

## Effects of Exercise Program on Subacromial Space and Functional Disability in Patients with Subacromial Impingement Syndrome

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**Abstract— Background:** Subacromial impingement syndrome is an infringement of rotator cuff subacromial tissues, bursa, and the tendon of long head of the biceps due to decline of the subacromial space. Actions demanding a frequent or continued usage of the arms overhead regularly influence the tendon of rotator cuff muscles. **Objectives:** To examine the effect of exercises program on subacromial space in patients with subacromial impingement syndrome. **Materials and Methods:** A pilot clinical study was conducted on 15 patients suffering from Subacromial impingement syndrome. They received exercises program (stretching posterior shoulder capsule, strengthening exercises and mobilization exercises for shoulder joint) three times a week, for 4 successive weeks. Patients were assessed before and after treatment for shoulder functional disability and shoulder subacromial space in adduction and abduction using ultrasonography (US). **Results:** All patients showed significant improvement in shoulder functional disability and shoulder subacromial space in adduction and abduction ( $p < 0.001$ ). **Conclusion:** Exercises program is effective in improvement of shoulder functional disability and shoulder subacromial space in adduction and abduction.

**Keywords-** Subacromial Impingement Syndrome, Exercises Program, subacromial space.

### 1. INTRODUCTION

Subacromial impingement syndrome (SIS) is an infringement of rotator cuff subacromial tissues, bursa, and the tendon of long head of the biceps due to decline of the subacromial space. It is considered as one of the main reasons of shoulder pain that resulting in functional disabilities and disturbed quality of life (1).

Subacromial space comprises the inferior surface of the acromial bone, superior part of humeral bone, roof of the glenohumeral joint, and acromioclavicular joint. It covers rotator cuff tendons, (subscapularis, teres minor, infraspinatus, and supraspinatus), the acromial/subdeltoid bursa, and the long head of the biceps. From 9 to 10 mm is the space height in healthy shoulder, whereby  $< 6$  mm in the radiographic measurement is identified as pathologic sign for rotator cuff compression. From 5 to 6 mm is the definite breadth of the rotator cuff tendon, parting identical slight clearance in conditions of enlarged tendon or bursa or gliding surface irregularities (2).

Rotator cuff syndrome or (SIS) of the shoulder is a common disorder. The cumulative incidence of shoulder complaints in general practice is estimated to be 11.2/1000 patients per year, the impingement being the most frequent recorded disorder (3). It is the most common disorder of the shoulder accounting for 44-65% of all complaints of shoulder pain. The disorder ranges from inflammation to degeneration of rotator cuff tendons and causes functional loss and disability (4). The cost of the care for this disorder is

variable because several treatment options are available, the selection of an effective treatment regimen is difficult, because of multifactorial causes of impingement syndrome (5).

Activities requiring repetitive or sustained use of the arms over head often predispose the rotator cuff tendon to injury. There are two reasons for this biomechanical trauma, these are mechanical impingement of the subacromial structures against the anterior acromion and coracoacromial ligament when the arm is lifted over head especially in abduction and flexion with the arm internally rotated, and hypovascularity of the rotator cuff tendons in this region (6).

Physical therapy modalities are often the first line of management for the shoulder pain (7). Conservative management of individuals with impingement indicators usually comprises therapeutic exercise programs intend to restore normal kinematics and muscular control of scapula (3). There are a lot of studies which investigated the effect of exercises on shoulder impingement syndrome (5, 8, 9) reported that rotational strength assessment in healthy and impinged shoulders showed that there is a great role of rotator cuff strengthening to reduce humeral head depressor weakness.

