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Effectiveness of Scapular Stabilization Exercise and Eccentric Rotator Cuff Exercise Along with Stretching Among Competitive Swimmers with Subacromial Impingement Syndrome

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Abstract

Background: Subacromial impingement syndrome is a common cause of shoulder pain in swimmers and is associated with repetitive overhead activity, rotator cuff loading, altered scapular mechanics, pain, restricted shoulder movement, and reduced function. Objective: To compare the effectiveness of scapular stabilization exercise with shoulder girdle stretching and eccentric rotator cuff exercise with shoulder girdle stretching in competitive swimmers with subacromial impingement syndrome. Methods: Sixty competitive swimmers aged 18–30 years with clinically diagnosed subacromial impingement syndrome were included and randomly allocated to two groups of 30 participants each. Group A received scapular stabilization exercises with stretching, whereas Group B received eccentric rotator cuff exercises with stretching. Both groups were treated for 50 minutes per session, five days per week, for six weeks. Outcomes were assessed before and after treatment using the Numerical Pain Rating Scale (NPRS), Shoulder Pain and Disability Index (SPADI), and goniometric shoulder range of motion. Results: Both groups showed improvement after six weeks. In Group A, NPRS decreased from 7.90 to 2.07 and SPADI from 71.40 to 47.67. Shoulder flexion increased from 138.87° to 173.53°, abduction from 130.87° to 171.53°, internal rotation from 50.53° to 68.13°, and external rotation from 58.53° to 86.13°. In Group B, NPRS decreased from 8.00 to 3.23 and SPADI from 72.23 to 58.36. Shoulder flexion increased from 138.60° to 167.87°, abduction from 130.60° to 165.87°, internal rotation from 50.40° to 64.93°, and external rotation from 58.40° to 80.93°. Statistically significant pre–post improvements were reported in both groups, with greater mean improvement in Group A. Conclusion: Scapular stabilization exercise combined with shoulder girdle stretching produced greater improvement in pain, disability, and shoulder range of motion than eccentric rotator cuff exercise combined with stretching in competitive swimmers with subacromial impingement syndrome.

Keywords: Subacromial impingement syndrome; scapular stabilization exercise; eccentric rotator cuff exercise; competitive swimmers; shoulder pain; SPADI; NPRS.

1. Introduction

Shoulder pain is a frequent musculoskeletal complaint and is particularly relevant in athletes who repeatedly perform overhead movements. Subacromial impingement syndrome (SAIS) encompasses a group of painful conditions involving the structures within the subacromial space, including the rotator cuff tendons and subacromial bursa [1,2]. Clinically, affected individuals commonly report pain during arm elevation and overhead activity, and symptoms may interfere with both athletic performance and activities of daily living. The anatomical relationship of the subacromial structures is shown in Figure 1.

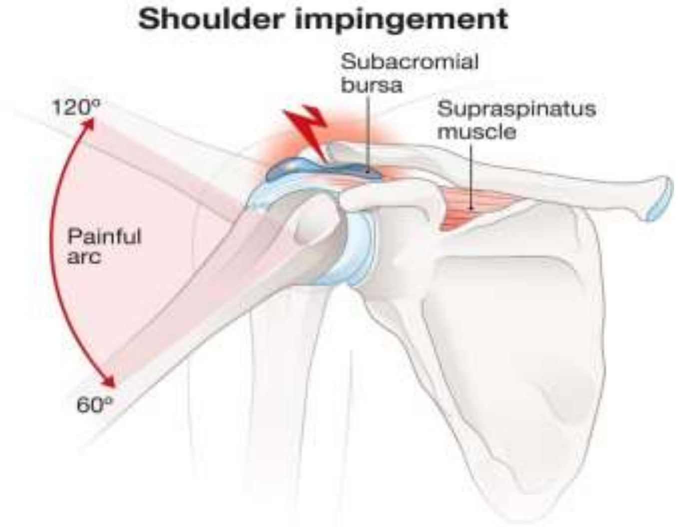

Fig 1: Subacromial space and structures involved in shoulder impingement.

Competitive swimmers are exposed to a particularly high volume of repetitive shoulder motion. Training may involve approximately 10,000–14,000 m of swimming per day on six or seven days each week, resulting in thousands of shoulder revolutions with limited recovery time [3,4]. This repetitive loading can produce cumulative microtrauma and is one reason shoulder pain is common in swimming. A cross-sectional study among Egyptian swimmers reported a prevalence of subacromial impingement of 37.3%, while earlier sports-medicine reports have described shoulder problems in approximately 40%–60% of swimmers, particularly in freestyle, butterfly, and backstroke events [5,6].

