E., Mufti, H. A., Faraz, K., & Waqar, Z. (2023). Effects of combining both mobilization with movement and spencer's technique in diabetic adhesive capsulitis patients. *International Journal of Health Sciences*, 7(S1), 2328–2343. <https://doi.org/10.53730/ijhs.v7nS1.14494>

Effects of combining both mobilization with movement and spencer's technique in diabetic adhesive capsulitis patients

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Abstract---Adhesive capsulitis causes pain, stiffness and motion restriction in the shoulder joint and it is due to the adhesions in the glenohumeral joint capsule. First line treatment is conservative treatment by medications and physical therapy. It includes exercises, manual mobilization techniques and electrotherapeutic modalities for

relieving pain and to gain full range of motion. The objective of the study was to compare the combined effects of Mulligan's MWM and Spencer's MET with MWM, Spencer's MET and conventional therapy individually. A RCT was conducted for 6 months in THQ hospital Gujar Khan. 44 patients with mean age (55.57±7.422) meeting inclusion criteria were included. Participants were randomly allocated into 4 groups that are combined, MWM, Spencer and conventional group. Conventional treatment was given in all four groups and combined group received both the MWM and Spencer's technique. 3 sessions/week was given for 4 weeks. Outcome measures used were VAS, SPADI and goniometry. ANOVA was done for inter group analysis, post hoc test was done for between group analysis. There was a significant difference (p-value 0.000<0.05) in outcome measures SPADI and ROMs Flexion and Abduction of combined group as compared to the rest of three. However, for VAS combined group showed significant difference compared to Spencer and conventional (p-value 0.000<0.05) but difference between MWM and combined group was not significant (p-value=0.460>0.05), external and internal rotation showed no significant difference of combined compared to the rest of three (p-value >0.05).Mulligan 's MWM and Spencer's MET are both effective individually but when Mulligan's MWM and Spencer's MET is combined it gives significantly better results regarding SPADI, flexion and abduction ROMs and hence it is beneficial to combine these two techniques for the patients with diabetic adhesive capsulitis.

Keywords--adhesive capsulitis, mobilization with movement, mulligans's technique, spencer's technique, MET, diabetic adhesive capsulitis.

Introduction

One of the most common disorders that causes pain and decrease the active and passive movements of shoulder is the adhesive capsulitis. (1) Adhesive capsulitis does not represent a single pathology it involves other structures like muscles, ligaments and bursa along with the joint capsule. Starting with inflammation of joint capsule resulting in thickness and fibrosis, consequently adherence to the shoulder as well as the neck of humerus.(2)

Prevalence

Adhesive capsulitis affects between 2 and 5 percent of the world's population, hence it is regarded as a common ailment. (3) It is rare in those under the age of 40, has a high incidence in those over 40 and under 60, and is rare in those over 70 years old, with the exception of secondary causes. (4) Economically, adhesive capsulitis has a negative impact on individuals in working age by 8.2 percent for men and 10.1 percent for women. (5) Women are more likely to experience it than males.(5) 8% of individuals who get this illness on the opposite side during the next five years are those who have seen it develop in both shoulders at once (14%

of patients). A swollen, tight capsule with adhesions damaging the natural axillary fold is a sign of adhesive capsulitis in a joint.

Pathophysiology

The capsular adhesions start to develop first at the anatomic neck of the humerus (Fig 2). Reduction in volume of synovial fluid causes decreased overall joint volume. The normal volumetric capacity of shoulder joint is 28 to 35 mL, however, the diseased joint receives only 5 to 10 mL of injected fluid. (6) Biopsy of the capsule revealed synovial lining absence, chronic inflammation and medium to wide-ranging sub-synovial fibrosis along with perivascular lymphocytic reactions. (2)

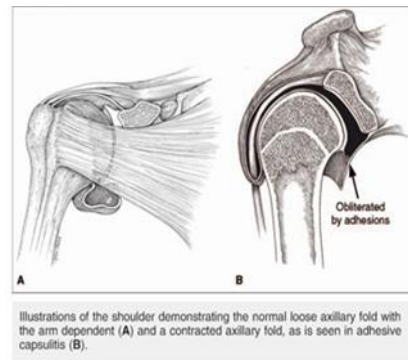


Figure 1

Risk Factors

Factors that can lead to adhesive capsulitis may include being female, 40 years or above age, an injury or trauma, HLA-B27 presence and long-term immobilization of the shoulder joint. According to an estimate 70% of people suffering from adhesive capsulitis are females. (7) Most of the patients with this adhesive capsulitis are females within age limits of 38 to 62 years. (8) Patients non-dominant arm normally faces the most problems. Persons in sedentary vocations face commonly the Adhesive capsulitis than people who partake in manual labor. (9) Associations with systemic conditions, including cardiovascular disease, breast cancer treatment and thyroid disorder, are very common (10). The risk of developing adhesive capsulitis is greater if patients already suffer from different diseases and diabetes. (11) However Diabetes is a far greater concern as it can be linked to a greater prognosis, requiring a significant need for surgical attention. (12)

