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SCAPULOTHORARIC JOINT MOBILIZATION IMPROVES RANGE OF MOTION AND FUNCTIONAL ABILITY IN FROZEN SHOULDER

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ABSTRACT

Frozen shoulder or commonly known as adhesive capsulitis. It is a condition of inflammation in the joint capsule or capsule that protects the glenohumeral joint. The purpose of this study was to prove the effect of adding scapulothoracic joint mobilization interventions in increasing the range of motion and functional ability in individuals with a frozen shoulder. The design used in this study was experimental with pre-test and post-test control group design involving 24 samples divided into two groups. Group 1 received conventional intervention including glenohumeral joint mobilization, while Group 2 received the additional intervention, namely scapulothoracic joint mobilization in addition to glenohumeral joint mobilization. Ultrasound was given to both groups as initial therapy. The goniometer was used as a measurement of the shoulder range of motion and SPADI was used to measure the functional ability of the shoulder. Hypothesis testing using the independent sample t-test to compare the two interventions was found to be significantly different with the p-value = 0.000 ($p < 0.05$). It can be concluded that the addition of scapulothoracic joint mobilization to conventional interventions proved to be effective in increasing the range of motion and functional ability of the shoulder in individual with frozen shoulder.

Keywords**: frozen shoulder, scapulothoracic joint mobilization, glenohumeral joint mobilization, ultrasound, range of motion, SPADI

INTRODUCTION

Frozen shoulder or what is often referred to as adhesive capsulitis is a condition of inflammation of the joint wrapper or capsule that protects the glenohumeral joint, causing symptoms in the form of pain that is accompanied by a tightness during movement of the glenohumeral joint[1] .Based on epidemiological studies, frozen shoulder mainly affects individuals aged 40-60 years, with the incidence being predominantly female. The incidence and prevalence of frozen shoulders have a rate of 2% -5% in the general population. Individuals with diabetes mellitus, who also associated by prolonged immobility of the shoulder (trauma, injury or excessive surgery) or systemic disease (hyperthyroidism, hypothyroidism, cardiovascular disease or Parkinson's disease) are at high risk for frozen shoulder[1,2].

For frozen shoulder, there was a significant decrease in range of motion and a significant decrease in functional measurements using the Shoulder Pain Disability Index (SPADI) and the Disability of Arm, Shoulder, and Hand (DASH)[3].There are a lot of physiotherapy management in frozen shoulder cases, which is commonly managed with therapeutic modality such as ultrasound, Glenohumeral. Joint Mobilization and manipulation[3].

Glenohumeral Joint Mobilization is a joint mobilization method which uses the concept of glenohumeral joint accessory movement to produce movement on the joint surface with limitations. Joint mobilization is focused on impairment of limitations that occur in joint structure which aim to stretch the joint capsule as well as improve the arthrokinematics mechanism consisting of the roll, slide, and spin, thus an increase in osteokinematics movement is obtained[4].

Biomechanical studies show that there is a large influence between the movements that occur in the scapula on the thoracic cage and the movements that occur in the glenohumeral joint during functional

movement of the shoulder complex known as the Scapulohumeral Rhythm. The relationship between these two joints results in the potential for glenohumeral movement problems if a dysfunction in the scapulothoracic joint present[5].Despite of this theory, yet experience by clinician shows most of the treatment aimed only to improve glenohumeral joint motion. This creates a gap between theory and practice, and raises the question of whether it is true that improving scapulothoracic joint motion can improve shoulder function in accordance with biomechanical theory.

The addition of scapulothoracic joint mobilization in the management of frozen shoulder is a combination of therapeutic techniques which in biomechanical studies has a positive impact on treating frozen shoulder because it improves the kinematics of the shoulder complex in overall, especially the combination of movements, scapulohumeral rhythm. Scapulothoracic joint mobilization can also correct the relative scapula position against the thoracic cage, therefore it reduces the stress on the glenohumeral joint[6].

From the description above, the author, conducted a study to prove the effect of adding scapulothoracic joint mobilization in improving the range of motion and functional ability for individual with frozen shoulder compared to the standard intervention protocol which only using glenohumeral joint mobilization.

