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Efficacy of the Mulligan technique on subacromial space in patients with shoulder impingement syndrome

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Abstract

Introduction. To estimate the effectiveness of the Mulligan technique for the shoulder complex on the subacromial space, shoulder ROM, pressure pain threshold, and function of the shoulder in the impingement syndrome patient.

Methods. Thirty patients who suffered from shoulder impingement syndrome were at random allocated into two groups; the experimental group received shoulder complex mobilization with movement plus conventional therapy, and the control group received conventional treatment. All patients were examined by ultrasonography for subacromial space, shoulder range of motion using a digital goniometer, electronic algometry for pressure pain threshold, and the Quick DASH for a difficulty level involved in carrying out several physical activities.

Results. In comparison to group B post-treatment, there were statistically significant improvements in the subacromial space ($p > 0.004$), flexion and abduction ROM, PPT of the biceps and supraspinatus ($p > 0.001$), and a significant reduction in the quick DASH ($p > 0.001$).

Conclusions. Shoulder complex mobilization with movement plus conventional therapy improved subacromial space, shoulder ROM, pressure pain thresholds, and function more than conventional therapy alone in shoulder impingement syndrome patients.

Key words: shoulder impingement syndrome, Mulligan technique, sub-acromial space, shoulder complex

Introduction

The term “shoulder impingement syndrome” (SIS) describes a rotator cuff mechanical entrapment involving the subacromial bursa or supraspinatus tendon, in the region between the acromion or coracohumeral ligament and the head of the humerus [1]. It is estimated that 7% to 34% of all joints develop shoulder problems, and it is thought that SIS accounts for 44% to 65% of all shoulder-related disorders [2]. Discomfort with arm abduction (painful arc), a decrease in arm function and force, and a diminished active range of motion (ROM) are the clinical features of shoulder impingement [3].

The two main contributing factors to the multifactorial etiology of SIS are the enlargement of subacromial tissues and the narrowing of the subacromial space [1]. During flexion, abduction, and medial rotation of the shoulder, the subacromial gap becomes smaller as a result of the usual shoulder girdle movement. The subacromial gap which is typically 1.0 to 1.5 cm wide, becomes narrower as the head of the humerus moves superiorly and moves closer to the anteroinferior edge of the acromion [2]. Patients with SIS show improper anterior or superior translational movements of the head of the humerus during active movements. The humeral posterior glide during dynamic shoulder movements was, therefore, predicted to correct these faulty mechanics. Physical therapy and anti-inflammatory drugs are the first treatment options regarding SIS. Physical therapy techniques often involve manual therapy and exercises [4].

Mobilization with movement (MWM) is the process of exerting a sustained passive accessory glide or force on a joint as a patient actively performs an activity that has been previously identified as problematic [5]. Ajit and Shika [1] reported that MWM for SIS patients is an effective method in increasing the subacromial space, decreasing pain and disability, and enhancing function [1].

The term “shoulder girdle” is frequently used to describe the articulations that connect the combined thoracic, clavicular, and scapular segments. As a result, the motion of the scapulothoracic region is the motion of the entire shoulder girdle complex. The scapula and arm move together in a coordinated manner, allowing the arm to be moved and positioned in the best way possible to complete activities. The scapulothoracic complex motion is essential to maximize the total ROM and keep the humeral head articulating with the glenoid [6].

During shoulder elevation, the majority of the observed scapulothoracic upward rotational motion is created by the combination of sternoclavicular (SC) elevation and upward rotation of the acromioclavicular (AC) joint [7]. Without movement at either, or most commonly, both of the SC and AC joints, the movement of the scapulae on the thoracic wall is not possible [6]. Reduced upward rotation, greater internal rotation, and decreased posterior tilting of the scapula have commonly been assumed to contribute to the development of shoulder impingement [7]. The previous studies investigate the effect of a Mulligan on the glenohumeral joint and subacromial space but not the shoulder complex. A relationship between the glenohumeral, SC, and AC during arm elevation and impingement syndrome of the shoulder has also been described. This research aimed to examine the impact of a Mulligan on the shoulder complex in a patient with shoulder impingement.