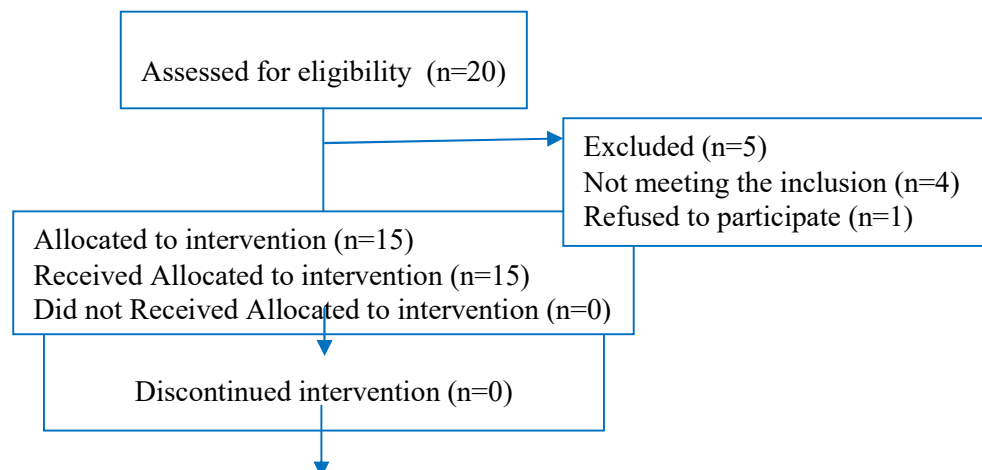
Hjelm et al. (9) concluded that there is a deficiency of the anterior inferior capsular in tender shoulders, that capsular stretching exercise considered to reduce capsular tautness have a role in the treatment of painful shoulder. Michener et al. (5) concluded that therapeutic exercises, laser intervention, and mobilization are beneficial physiotherapy modalities for pain control and reducing functional disabilities in individuals experiencing shoulder impingement syndrome. The study was proposed to examine the effects of exercises program on subacromial space in patients with subacromial impingement syndrome.

## 2. MATERIALS AND METHODS

This pilot clinical study was conducted at the outpatient clinic of physical therapy, King Khaled Hospital, Al-Kharj to examine the effect of exercises program on subacromial space and functional disability in patients with subacromial impingement syndrome. The study was ethically approved by the local Ethics Committee of the Physical Therapy Department at Prince Sattam bin Abdulaziz University (RHPT/019/054).

### 2.1. Subjects

Participants were identified and recruited over 10-month period between February and December 2019. Twenty patients diagnosed clinically with subacromial impingement syndrome (according to location of trigger points at rotator cuff muscles and aggravation of pain with over head activities) were assessed for eligibility to be included in the study (Figure 1).



## 2.1.1. Inclusion criteria

Analyzed (n=15)

Patients were included in the study if they reported a positive "Neer sign" and "Hawkins sign", testified pain with actively elevating shoulder in the scapular level (eg: welders, plate workers, slaughterhouse workers and overhead playing athletes), testified pain during rotator cuff palpation, and suffered from pain during isometric resistance for shoulder abductors.

## 2.1.2. Exclusion criteria

Frozen shoulder, rotator cuff tear, glenohumeral or acromioclavicular arthritis, implanted pace maker, and pregnancy were excluded from the study.

The experiment was fulfilled with 15 patients (9 female and 6 male), their age ranges from 30 to 50 years signed an informed consent. They received exercises program (stretching posterior shoulder capsule, joint mobilization, and strengthening exercise for shoulder joint) thrice a week, meant for 4 successive weeks.

## 2.2. Assessment procedures

The shoulder pain and disability index (SPADI) was consumed to assess pain and functional disability. It is a valid and reliable tool for determining pain and disability of the shoulder joint. It comprises pain and functional disability domains. All questions of the pain scores were calculated, and thereby the mean was determined. Also, All questions of the functional disability scores were calculated and the mean was determined for including in the statistical analysis. The total score of each domain was analyzed distinctly (10).

The US assessment of the subacromial space was performed by employing the US head on the shoulder joint laterally on the longitudinal humeral alignment. US assessment of the subacromial space was known as the peripheral space between the acromial edge and the head of humerus. The evaluation found consequently characterizes the acromiohumeral space at the subacromial inlet. The acromiohumeral space was assessed with sitting position (neutral shoulder rotation, 0-45 degrees arm abduction, 60 degrees elbow flexion, and hand pronation) to eliminate undesired shoulder internal rotation (11).

## 2.3. Treatment procedures

Exercises program was conducted 12 sessions, 3 session/week, consisted of stretching, strengthening, and mobilization exercises. Stretching exercises were performed for shoulder capsule posteriorly and neighboring muscles, thrice a session with 30 sec maintaining and 10 sec rest in between (3).

The strengthening exercises consists of six-strengthening trainings all of which were suggested as necessary for shoulder rehabilitation programs. These exercises included shoulder flexion, scaption, rowing, and horizontal extension for each, a repetition maximum (RM) of 10 was detected. The RM was determined depending on the observation of the therapist for the quality of the motion and patients' response regarding pain and fatigability. Worsening in the quality of the motion or pain beyond a

minor distress was sidestepped throughout resistance exercise by either eliminating resistance level or adjusting the range of motion until the patient was competent to develop. Each training was completed as 3 sets of 10 rep., with a 60-sec rest in between. The last 2 exercises included elbow pushing-up and seated pressing-up. Both exercises were continued until tiredness or for a 25 rep. maximally. All repetitions of the exercise were constantly checked by the therapist (3).