METHODS

a. Methodology

The research was conducted by pre-test and post-test control group design, with the aim of knowing the effectiveness of adding scapulothoracic joint mobilization to intervention glenohumeral joint mobilization in increasing ROM and functional mobility in frozen shoulder. In this study, ROM was measured by using Universal Goniometer, and functional ability was measured using SPADI.

The study population was all patients with indications of frozen shoulder who visited the Sesetan Physiotherapy Practice. A total of 24 patients were obtained through consecutive sampling techniques in the period from August to September 2019, then randomized and divided into two treatment groups with a total of 12 people in each group.

b. Material and Procedures

Material

Weight measurement was carried out using weight scale with brand of OneMed type of BR9707 in kilograms. Height measurement was done using *stature* meter with brand of OneMed in centimeters. Standard goniometer and the Shoulder Pain and Disability Index (SPADI) were used as the outcome measurement which are explained more detail in assessment. Ultrasound therapy was given using ultrasound with brand of EME PHYSIO US50, made in Italy.

Procedures

Glenohoumeral joint mobilization was performed by a physiotherapist. Glenohumeral joint mobilization was began by patient lying in supine position and placing patient's arm into maximal loose packed position which is 50^0 of abduction, 10^0 of horizontal adduction, and slightly external rotation. Physiotherapist then performed a distraction force by pulling humeral head into lateral-ventral-cranial direction with grade 1 oscillation and slowly progress into grade 4 oscillation. To emphasize on external rotation, abduction, and internal rotation ROM, distraction was done along with anterior glide, inferior glide, and posterior glide respectively. Each session, mobilization was performed for 2 minutes for each motion with rest interval of 1 minutes between each motion. Mobilization was done 3 times a week for 12 sessions.

Scapulothoracic joint mobilization was given after glenohumeral joint mobilization. Initially, patient was positioned in side lying on the non-affected arm. While patient were asked to relax, physiotherapist gently mobilized scapular bone passively and linearly into superior, inferior, anterior, and posterior direction in relative to the posterior rib cages. Then, patient were asked to slowly move their shoulder into intended motion (external rotation, abduction, and internal rotation) while physiotherapist at the same time mobilizing the scapular bone into retraction, upward rotation, and protraction respectively. Scapulothoracic joint mobilization was performed for 2 minutes for each motion with rest interval of 1 minutes. Scapulothoracic joint mobilization was done 3 times a week for 12 sessions in total.

c. Assessment

Patient who was suspected of having frozen shoulder, initially underwent an examination using physiotherapist shoulder examination algorithm. Restriction of both passive and active movement with capsular pattern type of restriction (external rotation was the most restricted, followed by abduction and internal rotation), absence of pain during isometric testing, and noticeable limitation during joint play movement testing with firm-less hard end feel were clinical predictor to rule in the diagnosis.

ROM measurement was taken before and after the intervention using a standard goniometer. The two most restricted movement, external rotation and abduction ROM were recorded to represent the glenohumeral ROM. Shoulder functional ability was measured using the Shoulder Pain and Disability Index (SPADI)[7–9].SPADI was a measurement instrument used to provide an overview related to the patient's functional level in the shoulder joint region which consists of 5 questions to indicate the level of pain, and 8 questions to indicate the level of disability where each question has 10 parameters. The number 0 shows the absence of pain or difficulty in carrying out activities, while the number 10 shows the worst pain or difficulty requiring assistance in carrying out activities[8–10].

d. Data Analysis

Descriptive test is used to see the distribution of subjects on the characteristics of the sex and age of the subject, Normality Test with the Shapiro Wilk Test and normal values were obtained so that it was followed by parametric hypothesis testing.

RESULTS

Table 1. Gender Distribution

Characteristics		Frequencies (%)	
		Group 1	Group 2
Sex			
	Male	3 (25.00)	4 (33.33)
	Female	9 (75.00)	8 (66.67)
Age			
	Mean ± SD	47.50±2.71	47.58±2.93

In Group 1, 3 subjects (25.00%) were male and 9 (75.00%) female subjects. Whereas in Group 2, 4 subjects (33.33%) were male and 8 subjects (66.67%) were female. Group 1 had a mean age (47.50 ± 2.71) years and Group 2 had a mean age (47.58 ± 2.93) year. Each group consisted of 12 subjects so that the total number were 24 subjects.