Subjects and methods

Study design and participants

Randomized control trial (pretest-posttest design) performed in the outpatient clinic for physical therapy at Deraya

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University. The patients were diagnosed with SIS and referred by an orthopedist to the physical therapy outpatient clinic (Deraya University). Patients were eligible to join this trial if their ages were between 30 to 55 years old, had pain in the shoulder, and two out of the four objective symptoms and signs, including the following: the Hawkins Kennedy impingement test was positive, the Neer impingement test was positive, limited or painful in active elevation of the shoulder (abduction flexion, and scaption), and painful or limited hand-behind-head or hand-behind-back functional movement patterns. Patients who had adhesive capsulitis, cervical radiculopathy, previous shoulder surgery, or who had received an injection of corticosteroids during the previous month were excluded from the trial.

Intervention

Group A received MWM for the shoulder complex, 3 sessions per week for 2 weeks. The duration of the session was about an hour (Table 1) [5, 8]. Also, they received conventional therapy similar to the control group (group B).

Conventional therapy

Both groups received conventional therapy.

1 – Stretching exercises increase the flexibility of the upper thoracic spine, pectoralis muscle, posterior capsule, and glenohumeral joint. The subjects were advised to repeat the stretch three times for 30 s. They were directed to do flexibility exercises twice daily (Table 2).

Table 1. MWM for the shoulder complex

Exercise	Exercise description
1 – MWM for flexion/abduction/scaption and/or elevation (posterolateral glide)	The patient was seated, and the therapist supported the posterior aspect of the scapula with one hand while standing on the side opposite the area of pain. The other hand laterally and posteriorly translated the humeral head. The patient actively raised their arm through the plane of elevation while the glide was maintained. Apply sets of 6 to 10 repetitions each, with 3 to 5 sets every treatment session.
2 – MWM for the AC joint	The patient was seated with their arm at their side. The therapist performed a caudal and/or posterior or anterior glide to the distal end of the clavicle, and the patient actively moved in the previously painful or limited direction while the glide was being sustained. 3 sets of 3 repetitions each should be performed.
3 – MWM for the SC joint	The patient is lying supine, and the therapist stands at the head of the table and places the cephalic hand on the shoulder that needs to be moved at the SC joint. To facilitate rotation upward, the caudal hand was placed over the clavicle. The therapist used the cephalic hand to apply a force (accessory glide) at the proximal clavicle in an inferior direction while the patient raised the arm into shoulder flexion. This was done repeatedly until a larger degree of shoulder flexion was achieved.

Table 2. Flexibility exercises, strengthening of the rotator cuff and scapular stabilizers, and upper-quarter postural awareness

Exercise	Exercise description
Flexibility exercises	
1 – Internal rotation towel stretch	Subjects pulled the affected arm up back while holding a towel behind their backs with the unaffected arm.
2 – Cross-body stretch	The patients gently pulled the affected elbow across the body until they felt a comfortable stretch while holding the affected elbow with the other hand in front of the body.
3 – Doorway pectoral muscle stretch	The patients were directed to stand between 0.3 and 0.6 meters from a doorframe, hold it at shoulder height, and then twist their upper bodies away from the door.
4 – Shoulder flexion stretch	The patients were told to lie on their backs, holding a stick/cane in both hands and then raise both arms overhead with the unaffected arm until they felt a comfortable stretch.
Strengthening the rotator cuff and scapular stabilizers	
1 – Shoulder external rotation	Starting with the elbow flexed to 90° and the arm by the side in an internal rotation of about 45°.
2 – Shoulder extension	Starting with an approximate 45-degree forward flexion of the arm.
3 – Shoulder flexion	Starting with the elbow flexed 90° and the shoulder in neutral rotation, punch forward while also extending the elbow and flexing the shoulder in a 0 to 60° arc.
4 – Scapular retraction	Beginning with the arms at the side, the shoulder in neutral rotation, and the elbows flexed 90°, compress the scapulae.
5 – Shoulder abduction	Holding the band in the hand with the band placed horizontally across the body, moving the shoulder over a 0° to 60° arc while maintaining neutral shoulder rotation.
Improve upper-quarter postural awareness	
1 – chin-tuck exercise	The patient was asked to press down on their chins with their fingers while pulling their heads back, holding it for 3 seconds at least 3 times every hour. It was important to maintain a horizontal motion and avoid looking up or tilting the head back.