Clinical Features

Patients complain of pain for more than a few weeks in the early phase especially at night when sleeping on affected side. Sudden movement causes pain, adhesions and contracted joint capsule cause loss of motion. Motion loss may appear side by side with pain or in some cases motion loss can take place before the pain and turn out to be more prominent than the pain. Daily life activities cannot be performed by the patients which include the overhead movement such

as dressing, combing hair and approaching the back pocket. Motion loss grows to be acute and obvious in third and fourth stages in which all direction movement is affected. There is reduced pain and the pain is caused only when patient moves the arm beyond the available range limit. (13) There is no specific tenderness detected during a physical examination. However, the long head of the bicep tendon can occasionally cause tenderness, due to its confluence with the synovium of the glenohumeral joint. Strength at the rotator cuff is usually normal. This mechanical restraint is most noticeable when the arm is at the side and on passive external rotation with adhesive capsulitis. the contracted capsule will cause a distinct sense of tethering. Before adhesion formation (i.e., Stage 1 disease) is deemed difficult from other pathology due to the fact that the signs and symptoms are extremely vague. (14)

Interventions

Pharmacologic therapy in conjunction with physical therapy is the first line treatment for adhesive capsulitis. Sleep, therapy, and NSAID use may be made more tolerable with nonsteroidal anti-inflammatory drugs, but their effects on recovery are minimal. (15) Many authors have recommended that adhesive capsulitis is required to be cured with only minimal home exercise and heat in the start. Interventions must be targeted at hastening the recovery of motion and diminishing pain. Given the prolonged disability these patients endure. In addition to physical therapy and other conservative treatments, cryotherapy, ultrasound, mobilization, mobility exercises, stretching, and (NSAIDs) have also been used. it is also beneficial to use pendular exercises and Surgical interventions can also be done if severe. For a pain free manipulation, a nerve block Scapular procedure can be carried out. A combination of physical therapy and home exercises is the cornerstone of treatment, regardless of the stage.

Spencer muscle energy technique has gained popularity in recent years as an effective intervention for adhesive capsulitis. In this technique, the glenohumeral and scapula-thoracic joints are mobilized through osteopathic manipulative techniques. In addition to improving the functions of restricted joints, it provides positive effects on other emotional, social and cognitive areas. (16) Clinical outcomes suggest that the spencer muscle energy technique improves shoulder range of motion more effectively than conventional physical therapy. A unique aspect of Spencer muscle energy technique is client involvement in the process.

The technique involves two steps repeated in seven stages. First step is rhythmic oscillation at the end of available range and the second step is isometric contractions of antagonist muscle at different ranges to achieve a new barrier. This technique works on the principle of reciprocal inhibition.

- The patient should be in side lying position while the affected shoulder facing upwards.
- The therapist should stand on lateral side of the patient and stabilize the upper side of the shoulder girdle, which provides support so that the technique can be applied specifically at the joint level. It is necessary that

during the application of this technique the wrist and forearm are well supported.

- Step 1 – To improve the extension
- Step 2 – To improve the shoulder flexion
- Step 3 – Circumduction with compression
- Step 4 – Circumduction with distraction
- Step 5 –To improve the Abduction, to improve the Adduction with External rotation
- Step 6 – Internal rotation.
- Step 7 – Distraction in abduction.(17)

Mulligan's technique Mobilization with Movement

Mulligan technique as described by the Brian Mulligan following the PILL principle (pain free, instant result, long lasting) should be applied. Steps involved in technique are given below:

- Patient should be positioned in supine/sitting position as required for the desired movement to be performed.
- The therapist should apply and maintain passive accessory glide as the patient performs active ROM within pain free range.
- Therapist then apply the overpressure.(17)