The development of SAIS is multifactorial. Structural narrowing of the subacromial space may contribute to primary impingement, whereas secondary impingement may arise from altered humeral head control, muscular imbalance, scapular dyskinesis, and disturbed scapulohumeral rhythm [7–9]. Scapular position and movement are therefore important components of shoulder function, especially in overhead athletes. Changes in scapular kinematics can alter the relationship between the humeral head, rotator cuff, and subacromial structures and may contribute to pain and functional limitation [7,8].

Conservative rehabilitation is commonly recommended as an initial approach for SAIS [10]. Scapular stabilization exercises aim to improve the strength, endurance, and neuromuscular control of the serratus anterior, trapezius, rhomboids, and other muscles that contribute to dynamic scapular control. Previous studies have reported improvements in pain, posture, shoulder mobility, scapular kinematics, and functional status following scapular-focused rehabilitation [11,17–20].

Stretching is also relevant in swimmers because anterior shoulder tightness, posterior shoulder tightness, and muscle imbalance can contribute to altered posture and shoulder mechanics. Stretching of the posterior capsule and pectoral region has been associated with improved flexibility, reduced pain, and improved shoulder mobility [12,13,23]. Eccentric strengthening is another commonly used rehabilitation strategy. During eccentric exercise, the musculotendinous unit lengthens under load, providing a controlled mechanical stimulus that may improve strength, tendon load tolerance, and function. Eccentric rotator cuff programmes have shown beneficial effects in patients with subacromial pain and rotator cuff tendinopathy [14,15,21,22].

Although both scapular stabilization and eccentric rotator cuff training have been used in the management of shoulder impingement, direct comparison of these approaches when combined with the same shoulder stretching programme is limited, particularly in competitive swimmers. The present study therefore compared scapular stabilization exercise with shoulder girdle stretching against eccentric rotator cuff exercise with shoulder girdle stretching in competitive swimmers with SAIS. It was hypothesized that there would be a difference between the two treatment approaches in pain, disability, and shoulder range of motion.

2. Materials and Methods

2.1 Study Design and Setting

This experimental comparative study was conducted in the Department of Physiotherapy, Mohamed Sathak A.J. College of Physiotherapy, Nungambakkam, Chennai. Participants were recruited from the outpatient department. Individuals clinically diagnosed with subacromial impingement syndrome were screened for eligibility, informed about the study procedures, and enrolled after providing consent.

2.2 Participants and Group Allocation

A total of 60 participants were included. Eligible participants were competitive swimmers aged 18–30 years, of either sex, with unilateral shoulder pain, pain during overhead activity, a positive Neer test, and a positive Hawkins–Kennedy test. Participants were excluded if they had a rotator cuff tear, shoulder instability, previous shoulder surgery, fracture or dislocation around the shoulder, cervical radiculopathy, neurological disorders, or a steroid injection during the previous six months.

Participants were randomly assigned in a 1:1 ratio to Group A or Group B, with 30 participants in each group. Group A received scapular stabilization exercises together with shoulder girdle stretching. Group B received eccentric rotator cuff exercises together with the same shoulder girdle stretching protocol.

2.3 Outcome Measures

Pain intensity was assessed using the 11-point Numerical Pain Rating Scale (NPRS), a practical measure of clinical pain intensity [24]. The Shoulder Pain and Disability Index (SPADI) was used to assess shoulder-related pain and disability; the instrument contains 13 items divided into pain and disability domains [25,26]. Shoulder range of motion was measured using a goniometer. Flexion, abduction, internal rotation, and external rotation were recorded before and after the intervention. Goniometric assessment is widely used for the clinical measurement of shoulder range of motion [27].

Materials used during assessment and intervention included a couch, pillow, towel, resistance tube, notepad and pen, stopwatch, goniometer, and dumbbell. The principal materials are shown in Figure 2.

A. Towel

B. Couch

C. Resistance tube

D. Pillow

E. Notepad and pen

F. Stopwatch

G. Dumbbell

H. Goniometer

Fig 2: Materials used in the study: (A) towel, (B) couch, (C) resistance tube, (D) pillow, (E) notepad and pen, (F) stopwatch, (G) dumbbell, and (H) goniometer.

2.4 Intervention Protocol

Both groups received treatment for 50 minutes per session, one session per day, five days per week, for six weeks, giving a total of 30 treatment sessions.