2 – Strengthening of the rotator cuff muscles and the stabilizers of the scapula. Strengthening exercises were performed using the lightest graded (yellow) Thera-Band (Table 2).

3 – Improve awareness of upper-quarter posture.

The individuals were advised to complete two or three sets of 10 repetitions of each activity once daily [9] (Table 2).

Outcome measures

At baseline, every measurable outcome was evaluated, and after 3 sessions every week for 2 weeks. The primary outcome measure was subacromial space, the secondary outcomes were shoulder ROM, pressure pain threshold (PPT), and function.

1 – The subacromial space was measured by ultrasonography (US). A Hitachi Noblus scanner with a serial code of G330131514 (Santax Medico/Santax Nordic Group, Denmark, Copenhagen) as well as a Hitachi Medical Technologies Musculoskeletal Linear Probe model L64 18-5 MHz, 50 mm, having a central frequency of ten MHz in gray level B-mode were the instruments used [10]. According to reports, it is a valid and reliable tool [11]. The subacromial space was the shortest straight separation between the top margin of the humerus and the lower margin of the acromion (Figure 1). The individuals were seated erect in a back-supported chair and their feet flat on the floor. They were advised to maintain a straight line of vision and to put their upper limb to the side and flex their elbow to 90° [10].

2 – Shoulder ROM was assessed using a digital goniometer. It is considered to be the most valid, objective, and available technique for determining the range of movement of the joint [12]. The starting posture for measuring shoulder flexion was supine, with the lateral epicondyle serving as the measurement axis. The stationary limb was directly parallel to the floor, while the mobile limb was parallel to the humerus. For measuring shoulder abduction, the frontal portion of the acromion process served as the measurement axis. The movable limb was parallel to the humerus, while the fixed limb was parallel to the floor's surface [13].

3 – PPT was measured using digital algometry. To assess tender points, a pressure probe was used to determine the pain threshold for the Model FDI of the Force One scale (Wagner Instruments, Greenwich, CT, USA) [14]. It is a valid and reliable way to examine PPT [15]. A pressure algometer uses a probe to evaluate the force exerted on tissues, also known as a noxious stimulus. It was evaluated over supraspinatus (the midpoint over the scapular fossa) and biceps major (midway between the radial head and the coracoid process) [16]. The pressure was gradually increased while the transducer probe was positioned perpendicularly above the MTrP. PPT measurements were obtained in kilogram-force (kgf). When the pressure turned into discomfort, the examiner measured the PPT levels three times at 20-second intervals, and the analysis considered the mean [15].

4 – Shoulder function was measured by the Quick DASH (Q-DASH), it was a shorter version of the DASH questionnaire. For examining the patient with problems affecting the upper extremity, the Arabic version of the (Q-DASH) questionnaire is a valid and accurate upper limb outcome measure [17] and includes 11 items to evaluate the difficulty level of performing several physical tasks requiring the shoulder, arm, or hand (six questions), the degree of tingling and pain (two questions), and the effect of the disorder on sleep, work, and social activities (three questions). Five different answers are available for each question, varying from being able to perform daily activities with no difficulty to having very severe symptoms. After adding up the results of each item's scores and transforming them, each score varied from zero (no impairment) to 100 (the most severe impairment) [18].

Sample size

G*POWER statistical software was used to do sample size calculations [version 3.1.9.2; Franz Faul, University Kiel, German] depending on the information of subacromial gap from a pilot research study conducted on five individuals in each group; and showed that this study needed 13 participants in each group as a sample size. Using an effect size of 1.2, power of 90%, and $\alpha < 0.05$, the calculation was performed. Estimating a dropout rate of 15%, the number of subjects increased to 15 subjects in each group.

Figure 1. The subacromial space

Randomization and blinding

Patients were randomly allocated to receive either conventional therapy alone (control group) or shoulder complex MWM and conventional therapy (experimental group) using random block randomization produced by a computer. To prevent bias and variability between groups, the block sizes were 6 and 8, and the allocating ratio was 1:1. Utilizing sealed opaque envelopes, the concealed allocation was completed by the first author, who was not engaged in data collection or treatment of the participants. Baseline measurements were applied by the fourth author, and after measurements; the second author opened the envelopes and continued treatments according to group assignments.