Patients were received grade (III and IV) caudal and dorsal gliding mobilization of Maitland technique for the shoulder. The caudal mobilization technique was performed twice to quartile, with 30-sec holding and 10-sec rest. The dorsal mobilization technique was done with the glenohumeral joint abducted 90 degrees in the scapular plane and force performed in the posterolateral movement (12-14).

#### 2.4. Statistical analysis

Data obtained from the study was coded and entered using SPSS (V.19, Armonk, NY: IBM Corp.). Descriptive statistics for demographic data and all outcome measures were expressed as mean and standard deviation. Comparisons within group were conducted using paired *t*-test. However,  $p$ -value  $< 0.05$  was statistically significant.

### 3. RESULTS

A total of 15 patients (9 females and 6 males) with mean age of  $36.26 \pm 6.54$  years and mean duration of illness of  $1.96 \pm 0.69$  months participated in this study.

Paired *t*-test was used to determine the differences within group of the exercise program after treatment. There was significant difference regarding functional disability ( $t = 24.57$ ,  $p < 0.001$ ), subacromial space in adduction ( $t = -6.65$ ,  $p < 0.001$ ) and subacromial space in abduction ( $t = -8.87$ ,  $p < 0.001$ ) as shown in Table 1.

**Table 1. Within group difference of exercises program after treatment**

Measures	Pre-treatment	Post-treatment	<i>t</i> -value	<i>p</i> -value
Functional disability	$76.16 \pm 10.47$	$8.91 \pm 2.05$	24.57	$< 0.001$
Subacromial space in adduction	$6.74 \pm 1.05$	$8.64 \pm 0.89$	-6.65	$< 0.001$
Subacromial space in abduction	$5.22 \pm 1.13$	$7.49 \pm 1.13$	-8.87	$< 0.001$

All data are presented as mean  $\pm$  standard deviation, significance level at  $p$ -value  $< 0.05$ .

### 4. DISCUSSION

Subacromial impingement syndrome is identified as one of the commonest shoulder dysfunction due to mechanical firmness of the subacromial tissue and rotator cuff under the coracoacromial arch. Recurrent or continued overhead use of the arm in particular works or sports activities.

All patients had indicators of subacromial impingement syndrome, this agrees with Koster et al., 2005 who reported that patients with subacromial impingement syndrome report pain restricted to the antrolateral acromion and regularly releases to the lateral mid humerus, individuals frequently suffer from pain at night, aggravated by lying on the affected shoulder or overhead activity (15). From the finding of the current study the exercise program is effective in improvement of shoulder functional disability and shoulder subacromial space in adduction and abduction.

Regarding functional disabilities, there were significant reductions in functional disabilities. This finding has been supported by Senbursa et al., 2007 who concluded that manual physical therapy applied by experienced physical therapist combined with supervised exercises might be improved and former than exercises alone for improving muscle strength, declining pain, and restoring function in individuals experiencing impingement syndrome (16).

Michener et al., 2004 found by a systemic review that exercises and joint mobilization was effective for reducing pain and restoring functions for individuals suffering from impingement syndrome. These results supported the use of therapeutic exercises and mobilization in treating shoulder impingement syndrome patients (5).

Sauers, 2005 concluded that control exercises, laser therapy and mobilization exercise are effective physiotherapy modalities for pain relief and controlling functional disability in patients experiencing shoulder impingement syndrome (17). The improvement of functional ability of (SIS) patients also, due to improvement of muscle strength this has been supported by Leroux et al., 1994 reported that isokinetic assessment of rotation strength in healthy and impinged shoulders showed that there is a great role of rotator cuff strengthening to reduce humeral head depressor weakness (8).

The range of motion improvement after therapeutic exercise cause improvement of shoulder function. Mobilization exercise is known to be a beneficial interventional modality for improving range of motion in the patients with subacromial impingement (12).

There was a statistical improvement in subacromial space between pre and post results using ultrasonography during shoulder adduction and shoulder abduction at the end of treatment. Ultrasonography as a non-invasive investigativemethod of the shoulder soft parts that was familiarized in 1980s. Subsequently, numerous researches of skilled radiological investigators have revealed a great kindness and speciality for demonstrating the rotator cuff tears, rupture, and dislocated long head of the biceps brachii (18). Ultrasonography as well as magnetic resonance imaging (MRI) has a high precision for recognizing rotator cuff tear and biceps problems. The imaging test selection to be applied is depending on the clinical information of the patients (glenoid labrum, muscle, bone, or joint capsule lesions), experiencing, cost of the radiological procedures (19).