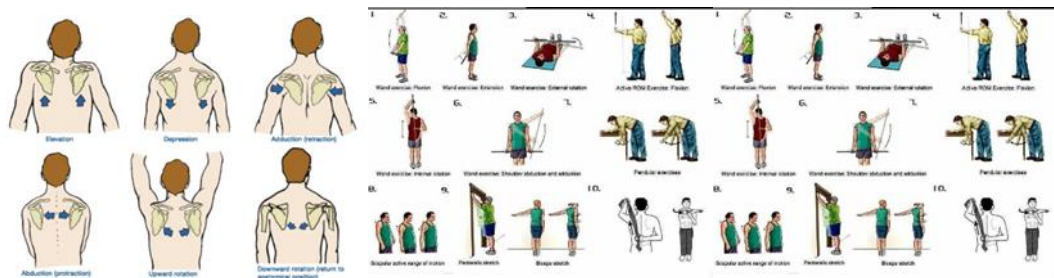
To Enhance Shoulder Flexion: The patient should be in supine lying or sitting position and the therapist should be standing on lateral side of the side to be treated in a stride position, the therapist then stabilizes the scapula and clavicle using one hand and then place the other hand at distal end of humerus. A belt secured around the therapist' waist should be placed close to the joint line to distract the humerus laterally. Patient then performs the active flexion within pain free range. Therapist then apply the passive overpressure at the end in order to gain a new range. The therapist must move accordingly in order to maintain the glide along the treatment plane.

Internal and External Rotation: The patient position should be supine lying while the therapist is standing on lateral to the affected joint. The afflicted side's shoulder and elbow are in a 90° flexion posture. To divert the humerus laterally, a belt should be put on the shoulder by the joint line and around the patient's waist. The humerus' distal end may then be supported with one hand. The patient is then instructed to replicate the problematic internal and external rotation movement, and at the end of this new range, passive overpressure is applied with the opposite hand.

Abduction: In this technique the patient is in sitting position, the belt is positioned at the humerus head and postero-lateral and inferior glide is retained. The therapist grasps the belt using one hand in place maintaining the glide. Using the other hand at the scapula, counter pressure is applied. The patient is asked to perform shoulder abduction to the maximum of the range available. The glide should be maintained throughout the movement and released after the arm come back to initial position. Overpressure at the end range is given passively.(18-21)

Conventional Therapy

This treatment protocol includes both the exercises and ultrasound therapy. The program consists of active/active-assisted exercises, Codman's pendulum exercises, isometric exercises, pulley, finger ladder and wand exercises, capsular stretching alongside a pectoral stretch, warm water fermentation and scapular stabilization exercises. (22)



Materials and Methodology

Study Design

Randomized Clinical Trial with four groups i-e Combined, MWM, Spencer and Conventional group.

Study Setting

The study was conducted in THQ Gujar Khan.

Sample Size

Sample size was calculated using epi-tool for primary outcome measure that is VAS. (18) Sample size was increased up to 44 as participants had to be divided equally into four groups.

Sampling Technique

Non probability Purposive Sampling and sealed envelope method.

Inclusion Criteria

- Both male and female
- Age 30-70 years
- Diabetic patients
- Shoulder pain for at least three months
- Restricted active and passive shoulder movements, with a reduction in external rotation of at least 50%.

Exclusion Criteria

- Shoulder surgical position.

- Rupture/trauma of the rotator cuff
- Limited shoulder mobility due to neurological deficits.
- Pain or restricted motion from disorders in elbow/wrist
- Calcification of tendons.
- Osteoarthritis and Rheumatoid Arthritis
- Osteoporosis
- Pregnancy
- Skin deformation/cuts

Data Collection Procedure

A complete physical examination, history and thorough assessment done. The patient completed SPADI and VAS. Shoulder Ranges (flexion, abduction, internal & External rotation) were measured using goniometer. Specific treatment was applied to the selected subjects according to their allocation. VAS and Goniometry was done after first session. In next visits, Post treatment readings were taken using VAS, SPADI and goniometer. Three sessions of treatment per week with a home plan were given. Post treatment readings were taken at the end of 1st week, 2nd week, 3rd week, 4th week and then at 6th week. Total treatment duration was of 4 weeks.

Intervention

Participants were divided into four groups these are Combined, Mulligan, Spencer and Conventional. Intervention for each group is given below. All subjects were given a home exercise program at least twice daily that included Codman's pendulum exercises.

Table 2
Intervention groups

<p>COMBINED</p> <p>Mulligan's technique</p> <ul style="list-style-type: none"> • Patient positioned in supine/sitting position • The therapist applied and maintained passive accessory glide as the patient performed active ROM within pain free range. • Therapist then applied the overpressure. <p>Dosage 10 repetitions with 1minute rest between sets. 3 times a week for 4 week</p> <p>Spencer's Technique</p> <ul style="list-style-type: none"> • Patient was positioned in side lying with the shoulder to be treated uppermost • The therapist stabilised the patient's upper shoulder girdle while standing in front of them. • The therapist moved back and forth in a passive, rhythmic motion to the maximum extent possible. • The technique was applied in seven step for improving all the movements of shoulder joint in the given sequence (Extension, Flexion, Circumduction, Abduction, External rotation and Adduction, Internal rotation, Distraction
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in abduction) Dosage: Every step 10 repetitions with 1-minute rest between each step, 3 times a week for 4 week
CONVENTIONAL
Conventional Treatment: 1- Ultrasound treatment <ul style="list-style-type: none"> • 1MHz frequency • 1.5 W / CM 2 intensity • 5 –10 minutes' duration. 2- Exercise therapy program <ul style="list-style-type: none"> • AROMs and A-AROMs exercises • Isometric exercises • Capsular stretching • Pectoral stretch • Scapular stabilization exercises Dosage: 3 sets of 10 repetitions with 2 minutes' rest between 2 sets per day for 4 weeks.