Statistical analysis

For comparing the individual features between groups, an unpaired *t*-test was employed. The sex distribution between the groups was compared using a chi-squared test. Applying Shapiro–Wilk testing was applied to determine if the data were distributed normally. The test of Levene for variance homogeneity was used to determine the homogeneity between groups. On the mean values of shoulder flexion and abduction ROM, PPT, subacromial space, and the quick DASH, mixed MANOVA was carried out to assess the effects of time (before and after) and treatment between groups in addition to the interaction between time and treatment. For subsequent multiple comparisons, the Bonferroni correction was employed for post-hoc analysis. Statistical measurements were carried out using the SPSS version 22 for Windows. A significance level of $p < 0.05$ was applied for all statistical tests.

Results

The flowchart for the study is shown in Figure 2, which identifies forty-six patients having a syndrome of shoulder impingement who were chosen from the physical therapy outpatient clinic of Deraya University and participated in this study. Sixteen participants were excluded because three of them refused to take part, and thirteen did not meet the inclusion criteria (three had shoulder surgery, six had cervical radiculopathy, and four had adhesive capsulitis). To take part in the study, thirty people were eligible and assigned to two groups at random, fifteen in each group. They were allocated for assessment of the subacromial space, shoulder ROM, PPT, and function before intervention. The first group, group A, received Mulligan shoulder mobilization techniques and conventional treatment, and the second group, group B, received the conventional treatment and the outcomes were assessed after the intervention.

Table 3 demonstrates the individual characteristics of group A and group B. Between-group evaluations revealed no statistically significant differences ($p > 0.05$).

Mixed MANOVA was performed to examine the impact of treatment on shoulder flexion and abduction ROM, PPT, subacromial space, and quick DASH scores. Time and treatment had a significant interaction impact ($p < 0.001$). The treatment's main effect was significant ($p < 0.001$). The main effect time was significant ($p < 0.0001$). There was a significant treatment × time effect ($F = 31.11$, $p < 0.001$, partial eta squared = 0.89), the time's main effect was significant ($F = 146.93$, $p < 0.001$, partial eta squared = 0.97), and the treatment's main effect was significant ($F = 24.05$, $p < 0.001$, partial eta squared = 0.86).