Farin et al., 1990 consuming a portable US, defined bursitis, liquid distentions and combining of liquid lateral to the subdeltoid bursa as a sign of earlier impinged shoulder. They found extensive range of abnormality can be observed on a portable US in the presence of subacromial impingement (20). Bureau et al., 2006 reported that portable US permit shortest conception of the associations between the humeral head and acromion overriding soft tissue throughout dynamic shoulder movement and may deliver valuable effects concerning possible intrinsic and extrinsic reasons of impinged shoulder (21).

Recently, the shoulder US has added growing reputation with the progression of qualitative instruments, respectation of US anatomy, and explanation of investigation procedure. US is a less cost, more prompt, and more favorable for the patients than MRI and also is truthful as well as MRI in detecting the rotator cuff tear. US typically is engaged in impinged shoulder to display the tear of the rotator cuff. US may deliver a tributary indication of tendinitis or impinged rotator cuff tendon, condensed subacromial

deltoid bursa, coracoacromial ligament swelling, or acromion hyperostosis. Impingement characteristics on active movement assessment involve supraspinatus tendon or subdeltoid bursa compression. The ultrasound measure of the acromiohumeral space is sensitive and reliable. While a distinctive variation of acromiohumeral space is patients with SIS might not be endorsed, a highly positive correlation was presented between the increase of the acromiohumeral space and the improvement of functional performance in individuals suffering from impinged shoulder after rehabilitation program (22).

The assessment of the acromiohumeral space using US was performed through employing the US head on the shoulder joint laterally on the longitudinal humeral alignment. US assessment of the subacromial space was known as the peripheral space between the acromial edge and the head of humerus. The evaluation found consequently characterizes the acromiohumeral space at the subacromial inlet. The acromiohumeral space was assessed with sitting position (neutral shoulder rotation, 0-45 degrees arm abduction, 60 degrees elbow flexion, and hand pronation) to eliminate undesired shoulder internal rotation (11).

In shoulder subacromial impingement syndrome patients as a result of failed cuff or inhibiting pain, depressed humeral head by the rotator cuff muscles is thought to be inadequate to frustrate the action of the deltoid muscle, resulting in extreme superior displacement of the head of the humerus and extreme narrowing of the acromiohumeral space (23). This supports the use of strengthening exercises of the rotator cuff in treating patients with impinged shoulder. Therefore helping to increase the acromiohumeral space and improving the patient's symptoms. The clinical intervention with the symptoms of the impingement syndrome regularly involves strengthening exercise for the rotator cuff muscles and stretching exercise for the posterior joint capsule to promote normal transition of the humeral head (4).

Superior humeral head conversion in the initial degree of abduction, probably related to the action of the deltoid muscle, leading to decrease of the acromiohumeral space (24). The significant clinical improvement in Shoulder functional disability in both groups may be due to the using of stretching exercises of the posterior shoulder capsule which increase the subacromial space because tight posterior shoulder capsule holds the humeral head higher than the normal level (25) and due to using of strengthening exercise (for rotator cuff muscles, deltoid...etc) because weakness of these muscles disturb the normal shoulder mechanics and functions (26).

Conroy and Hayes, 1998 stated that mobilization exercise efficiently stretched the inferior and posterior portions of the capsule to such a degree that, as the movement reduced the acromiohumeral space, the greater extensible capsule of the experimented patients provided greater opposite gliding movement, leading to reducing subacromial pain and pressure. This means that joint mobilization leads to an increase of the acromiohumeral space which leads to reduction of pain and an improvement of functional disability (12). Mobilization and therapeutic exercises help to increase the acromiohumeral space by improving rotator cuff strength and posterior capsule tightness mobility to improve the shoulder impingement syndrome patient's symptoms (27). The improvement of subacromial space may be result from positive effect of strengthening the rotator cuff muscle in reducing superior humeral head conversion and improving posterior capsule flexibility by interventional exercise program.

This limitations of the current pilot study were; the small sample size that affect the generalizability of the the study findings and could not represent other patients with impinged shoulder. One more limitation, no long-term follow-up assessment was performed after completing the study program.

## 5. CONCLUSIONS

In accordance with the results of the current pilot study, the exercise program is effective in improvement of shoulder functional disability and shoulder subacromial space in adduction and abduction in patients with subacromial impingement syndrome. Future randomized clinical studies with larger sample and long-term follow up assessment are recommended to assess different type and intensities of inerventional exercise programs.

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