Results

Total 44 patients were included in this study and were equally divided into four groups. Mean age of patients was 55.57 ± 7.422 years. Group wise mean age of patients is given in Table 3. Out of 44 patients 20 (45.5%) were males and 24 (54.5%) were females. Shown in Table 4.

Table 3
Age Distribution among Participants

<i>Group</i>	<i>No. of participants</i>	<i>Mean ± SD</i>
<i>Combined</i>	11	49.82±8.830
<i>MWM</i>	11	56.09±4.482
<i>Spenser</i>	11	58.36±7.339
<i>Conventional</i>	11	58.00±5.762
<i>Total</i>	44	55.57±7.422

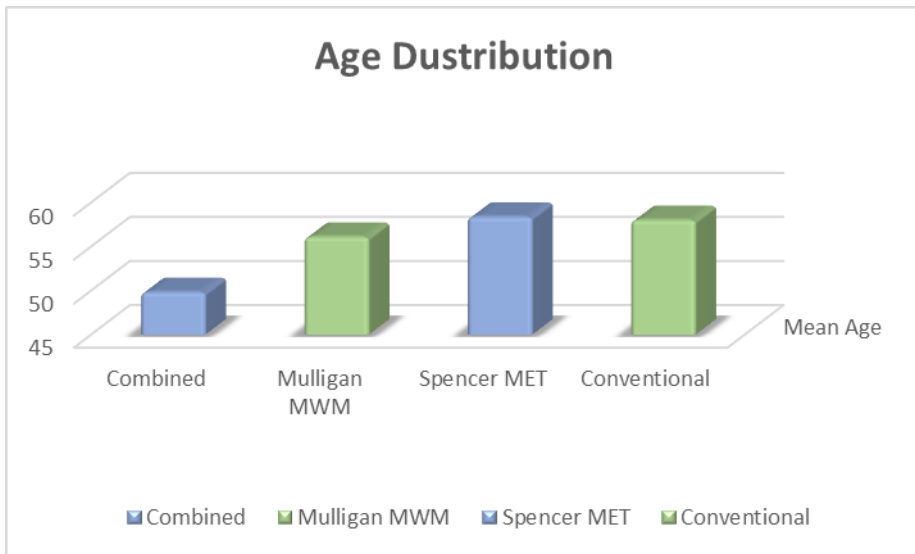


Figure 8

Table 4
Gender Distribution Among Participants

Gender	Frequency	Percentage%
Male	20	45.5
Female	24	54.5
Total	44	100

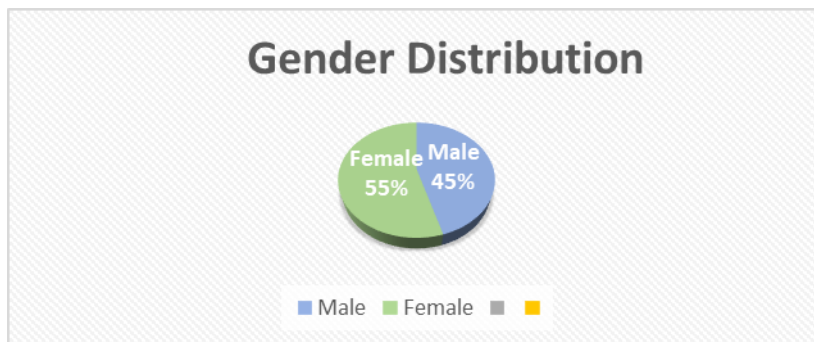


Figure 9. Gender distribution

Mixed ANOVA was applied for the groups comparison on 7 time points including the baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week. The equality of variance was checked with Mauchly's sphericity test and assumption of equal variance was violated as ($P < 0.05$). Since assumption of equal variance was violated and $\epsilon < 0.7$ so Greenhouse-Geisser corrected results are reported for all variables. The descriptive data of variables presented in Mean±Std deviation on each time point. F value, P value and partial ETA squared (η^2) were recorded (Table 4).

Table 5
Mixed Model ANOVA

Interaction effect: VAS, ROMs and SPADI with factor treatment group and time.