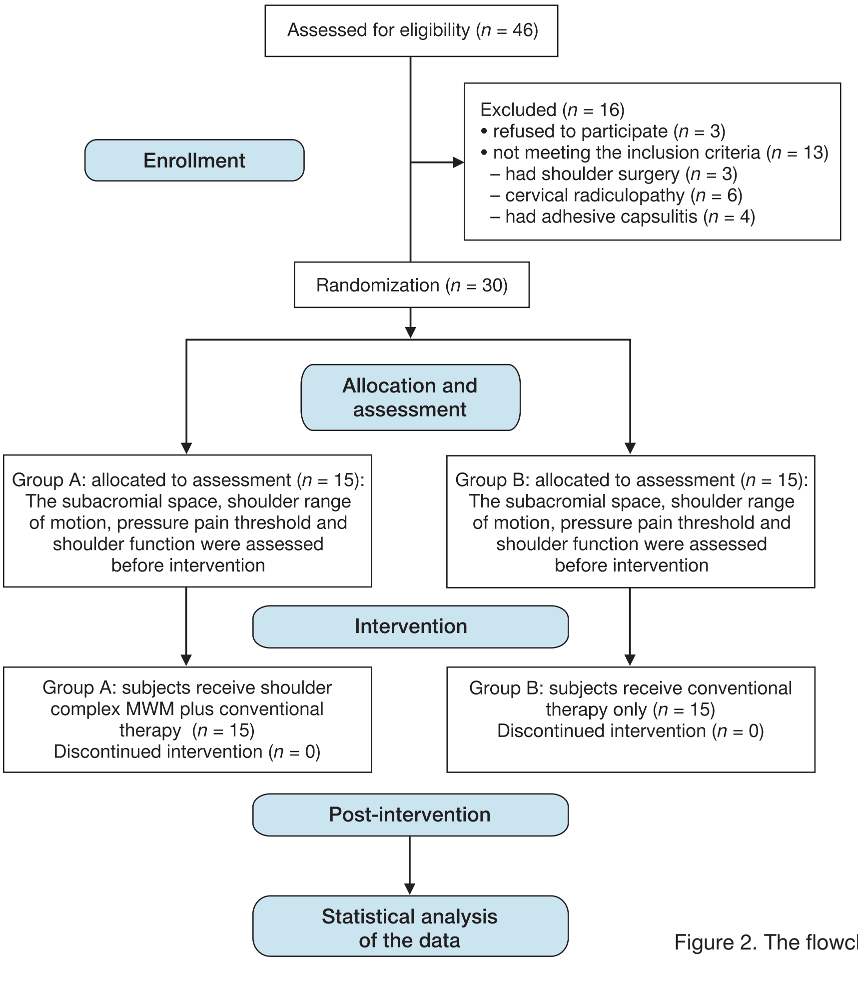

Figure 2. The flowchart of the study

Table 3. Comparison of subject characteristics between groups A and B

Demographic data	Group A (mean ± *SD*)	Group B (mean ± *SD*)	*p*-value
Age (years)	43.6 ± 7.69	42.93 ± 6.52	0.8
Weight (kg)	71.66 ± 10.35	72.2 ± 11.07	0.89
Height (cm)	164.13 ± 8.09	165.46 ± 6.51	0.62
BMI (kg/m²)	26.63 ± 3.59	26.49 ± 4.35	0.92
Sex, *n* (%)			
females	11 (73%)	11 (73%)	1
males	4 (27%)	4 (27%)	

Table 4. Mean shoulder flexion and abduction ROM, subacromial space, PPT of the biceps and supraspinatus, and the quick DASH, pre- and post-treatment of groups A and B

Outcome measure	Pre-treatment (mean ± *SD*)	Post-treatment (mean ± *SD*)	MD	% of change	*p* value
ROM (°)					
Flexion					
group A	104.4 ± 21.86	172.73 ± 7.85	–68.33	65.45	0.001
group B	105.66 ± 27.24	132.8 ± 12.02	–27.14	25.69	0.001
MD	–1.26	39.93			
	$p = 0.88$	$p < 0.001$			
Abduction					
group A	93.73 ± 12.58	176 ± 8.49	–82.27	87.77	0.001
group B	89.93 ± 17.62	118.06 ± 12.3	–28.13	31.28	0.001
MD	3.8	57.94			
	$p = 0.5$	$p < 0.001$			
Subacromial space (cm)					
group A	0.84 ± 0.08	1.15 ± 0.09	–0.31	36.90	0.001
group B	0.89 ± 0.12	1.01 ± 0.14	–0.12	13.48	0.001
MD	–0.05	0.14			
	$p = 0.24$	$p < 0.004$			
PPT (kg)					
Biceps					
group A	1.49 ± 0.41	3.17 ± 0.59	–1.68	112.75	0.001
group B	1.51 ± 0.39	1.86 ± 0.49	–0.35	23.18	0.002
MD	–0.02	1.31			
	$p = 0.92$	$p < 0.001$			
Supraspinatus					
group A	1.23 ± 0.43	2.94 ± 0.59	–1.71	139.02	0.001
group B	1.32 ± 0.49	1.8 ± 0.71	–0.48	36.36	0.001
MD	–0.09	1.14			
	$p = 0.61$	$p < 0.001$			
Quick DASH (%)					
group A	57.24 ± 7.73	9.7 ± 1.65	47.54	83.05	0.001
group B	59.4 ± 9.85	33.41 ± 2.32	25.99	43.75	0.001
MD	–2.16	–23.71			
	$p = 0.24$	$p < 0.001$			

MD – mean difference, DASH – disabilities of the arm, shoulder and hand

Between groups effect

Before treatment, no differences were statistically significant between the groups ($p > 0.05$). The mean differences between groups A and B (post-treatment) in shoulder flexion and abduction ROM were 39.93° and 57.94°, respectively, and the PPT of the biceps and supraspinatus was 1.31 kg and 1.14 kg, respectively. The subacromial space was 0.14 cm, and the quick DASH was 23.71%. Post-treatment, the comparison between groups showed a significant improvement in shoulder flexion and abduction ROM, subacromial space, and PPT of the biceps and supraspinatus, and a significantly lower quick DASH in group A compared to group B ($p < 0.01$, Table 4).