Table 2. Normality and homogeneity

Data Group	Shapiro Wilk Test		Levene's Test
	Group 1	Group 2	
	p	p	
Pre-Intervention			
ROM Abduction	0.200	0.961	0.816
ROM External Rotation	0.051	0.469	0.921
SPADI Post-Int	0.108	0.773	1.000
Post-Intervention			
ROM Abduction	0.110	0.163	0.325
ROM External Rotation	0.149	0.240	0.984
SPADI Post-Int	0.200	0.911	0.431

Based on The Shapiro Wilk test and Levene's test showed that the data were normally distributed and homogeneous in the data before the intervention (p value Group 1= 0.200, 0.051, 0.108 and Group 2 = 0.961, 0.469, 0.773 for measurements of ROM abduction, external rotation and SPADI values, with Homogeneity values = 0.816, 0.921, and 0.100 respectively. Data after the intervention showed the p-value of Group 1=0.110, 0.149, 0.200 and Group 2=0.163, 0.240, 0.911 for measurements of ROM abduction, external rotation, and SPADI values with values of homogeneity=0.325, 0.984, 0.431 respectively.

Table 3. Paired Sample t-Test Group 1 test

	Mean±SD	p
ROM Abduction	46.167±8.021	0.000
ROM External Rotation	5.583±1.832	0.000
SPADI	6.667±2.570	0.000

Table 4. Paired Sample t-Test Group 2

	Mean±SD	p
ROM Abduction	64.58±8.361	0.000
ROM External Rotation	21.33±1.923	0.000
SPADI	22.58±2.644	0.000

The Paired Sample t-Test conducted in Table 3. and Table 4. shows the value of $p = 0.000$ ($p < 0.05$) for different results in the mean increase in ROM and decrease in disability before and after the intervention in each group. The data represent that there is a significant increase in the ROM value and the functional ability of the shoulder.

Table 5. Independent t-test

	Group	Mean±SD	p
ROM Abduction Pre-Intervention	1	86.92±4.461	0.895
	2	87.17±4.726	
ROM Abduction Post-Intervention	1	133.08±10.396	0.000
	2	151.75±7.990	
Mean Different	1	46.167±8.021	0.000
	2	64.58±8.361	
ROM External Rotation Pre-Intervention	1	29.92±3.988	0.880
	2	29.67±4.030	
ROM External Rotation Post-Intervention	1	35.50±5.018	0.000
	2	51.00±5.045	
Mean Different	1	5.583±1.832	0.000
	2	21.33±1.923	
SPADI Pre-Intervention	1	52.67±2.839	1.000
	2	52.67±2.839	
SPADI Post-Intervention	1	46.00±5.018	0.000
	2	30.08±3.777	
Mean Different	1	6.667±2.570	0.000
	2	22.58±2.644	

Table 5. shows the results of the independent t-test to compare interventions in Group 1 and intervention in Group 2 to increase ROM and functional ability in individuals with frozen shoulders. The statistical results show the significance value of the difference between the increase in ROM and functional ability, namely p=0.000 (p <0.05). These results suggest that the addition of scapulothoracic joint mobilization more effective in producing increased ROM and functional ability in cases of frozen shoulder.

DISCUSSION

Sample Characteristics

Based on the results of this study, it showed that in the treatment Group 1 with the provision of glenohumeral joint mobilization intervention had a mean age of 47.50 ± 2,714 years and in treatment Group 2 with the provision of glenohumeral joint mobilization intervention accompanied by the addition of scapulothoracic joint mobilization had a mean age of 47.58 ± 2,937 years. This shows that the mean age of the sample is older adults.