		Combined	Mulligan	Spencer	Conventional	<i>p</i> -value	<i>F</i> -value	η^2
		Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD			
VAS	0 week	7.27 \pm 1.954	6.91 \pm 1.92	7.00 \pm 1.54	7.00 \pm 1.00	0.000	7.22(1.7, 68.7)	.351
	Session 1 st	5.18 \pm 2.18	5.55 \pm 0.934	6.64 \pm 1.56	7.09 \pm 0.944			
	week 1 st	4.27 \pm 1.55	5.36 \pm 0.809	6.64 \pm 1.56	7.09 \pm 0.944			
	week 2 nd	3.27 \pm 1.55	4.45 \pm 0.688	6.18 \pm 1.60	6.64 \pm 0.924			
	week 3 rd	2.82 \pm 1.32	3.91 \pm 1.13	6.18 \pm 1.60	6.64 \pm 0.924			
	week 4 th	1.82 \pm 1.66	2.73 \pm 1.42	5.00 \pm 1.89	5.73 \pm 1.00			
	week 6 th	1.64 \pm 1.62	2.55 \pm 1.57	5.00 \pm 1.89	5.73 \pm 1.009			
Flexion	0 week	94.0 \pm 12.55	88.9 \pm 11.7	94.7 \pm 11.8	104.5 \pm 20.4	0.000	9.25(2, 80.7)	.410
	Session 1 st	106.6 \pm 14.6	104.8 \pm 13.9	103.4 \pm 12.8	117.0 \pm 23.1			
	week 1 st	120.5 \pm 16.6	115.1 \pm 16.3	113.9 \pm 10.1	119.9 \pm 23.1			
	week 2 nd	128.6 \pm 13.8	123.8 \pm 15.3	121.2 \pm 11.9	122.7 \pm 22.6			
	week 3 rd	137.0 \pm 11.3	133.2 \pm 16.8	126.7 \pm 14.1	125.2 \pm 22.9			
	week 4 th	148.1 \pm 16.9	138.8 \pm 18.5	129.6 \pm 15.0	128.0 \pm 22.7			
	week 6 th	148.1 \pm 16.9	138.8 \pm 18.5	129.6 \pm 15.1	128.0 \pm 22.7			
Abduction	0 week	96.8 \pm 11.2	94.2 \pm 14.3	97.0 \pm 28.6	101.9 \pm 31.6	0.000	12.9(1.3, 53.6)	.492
	Session 1 st	108.1 \pm 12.0	102.0 \pm 14.8	103.0 \pm 28.2	103.7 \pm 32.1			
	week 1 st	118.6 \pm 9.1	109.8 \pm 13.5	108.3 \pm 27.9	105.3 \pm 32.3			
	week 2 nd	126.8 \pm 8.6	116.7 \pm 12.4	114.1 \pm 27.2	107.0 \pm 32.2			
	week 3 rd	135.0 \pm 9.5	122.6 \pm 13.2	119.0 \pm 26.7	109.3 \pm 32.7			
	week 4 th	144.1 \pm 13.1	127.7 \pm 12.5	125.0 \pm 25.9	111.0 \pm 32.9			
	week 6 th	145.0 \pm 12.3	127.7 \pm 12.5	125.0 \pm 25.9	111.1 \pm 32.6			
External Rotation	0 week	46.0 \pm 7.68	49.36 \pm 9.29	51.0 \pm 5.6	52.5 \pm 6.7	0.000	3.3(1.6, 66.9)	.199
	Session 1 st	46.18 \pm 5.26	47.0 \pm 5.0	55.4 \pm 4.74	58.64 \pm 6.5			
	week 1 st	52.0 \pm 6.9	49.2 \pm 4.83	58.18 \pm 3.9	60.2 \pm 5.9			
	week 2 nd	57.3 \pm 8.5	53.5 \pm 5.4	60.1 \pm 2.8	61.8 \pm 5.3			
	week 3 rd	62.73 \pm 10.5	55.5 \pm 4.5	62.0 \pm 3.1	63.9 \pm 5.2			
	week 4 th	65.4 \pm 9.9	59.1 \pm 6.2	64.4 \pm 3.9	65.0 \pm 5.0			
	week 6 th	65.4 \pm 9.5	59.1 \pm 6.2	64.4 \pm 3.9	65.0 \pm 5.0			
Internal Rotation	0 week	39.2 \pm 4.2	41.5 \pm 6.3	51.6 \pm 6.5	56.64 \pm 6.8	0.000	10.9(1.6, 62.3)	.451
	Session 1 st	42.7 \pm 4.3	44.8 \pm 5.3	54.9 \pm 6.9	59.1 \pm 6.5			
	week 1 st	49.0 \pm 5.4	48.8 \pm 5.7	58.4 \pm 7.3	61.1 \pm 6.9			
	week 2 nd	55.0 \pm 4.9	53.3 \pm 5.5	63.1 \pm 6.1	65.6 \pm 6.0			
	week 3 rd	63.3 \pm 7.2	60.9 \pm 7.0	66.0 \pm 5.3	68.1 \pm 6.8			
	week 4 th	70.2 \pm 5.7	63.5 \pm 7.9	69.3 \pm 6.1	70.1 \pm 6.4			
	week 6 th	70.73 \pm 6.3	64.1 \pm 8.5	69.3 \pm 6.1	70.1 \pm 6.4			
SPADI	0 week	74.91 \pm 9.762	72.00 \pm 2.683	67.64 \pm 6.329	70.55 \pm 6.729	0.000	17.6(1.9, 75.5)	.569
	week 1 st	51.82 \pm 8.727	59.00 \pm 5.079	60.00 \pm 8.854	62.18 \pm 5.845			
	week 2 nd	38.00 \pm 10.807	48.18 \pm 6.369	53.18 \pm 8.704	56.73 \pm 5.623			
	week 3 rd	25.73 \pm 8.150	38.91 \pm 7.595	48.36 \pm 11.351	51.27 \pm 5.850			
	week 4 th	18.18 \pm 7.054	30.64 \pm 5.005	43.73 \pm 13.312	47.36 \pm 6.637			
	week 6 th	18.27 \pm 7.143	30.64 \pm 5.143	44.18 \pm 11.864	46.45 \pm 5.888			