Group A: Scapular Stabilization Exercise with Stretching

Push-up plus. The participant assumed a high-plank position with the hands shoulder-width apart, elbows extended, and the body aligned from head to heels. After completing the push-up phase, the participant actively protracted the scapulae at the top of the movement while keeping the elbows extended. Scapular protraction was held for 2 seconds. Three sets of 15 repetitions were performed with 30 seconds of rest between sets.

Dynamic hug. In standing, a resistance tube was secured behind the body at shoulder level. With the shoulders abducted approximately 60°–90° and the elbows slightly flexed, the participant moved both arms forward in a hugging motion while protracting the scapulae. The end position was held for 2 seconds, followed by a slow 3-second return. Three sets of 15 repetitions were performed with 30 seconds of rest.

Prone Y. The participant lay prone with the involved arm positioned at approximately 120°–135° of abduction and the thumb pointing upward. After gently retracting and depressing the scapula, the arm was raised until level with the trunk. The position was held for 2 seconds and the arm was lowered slowly over approximately 3 seconds. Three sets of 15 repetitions were completed with 30 seconds of rest.

Prone T. The participant lay prone with the shoulder abducted to 90°, the elbow extended, and the thumb pointing upward. The scapula was gently retracted and depressed before the arm was raised to trunk level. A 2-second hold was followed by a controlled 3-second lowering phase. Three sets of 15 repetitions were performed with 30 seconds of rest.

Group B: Eccentric Rotator Cuff Exercise with Stretching

Eccentric external rotation. The participant lay on the uninvolved side with the involved shoulder adducted and the elbow flexed to 90°. The shoulder was moved to the maximum comfortable external rotation with assistance from the uninvolved hand. The participant then slowly lowered the forearm toward internal rotation over 3–5 seconds against the resistance of a dumbbell or resistance band. A 2-second hold was used at the end range before the eccentric return. Three sets of 15 repetitions were performed with 30 seconds of rest.

Eccentric scaption. In standing, the shoulder was elevated in the scapular plane, approximately 30° anterior to the frontal plane, with the thumb pointing upward. The involved arm was assisted to approximately 90° of elevation and then slowly lowered over 3–5 seconds against resistance. A 2-second hold was maintained at 90° before lowering. Three sets of 15 repetitions were performed with 30 seconds of rest.

Full-can eccentric lowering. The participant stood holding a dumbbell in the involved hand, with the shoulder positioned in the scapular plane and the thumb pointing upward. The arm was assisted to approximately 90° of shoulder elevation and then lowered slowly to the starting position over 3–5 seconds. A 2-second hold was maintained at 90° before lowering. Three sets of 15 repetitions were performed with 30 seconds of rest.

Common Shoulder Girdle Stretching Protocol

Posterior capsule stretch. In standing, the involved shoulder was flexed to 90° with the elbow extended. Using the opposite hand, the participant gently pulled the involved arm across the chest into horizontal adduction until a comfortable posterior shoulder stretch was felt. The scapula was stabilized to limit compensatory movement. The stretch was held for 30 seconds for three repetitions, with 15 seconds of rest between repetitions.

Pectoralis minor stretch. The participant stood at the corner of a wall with the forearms supported on the adjacent walls, the shoulders abducted to approximately 90°, and the elbows flexed to 90°. The trunk was slowly moved forward until a gentle anterior shoulder and chest stretch was felt. The stretch was held for 30 seconds for three repetitions, with 15 seconds of rest.

Levator scapulae stretch. The participant sat upright with the involved arm placed behind the back to stabilize the scapula. The head was rotated approximately 45° away from the involved side and the cervical spine was gently flexed so that the chin moved toward the opposite armpit. Gentle overpressure was applied with the uninvolved hand. The stretch was held for 30 seconds for three repetitions, with 15 seconds of rest.

2.5 Statistical Analysis

Pre-treatment and post-treatment mean values were compared for NPRS, SPADI, and shoulder range of motion, and mean differences were compared between the two intervention groups. The study report described the changes as statistically significant but did not provide the specific inferential test, test statistic, exact p values, standard deviations, or confidence intervals. Accordingly, only the reported means and mean differences are presented.

3. Results

Sixty participants completed the study, with 30 participants in each group. Both treatment groups showed improvement in pain, shoulder disability, and shoulder range of motion after six weeks.

Table 1. Pre- and post-treatment outcomes in Group A (scapular stabilization exercise with stretching).