Several studies have showed that the highest incidence of the frozen shoulder occurs at the age of 40-60 years[1,2,11].Several related studies also strengthen the results of the descriptive analysis of this study which states that the incidence of frozen shoulder is very rare before the age of 40 years.Study by Huang et al (2013) showed an association between frozen shoulder cases and type 1 diabetes mellitus and it was found that the highest prevalence of individuals experiencing frozen shoulder is in the middle 50 years of age[12].

Old adulthood (40 - 60 years) is productive for individuals, where at this time, individuals are in a phase where they spend most of their time working while being accompanied by physical conditions that slowly decline. Repetitive activities carried out by individuals at this age increase the risk of chronic trauma to eventually cause symptoms of frozen shoulder.

Obtained data on gender characteristics in this study were 17 female subjects and 7 male subjects. The results of this study indicated that there were differences in the number of male and female subjects on the incidence of frozen shoulder. The results of the study of Inayat et al (2017) reported that the incidence

of the frozen shoulder was more prevalent in women when compared to men[13].There are no studies that clearly explain the association with gender to the prevalence of frozen shoulder, but it is said that hormonal changes have a tendency to experience more somatic symptoms than men which indirectly cause a frozen shoulder[12,13].

The Intervention of Glenohumeral Joint Mobilization was proven to be Effective in Increasing ROM and Reducing Disability in Frozen Shoulder

The Paired sample t-test in Group 1 showed that the mean ROM abduction and external rotation before the intervention were 86.92 ± 4.461, 29.92 ± 3.988, and the mean after the intervention was 133.08 ± 10.396 and 35.50 ± 5.018 with p = 0.000 (p <0.05) showed significant differences in ROM abduction and external rotation. For disability scores using SPADI before the intervention was 52.67 ± 2.839 and after the intervention was 46.00 ± 5.018 with a value of p = 0.000 (p <0.05) which indicates that there is a significant difference in SPADI score before and also after the intervention. This indicates that the intervention of glenohumeral joint mobilization is proven to be effective in increasing ROM and reducing disability in frozen shoulder cases.

Studies proving the effectiveness of joint mobilization in cases of frozen shoulder[14,15].The reduction in pain after joint mobilization has been attributed to various mechanisms, such as the neurophysiological effects achieved by stimulation of type II mechanoreceptors and by inhibition of type IV nociceptors, stimulation of Golgi tendon organ activity, and inhibition of reflex muscles at the end of passive joint mobilization. Joint mobilization decreases muscle activity, reduces concentric activation of muscles, pain, and muscle tension in peri-articular tissue[16].

Johnson, et al (2007) through their research on the effects of mobilization anterior and posterior glide on the range of motion of external rotation in the case of adhesive capsulitis described some of the effects of mobilization glenohumeral and its relationship in increasing the range of motion of the joints, among others, glenohumeral mobilization techniques can improve arthrokinematics of the shoulder joint that experience limitations in the case of adhesive capsulitis[14].The occurrence of an inflammatory process in the joint capsule in cases of the frozen shoulder causes obstruction of the arthrokinematics movement of the shoulder joint, which is an essential process that occurs during the shoulder osteokinematics movement [6,14].Mobilization of the joint glenohumeral through distraction and translation processes are known to improve the missing arthrokinematics in cases of its frozen shoulder [14,16].

Chen (2012) strengthens the results of this study, where Chen (2012) describes the effectiveness of passive joint mobilization in shoulder dysfunction. In his study, it was shown that mobilization of the joint glenohumeral through its mechanism produced significant results in cases of dysfunction shoulder measured using SPADI [15].

However, the results of this study were different from research conducted by Yiasemides, et al (2011) which investigated the efficacy of shoulder joint mobilization in individuals with limited motion of the shoulder joints. Participants were randomly allocated to an experimental group where they received passive mobilization of the shoulder joint area with exercise and education, as well as to a control group where they received exercise and education only. The outcome measures showed similar results between the intervention group and the control group followed at baseline and repeated at 3 and 6 months[17].

These results indicate that the addition of passive joint mobilization of the shoulder region accompanied by training and education is no more effective than training and education alone in reducing pain and range of motion and improving function without significant differences in any of the outcome measures between the 2 groups on measurements in a short period, medium, or long term[17].