For measuring pain intensity VAS was used. The VAS scores on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week in Combined group was 7.27 \pm 1.954, 5.18 \pm 2.18, 4.27 \pm 1.55, 3.27 \pm 1.55, 2.82 \pm 1.32, 1.82 \pm 1.66, 1.64 \pm 1.62 respectively. Mulligan MWM group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week VAS scores were 6.91 \pm 1.92, 5.55 \pm 0.934, 5.36 \pm 0.809, 4.45 \pm 0.688, 3.91 \pm 1.13, 2.73 \pm 1.42, 2.55 \pm 1.57 respectively. Spencer MET group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week VAS scores 7.00 \pm 1.54, 6.64 \pm 1.56, 6.64 \pm 1.56, 6.18 \pm 1.60, 6.18 \pm 1.60,

5.00±1.89, 5.00±1.89 were respectively. Conventional group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week VAS scores were 7.00±1.00, 7.09±0.944, 7.09±0.944, 6.64±0.924, 6.64±0.924, 5.73±1.00, 5.73±1.009 respectively. The VAS F statistics was $F(1.7, 68.7) = 7.2, p = .000$.

Flexion range of motion was measured using goniometer. The Flexion range on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week in Combined group was 106.6±14.6, 120.5±16.6, 128.6±13.8, 137.0±11.3, 148.1±16.9, 148.1±16.9 respectively. Mulligan MWM group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week Flexion range was 88.9±11.7, 104.8±13.9, 115.1±16.3, 123.8±15.3, 133.2±16.8, 138.8±18.5, 138.8±18.5 respectively. Spencer MET group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week Flexion range was 94.7±11.8, 103.4±12.8, 113.9±10.1, 121.2±11.9, 126.7±14.1, 129.6±15.0, 129.6±15.1 respectively. Conventional group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week Flexion range was 104.5±20.4, 117.0±23.1, 119.9±23.1, 122.7±22.6, 125.2±22.9, 128.0±22.7, 128.0±22.7 respectively. The Flexion range. F statistics was $F(2, 80.7) = 9.24, p = .000$.

Abduction range of motion was measured using goniometer. The Abduction range on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week in Combined group was 96.8±11.2, 108.1±12.0, 118.6±9.1, 126.8±8.6, 135.0±9.5, 144.1±13.1, 145.0±12.3 respectively. Mulligan MWM group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week Abduction range was 94.2±14.3, 102.0±14.8, 109.8±13.5, 116.7±12.4, 122.6±13.2, 127.7±12.5, 127.7±12.5 respectively. Spencer MET group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week Abduction range was 103.0±28.2, 108.3±27.9, 114.1±27.2, 119.0±26.7, 125.0±25.9, 125.0±25.9 respectively. Conventional group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week Abduction range was 101.9±31.6, 103.7±32.1, 105.3±32.3, 107.0±32.2, 109.3±32.7, 111.0±32.9, 111.1±32.6 respectively. The Abduction range F statistics was $F(1.3, 53.6) = 12.9 p = .000$.