Within group effects

In comparison to before treatment, a significant improvement was made in both groups' subacromial space and ROM for shoulder flexion and abduction ($p > 0.001$). The percent of increase in shoulder flexion and abduction ROM and subacromial space of group A was 65.45, 87.77, and 36.9%, respectively, and in group B it was 25.69, 31.28, and 13.48%, respectively (Table 4).

The PPT of the biceps and supraspinatus significantly increased after treatment compared to before treatment in the two groups, whereas the quick DASH significantly decreased ($p > 0.01$). The percent of change in PPT of the biceps and supraspinatus and the quick DASH of group A was 112.75, 139.02, and 83.05%, respectively, and in group B it was 23.18, 36.36, and 43.75%, respectively (Table 4).

Discussion

The purpose of this research was to examine the impact of the Mulligan on the shoulder complex on subacromial space, shoulder ROM, pain, and function in SIS patients. The major finding of this research was a statistically significant difference between both groups concerning all outcome measures after three sessions a week for two weeks, with more favor in the experimental group ($p < 0.05$).

US was utilized to evaluate the effect of MWM of the shoulder complex on the subacromial space in patients suffering from shoulder impingement. The results reported statistical differences between the two groups in a significant manner with a mean difference of 0.14 cm. The minimal clinical important difference (MCID) of acromiohumeral distance (AHD) was 0.7 mm [19]. So, the difference between groups in subacromial space was a statistically and clinically important difference. Narrowing the subacromial space is one of several contributing factors to the etiology of SIS [1]. Individuals with SIS have improper movement of the humeral head in superior or anterior directions. Posterior humeral glide during dynamic movements of the shoulder was therefore predicted to help repair these poor mechanics [4]. In addition, the majority of the observed scapulothoracic upward rotation occurs during shoulder elevation as a result of the combination of AC upward rotation and SC posterior rotation [7]. It has been hypothesized that reduced scapular upward rotation is a mechanical risk factor for SIS because it reduces the subacromial space [20]. This study concludes that Mulligan MWM posterolateral glide for the glenohumeral joint, an inferior and/or posterior or anterior glide for the acromioclavicular joint, and an inferior glide as the SC joint assists in relocating the joint to correct a positional defect. This enables it to track normally and enhances scapular upward rotation, which leads to an increase in the subacromial space. This study's results are in agreement with other clinical trials [1, 21], but those trials were not sufficient to support the effect of a Mulligan for the entire shoulder complex on the subacromial space because they demonstrated the effect of a Mulligan for the glenohumeral joint alone.

A digital goniometer was used to investigate the impact of mobilization on movement (MWM) for the shoulder complex concerning ROM of the shoulder in patients suffering from SIS. The results reported statistically significant differences between both groups in ROM in flexion and abduction, with a mean difference of 39.93 and 57.94, respectively. When using goniometric measurements of the shoulder, it is generally agreed that a change of 6° to 11° is required to confirm the presence of clinical alterations [4]. So, the difference between groups in shoulder ROM was a statistically and clinically important difference. Deficiencies in ROM might exacerbate the symptoms of impingement by causing the humeral head to translate more anteriorly or superiorly [22]. The shoulder ROM is therefore increased by MWM posterolateral glide for the glenohumeral joint. Scapular upward rotation is necessary for the best function of the shoulder joint, particularly for pain-free and full range of flexion or abduction. However, the combined kinematics at the AC and SC joints are what matters [23]. So, activation in the upward rotation of the scapula during arm elevation is critical for the glenohumeral joint to move [20]. The results of the current research were matched with other research studies such as [21], which showed that, in comparison to control or sham conditions, Mulligan's MWM approach provided an immediate and significant increase in PPT and ROM from before to after the interventions in patients who suffer from severe shoulder movement restrictions. Another study showed that for shoulder impingement, MWM consistently increased ROM in all directions [24].