Additional Scapulothoracic Joint Mobilization Interventions has been shown to be Effective in Increasing ROM and Reducing Disabilities in Frozen Shoulder

Paired sample t-test in Group 2, the mean ROM abduction and external rotation before the intervention were 87.17 ± 4.726, 29.67 ± 4.030, and the mean after the intervention was 151.75 ± 7.990 and 51.00 ± 5.045 with p = 0.000 (p <0.05) showed a significant difference in ROM abduction and external

rotation. For disability scores using SPADI, the mean before the intervention was 52.67 ± 2.839 and also after the intervention was 30.08 ± 3.777 with a value of p = 0.000 (p <0.05) which indicates that there is a significant difference in SPADI scores before and after the intervention. This indicates that the addition of interventions is scapulothoracic joint mobilization proven to be effective in increasing ROM and reducing disability in cases of frozen shoulder.

These results are supported by predecessor studies from Surenkok, et al (2009). The studies suggest that mobilization at the scapulothoracic joint has been shown to be an effective intervention to improve shoulder mobility in patients with adhesive capsulitis.[18] The associated study used interventional joint procedures for mobilization of the scapulothoracic joint, superior and caudal gliding, upward and downward rotation, and techniques of distraction of the scapula against the cage of the thoracic with the patient lying on the unaffected side. Surenkok, et al also stated that the increased scapula movement was due to disintegration and release of adhesions in the scapulothoracic muscles induced by scapula mobilization. This increased scapular movement can be a mechanism for increasing shoulder movement in a frozen shoulder [18].

The results of this study are also supported by Boruah et al (2015) on 25 samples who experienced adhesive capsulitis which stated that scapular mobilization was proven to be effective in increasing active ROM and reducing disability as measured by SPADI during 3 weeks of intervention [19]. However, in this study, scapular mobilization was stated to be no more effective when compared to mobilization with movement (MWM) using the Mulligan technique. Increased ROM is accompanied by decreased disability due to reduced adhesion scapula to the thoracic cage which is common in cases of adhesive capsulitis [19].

Debnath, et al (2016), through their research to determine the effectiveness of scapula mobilization on adhesive capsulitis in 30 patients who were intervened for 4 weeks, found that there were significant differences in results in the scapula mobilization group compared to the standard care group assessed through ROM parameters using a goniometer and disability measured using SPADI [20].The mobilization techniques used include superior and inferior glide, upward rotation and downward rotation, and scapular distraction. Scapular mobilization is used to increase active and passive abduction. Although glenohumeral abduction depends on the upward or lateral rotation of the scapular. Scapular protraction and medial rotation mobilization help to normalize the upward rotation and downward rotation of the scapula which leads to normalizing the scapulohumeral rhythm [20].

Glenohumeral Joint Mobilization Intervention accompanied by Additional Scapulothoracic Joint Mobilization Interventions are More Effective in Increasing ROM and Reducing Disability in Frozen Shoulder compared to Glenohumeral Joint Mobilization Interventions

The results of the independent t-test comparing ROM values and SPADI scores in the two groups showed that the difference between ROM abduction and external rotation in Group 1 were 46,167 ± 8,021 (Abd) and 5,583 ± 1,832 (ER) and the increase in Group 2 were 64.58 ± 8,361 (Abd) and 21.33 ± 1,923 (ER) with both values p = 0.000 (p < 0.05) which showed a significant difference between Group 1 and Group 2 in terms of ROM improvement. For the reduction of disabilities, the difference between Group 1 was 6,667 ± 2,570 and Group 2 was 22.58 ± 2,644. This suggests that the addition of scapulothoracic joint mobilization interventions is more effective than glenohumeral joint mobilization interventions alone in increasing ROM abduction, external rotation, and reducing disability in cases of frozen shoulder.

According to a study by Sreenivasu, et al (2016) which shows the benefits of scapula mobilization in the case of adhesive capsulitis. They explained that the disruption of the scapulohumeral rhythm in individuals with frozen shoulders is one of the obstacles for these individuals to be able to carry out functional activities such as lifting their arms and reaching for something. Through the mobilization of the scapulothoracic joint combined with the mobilization of the glenohumeral joint, it is able to normalize the dysfunction that occurs in the scapulohumeral rhythm so that it can achieve maximum functional movement in the arms assessed using SPADI [21].