External Rotation range of motion was measured using goniometer. The External Rotation range on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week in Combined group was 46.0±7.68, 46.18±5.26, 52.0±6.9, 57.3±8.5, 62.73±10.5, 65.4±9.9, 65.4±9.5 respectively. Mulligan MWM group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week External Rotation range was 49.36±9.29, 47.0±5.0, 49.2±4.83, 53.5±5.4, 55.5±4.5, 59.1±6.2, 59.1±6.2 respectively. Spencer MET group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week External Rotation range was respectively. Conventional group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week External Rotation range was 55.4±4.74, 58.18±3.9, 60.1±2.8, 62.0±3.1, 64.4±3.9, 64.4±3.9 respectively. The External Rotation range F statistics was $F(1.6, 66.9) = 3.31, p = .000$

Internal Rotation range of motion was measured using goniometer. The Internal Rotation range on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week in Combined group was 42.7±4.3, 49.0±5.4, 55.0±4.9, 63.3±7.2, 70.2±5.7, 70.73±6.3 respectively. Mulligan MWM group: on baseline, 1st session,

1st week, 2nd week, 3rd week, 4th week and 6th week Internal Rotation range was 41.5±6.3, 44.8±5.3, 48.8±5.7, 53.3±5.5, 60.9±7.0, 63.5±7.9, 64.1±8.5 respectively. Spencer MET group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week Internal Rotation range was 51.6±6.5, 54.9±6.9, 58.4±7.3, 63.1±6.1, 66.0±5.3, 69.3±6.1, 69.3±6.1 respectively. Conventional group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week Internal Rotation range was 56.64±6.8, 59.1±6.5, 61.1±6.9, 65.6±6.0, 68.1±6.8, 70.1±6.4, 70.1±6.4 respectively. The Internal Rotation range. F statistics was $F(1.6, 62.3) = 10.9$, $p = .000$.

The functional mobility was measured through Shoulder pain and disability index (SPADI). The SPADI score on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week in Combined group was 74.91±9.762, 51.82±8.727, 38.00±10.807, 25.73±8.150, 18.18±7.054, 18.27±7.143 respectively. Mulligan MWM group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week SPADI scores were 72.00±2.683, 59.00±5.079, 48.18±6.369, 38.91±7.595, 30.64±5.005, 30.64±5.143 respectively. Spencer MET group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week SPADI score was 67.64±6.329, 60.00±8.854, 53.18±8.704, 48.36±11.351, 43.73±13.312, 44.18±11.864 respectively. Conventional group: on baseline, 1st session, 1st week, 2nd week, 3rd week, 4th week and 6th week SPADI scores were 70.55±6.729, 62.18±5.845, 56.73±5.623, 51.27±5.850, 47.36±6.637, 46.45±5.888 respectively. The SPADI score F statistics was $F(1.9, 75.5) = 17.6$, $p = .000$.

Table 6
Post Hoc Test-Multiple Comparison

Variable		Mulligan MWM p-value	Spencer MET p-value	Conventional p-value
VAS	Combined	.460	.000	.000
Flexion		.000	.000	.000
Abduction		.000	.000	.000
External Rotation		.427	.497	.139
Internal Rotation		.852	.067	.004
SPADI		.014	.000	.000

Tukey post-hoc test for VAS revealed significant pairwise differences between Combined group and Spencer MET ($P=0.000$) and between Combined and conventional ($P=0.000$) but there was no significant pairwise difference between Combined and Mulligan ($P=0.460$). These findings support the hypothesis that there is a significant difference in pain scores among the treatment groups. Further these results show that Mulligan MWM and Spencer MET combined is more efficient in decreasing pain in patients with diabetic adhesive capsulitis as compared to Spencer MET and conventional group but it is not more efficient than Mulligan MWM.

For Flexion there was significant pairwise differences between Combined group and Mulligan ($p=0.000$), Combined group and Spencer MET ($P=0.000$) and between Combined and conventional ($P=0.000$). These findings support the

hypothesis that there is a significant difference in flexion range among the treatment groups. Further these results show that Mulligan MWM and Spencer MET combined is more efficient for increasing flexion range in patients with diabetic adhesive capsulitis as compared to Mulligan MWM, Spencer MET and conventional group.

For Abduction there was also a significant pairwise differences between Combined group and Mulligan ($p=0.000$), Combined group and Spencer MET ($P=0.000$), between Combined and conventional ($P=0.000$). These findings support the hypothesis that there is a significant difference in range of motion among the treatment groups. Further these results show that Mulligan MWM and Spencer MET combined is more efficient for increasing abduction range in patients with diabetic adhesive capsulitis as compared to Mulligan MWM, Spencer MET and conventional group. For External Rotation the mean difference of Combined group is not significant when compared to Mulligan ($P=0.427$), Spencer MET ($P=0.497$) and Conventional ($P=0.139$). These findings support the hypothesis that there is no significant difference in External Rotation range among the treatment groups. Further this result shows that Mulligan MWM improved the External Rotation range more efficiently when compared to Spencer MET and Conventional.