An electronic algometer was used to evaluate the impacts of MWM for the shoulder complex on PPT in patients suffering from SIS. The results reported a statistically significant difference between both groups on PPT of the biceps and supraspinatus, with a mean difference of 1.31 and 1.14 kg, respectively. According to previous studies, a difference between groups in PPT higher than 1 kg/cm^2 is clinically significant [25]. If the subacromial surface decreases, soft tissue degeneration and rupture, in addition to a partial or complete rotator cuff rupture and pain develop [26]. In this study, the shoulder complex MWM increases the subacromial space, so the compression on the tissue decreases and reduces pain. Also, the movement created by MWM techniques reduced pain either by activating mechanoreceptors that blocked nociceptive impulses by way of the gate control mechanism or by promoting synovial fluid nitric oxide production [1]. When compared to controls, patients with impinged shoulders had a significant reduction in PPT values, which was related to more severe pain in all muscles [16]. Therefore, during this research, we discovered that due to pain alleviation, the PPT increased the post-shoulder complex MWM. This result is in agreement with [21, 4].

The Quick DASH was applied to investigate the impact of shoulder complex MWM on the level of difficulty of carrying out several physical activities in a patient having SIS. According to the findings, comparing both groups revealed a statistically significant difference with a mean difference of 23.71%. By using Quick DASH, the MCID was 57%, following a median of 10 physical therapy sessions [27]. So, the difference between groups in quick DASH was a statistically and clinically important difference. Quick DASH scores are improved by shoulder MWM because it reduces discomfort and enhances functioning after shoulder mobilization exercises [1]. These study's results agree with those of another study [26].

On the other hand, the control group had improvement in subacromial space. Evidence suggests that exercise therapy would enhance glenohumeral kinematics by increasing subacromial space, decreasing joint translation, and increasing the acromiohumeral distance (AHD). These changes would be correlated with increases in shoulder strength [28].

Additionally, the patients in the control group showed an improvement in shoulder ROM. This result agrees with those of other researchers [9, 29] who have observed improvements in ROM in patients suffering from SIS after an exercise program. The research by Moezy et al. [30] found that the improvement in ROM of the shoulder was a result of stretching exercises that were used to lessen the tight shoulder capsule and shortened muscle, particularly the pectoral muscles. Additionally, reducing patient pain may contribute to an increase in shoulder ROM.

There was also an improvement in "the control group" in PPT. This result agrees with Moezy et al. [30], who found that the rotator cuff muscles protect the space between the great tubercle and the acromion and avoid compression by stabilizing the head of the humerus in the glenoid, resulting in the humerus rotating outside, that is why resistance training using Therabands worked effectively to alleviate pain. Furthermore, our program's stretching exercises increased shoulder tissue flexibility, which could help to reduce pain and raise the PPT.

Finally, the function of the shoulder was improved in the control group. Systematic reviews have shown that strengthening and stretching exercises help SIS patients in minimizing pain and impairment [29]. A study by McClure et al. [9] found that in a group of individuals who have impinged shoulders, strengthening the rotator cuff, enhancing the posterior glenohumeral joint capsule's flexibility, promoting the extension of the upper thorax, and encouraging a retracted head position might enhance muscular strength, function, movement, and pain.

Limitations

The effectiveness of interventions was assessed for the PPT of the biceps and supraspinatus only, so, researches are required to evaluate the other muscles of the shoulder joint. Additionally, this study assessed the impact of Mulligan for the shoulder complex on elevation (flexion and abduction) only of the shoulder. So, studies are needed to evaluate all ROMs of the shoulder. Finally, the therapeutic interventions incorporated a short-term follow-up that was applied over 6 sessions for 2 weeks. Future studies should include a greater number of sessions and require a long-term follow-up.

Conclusions

Shoulder complex MWM plus conventional therapy improved shoulder ROM, pain pressure thresholds, the subacromial space, and function more than conventional therapy alone in SIS patients.

Acknowledgments

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Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and was approved by the Cairo University in Egypt's Faculty of Physical Therapy's Ethics Committee for Human Research (approval No.: P.T.REC/012/003613) and registered at Clinical Trials Registration (NCT05439525).

Informed consent

Informed consent was obtained from all individuals included in this study.

Disclosure statement

No author had any financial interest or received any financial benefit from this research.

Conflicts of interest

The authors state no conflicts of interest.

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Reference

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