A study conducted by Debnath, et al stated the effectiveness of scapula mobilization compared to standard mobilization in cases of frozen shoulder. It has been suggested that mobilization of the scapula

towards protraction and medial rotation can help normalize and reduce compensatory movements of the scapula towards upward rotation during glenohumeral abduction motion. This reduction in compensation can help improve the ratio of humerus and scapula movements that occur during arm elevation, thereby preventing reverse scapulohumeral rhythms [20].

To increase external rotational movements that are active and passive in incases of frozen shoulder, the scapulothoracic joint mobilization interventions that we use are scapular retraction mobilization and scapular protraction mobilization. The reason for giving this technique is that the reduction in scapular protraction in individuals with adhesive capsulitis during the elevation of the arm in the frontal plane can also be a reason for compensating for the severe limitations in the external motion of shoulder rotation [20].

Scapulothoracic joint mobilization was carried out according to the grade of mobilization given by Maitland, namely grade III and IV which consisted of rhythmic oscillatory movements. This movement results in tissue stretching which can sensitize stretch-induced pain and also causes rearrangement of connective tissue, extracellular matrix, and collagen tissue, resulting in tissue remodeling which increases the tissue's ability to accept loads tensile, and as a result, active shoulder ROM and passivity (flexion, extension, abduction, external rotation) increased as well as SPADI scores significantly decreased in the group that received scapulothoracic joint mobilization than in the control group.

The results of this study are in line with the theory by Neumann in his book that the movement of the shoulder consists of six basic kinematic components consisting of scapulohumeral rhythm, sternoclavicular and acromioclavicular movement, posterior tilting movements of the scapula, rotational movement of the clavicula towards the posterior, and the movement of the humerus toward external rotation naturally. This six basic kinematics are essential during arm elevation with the full range of motion. According to Neumann, it was stated that the limitation in one of the kinematic components would interfere with the overall arm elevation movement [5].The addition of Scapulothoracic joint mobilization in frozen shoulder was able to improve the basic kinematic of shoulder movement more than when compared to mobilization at the glenohumeral joint alone.

Based on the promising result, the implications of this study are to give the health profession especially physiotherapist for a better option to provide more effective, relatively easy, and safe intervention to target patients experiencing frozen shoulder primarily in improving the range of motion and functional ability for the shoulder. This harmless treatment combination can indirectly reduce the excessive costs incurred for medical treatment.

Despite the significant result, there are several limitations found in this study. First, the number of samples were still relatively small for a RCT so the results cannot be generalized properly to the population. Second, there were several variables that have an impact to the result but cannot be controlled such as physical activity, lifestyle, habit, and sample compliance in following the physiotherapy intervention schedule. Third. this study did not use a control group that did not receive any intervention therefore, researchers have not been able to measure the effect of the standard interventions given to the two groups. Fourth, due to the limited number of measurements taken, the results of this study have not been able to describe the improvement of the outcome variables after each session thus it is unknown whether these two interventions can provide short-term effects. And the last, there was no continuous follow-up on the sample after the end of treatment so it is unable to explain the long-term effect of the treatments.

CONCLUSIONS AND SUGGESTIONS

Conclusion

It can be concluded that the two interventions significantly increase the value of ROM measurement and functional ability in individuals with a frozen shoulder. However, when compared to each other, there is a significant difference where the addition of scapulothoracic joint mobilization increases the range of motion and functional ability more when compared to interventions glenohumeral joint mobilization alone.

Suggestions

Both intervention glenohumeral joint mobilization and the addition of scapulothoracic joint mobilization can be an option in the management of physiotherapy in patients with frozen shoulders, especially in increasing the range of motion and reducing disability in the shoulder joint. For development and generalization, it is necessary to conduct research with a larger number of samples and comparisons with other interventions that are also effective in cases of frozen shoulder. This intervention can also be studied for success in other cases in the shoulder region.

CONFLICT OF INTEREST

There is no conflict of interest

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