Regarding Internal Rotation the mean difference of Combined group is not significant when compared to Mulligan ($P=0.852$) and Spencer MET ($P=0.67$) but is significant when compared to Conventional ($P=0.004$). These findings support the hypothesis that there is a significant difference in Internal Rotation range among the treatment groups. Further this result shows that Combined group improved Internal rotation range more effectively than conventional group. For SPADI score mean difference of Combined group is significant when compared to Mulligan ($P=0.014$), Spencer MET ($P=0.000$) and Conventional ($P=0.000$). These findings support the hypothesis that there is a significant difference in SPADI score among the treatment groups. Further this result shows that Combined group improved SPADI score more effectively than Mulligan MWM, Spencer and conventional group.

Discussion

The current study was conducted to determine the effectiveness of Spencer technique and Mulligan's technique separately and then combined on pain, ranges of shoulder and functional disability in diabetic adhesive capsulitis population. Conventional treatment was given to all the subjects. Regarding the intensity of pain, the findings of this study infer that the administration of mulligan MWM and Spencer's MET combined and Mulligan MWM alone showed similar effects for reducing pain. Mulligan's technique decreases pain by working on neurophysiological systems. It also inhibits pain receptors and activates pressure receptors by changing sympathetic pathways that in turn cause reduction in pain sensation.

In congruence to the current study results, Shahbaz Nawaz Ansari et al reported evidence of similar effects of MWM in reducing pain in adhesive capsulitis patients. (19). Unlike the MWM, combined techniques showed greater improvement in pain as compared to the Spencer's MET and conventional

therapy. Spencer's technique works by changing the circulatory mediators of pain hence decreasing pain in these patients. The added benefits can be due to combined thermal, mechanical and neurophysiological effects caused this reduction in pain because of warm water fermentation, end range oscillatory movements and sustained glide respectively. Another study conducted by Shahbaz Nawaz Ansari et al (2012) who concluded that end range mobilization with ultrasound therapy is more effective than stretching with cryotherapy in reducing pain in adhesive capsulitis patients showed similar results and improvement in pain using VAS as an outcome measure and supports the current study.((20)

However, this is the first study to compare the effectiveness of MWM with combined effect of MWM and Spencer's MET and found out to be equally effective in reducing pain in diabetic adhesive capsulitis patients. Regarding the ROM; the study findings and interpretation for flexion and abduction revealed that combined techniques are more efficient for increasing flexion and abduction range in patients with diabetic adhesive capsulitis as compared to Mulligan MWM, Spencer MET and conventional group. The result of current study is in agreement with the study conducted by Raksha R, Jivani et al (2021) in which Spencer's MET was compared with Maitland's mobilization and results showed that spencer's technique was more effective in improving range of motion with significant improvement in flexion and abduction.(21) This muscle energy technique is based on stretching the tight soft tissues surrounding shoulder joint and the capsule itself so that it can increase the range of motion and restore joint function. This study showed when this technique is combined with MWM the effects are augmented.

Furthermore, another RCT conducted by Shrivastava in year (2011) concluded the improvements in terms of pain, range of motion and disability by Mulligan's MWM. (22) Increase in pain free range of motion in MWM and combined group is because of Mulligan's concept that is modification of positional errors and correction of joint arthokinematics. These studies support the results of current study suggest that the effects of spencer muscle energy technique in combination of Mobilization with movement (MWM) has more significant effects in improving the ranges and functionality of the joint over these techniques used alone. (23) This improvement in ranges after intervention is explained by the facts that MWM is a combined active and passive motion technique so there is activation of proprioceptive receptors and increased extensibility in shoulder capsule and surrounding soft tissues respectively. Whereas the Spencer's technique increases lymphatic flow, resets stretch reflexes, increase circulation and lubrication in joint structure by repetitive movements with end range traction or glide.

Regarding external and internal rotation ranges, current study showed no significant difference of combined group compared to the MWM and Spencer's MET alone this is in contrast to the thought that combining manual therapy techniques improve the results. Regarding SPADI, there was significant improvement in all four groups as there exist a significant interaction effect between the treatment groups and time regarding SPADI score and for multiple comparison the results of current research show that combined group improved SPADI score more effectively than Mulligan MWM, Spencer and conventional

group. Similar results were found by Vinod Babu et al (24) who concluded that Mulligan's mobilization with movement as well as Spencer's muscle energy technique are helpful in improvement of range of motion disability and pain in frozen shoulder. This study results are in agreement with the current study.

Conclusion

It is concluded from the study that Spencer's muscle energy technique and Mulligan's technique mobilization with movement are both effective in improving pain, range of motion and functional disability in patients with diabetic adhesive capsulitis. However, the overall effect increases if Mulligan's technique MWM is provided in combination with Spencer's MET.

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