Outcome	Pre-treatment mean	Post-treatment mean	Mean difference
NPRS	7.90	2.07	5.83
SPADI	71.40	47.67	23.73
Shoulder flexion (°)	138.87	173.53	34.67
Shoulder abduction (°)	130.87	171.53	40.67
Shoulder internal rotation (°)	50.53	68.13	17.60
Shoulder external rotation (°)	58.53	86.13	27.60

In Group A, NPRS decreased from 7.90 before treatment to 2.07 after treatment, corresponding to a mean reduction of 5.83 points. SPADI decreased from 71.40 to 47.67, with a mean difference of 23.73 points. Shoulder flexion increased by 34.67°, abduction by 40.67°, internal rotation by 17.60°, and external rotation by 27.60°.

Table 2. Pre- and post-treatment outcomes in Group B (eccentric rotator cuff exercise with stretching).

Outcome	Pre-treatment mean	Post-treatment mean	Mean difference
NPRS	8.00	3.23	4.77
SPADI	72.23	58.36	13.87
Shoulder flexion (°)	138.60	167.87	29.27
Shoulder abduction (°)	130.60	165.87	35.27
Shoulder internal rotation (°)	50.40	64.93	14.53
Shoulder external rotation (°)	58.40	80.93	22.53

In Group B, NPRS decreased from 8.00 to 3.23, corresponding to a mean reduction of 4.77 points. SPADI decreased from 72.23 to 58.36, with a mean difference of 13.87 points. Shoulder flexion increased by 29.27°, abduction by 35.27°, internal rotation by 14.53°, and external rotation by 22.53°.

Table 3. Comparison of mean changes between Group A and Group B.

Outcome	Group A mean difference	Group B mean difference
NPRS	5.83	4.77
SPADI	23.73	13.87
Shoulder flexion (°)	34.67	29.27
Shoulder abduction (°)	40.67	35.27
Shoulder internal rotation (°)	17.60	14.53
Shoulder external rotation (°)	27.60	22.53

Comparison of the mean changes showed consistently greater improvement in Group A. The reduction in NPRS was 5.83 points in Group A compared with 4.77 points in Group B, while the reduction in SPADI was 23.73 points compared with 13.87 points. Gains in shoulder flexion, abduction, internal rotation, and external rotation were also greater in Group A. These between-group differences were reported as statistically significant.

4. Discussion

The present study compared two exercise-based rehabilitation approaches for competitive swimmers with subacromial impingement syndrome. Both interventions were associated with improvements in pain, shoulder disability, and range of motion after six weeks, but the magnitude of improvement was consistently greater in the group that received scapular stabilization exercises with stretching.

The greater improvement observed with scapular stabilization is clinically plausible because swimming requires coordinated control of the scapula throughout repeated overhead movement. The scapula provides a stable base for humeral motion and contributes to maintenance of the subacromial space during elevation. When scapular control is altered, abnormal movement patterns may increase mechanical stress on the rotator cuff and other subacromial structures. Scapular-focused exercise therefore addresses not only local shoulder strength but also the dynamic control required during swimming [7,16–20].

The reduction in NPRS from 7.90 to 2.07 in Group A was larger than the reduction from 8.00 to 3.23 in Group B. This finding is consistent with the systematic review by Ravichandran et al., which concluded that scapular stabilization exercise programmes can reduce pain and disability in patients with subacromial impingement syndrome [28]. The findings also agree with controlled studies showing that scapular stabilization can improve pain, functional status, scapular kinematics, and shoulder mobility [11,17–20].

Both groups also demonstrated improvement in SPADI scores. The larger reduction in Group A suggests that restoring scapular control may have translated into better tolerance of functional shoulder activities. This interpretation is compatible with the role of the scapula in positioning the glenoid and supporting efficient transfer of force during upper-limb movement. Previous work has shown that strength and control of the serratus anterior and trapezius are relevant to shoulder disability and scapular movement in patients with subacromial pain [20].

Range of motion improved in both groups, with Group A showing greater mean gains in flexion, abduction, internal rotation, and external rotation. The common stretching programme used in both groups may have contributed to these improvements. Stretching of the posterior shoulder and pectoral region can reduce soft-tissue tightness and may improve glenohumeral and scapulothoracic movement [12,13,23]. Salamh et al. reported beneficial acute effects of stretching on posterior shoulder tightness, while McClure et al. found improvement in internal rotation following posterior shoulder stretching [29,30].

The eccentric rotator cuff programme was also effective, as reflected by the reduction in pain and disability and the increase in shoulder motion in Group B. Eccentric loading has been proposed to improve tendon load tolerance and neuromuscular performance, and previous clinical studies have reported improvements in pain, strength, and function following eccentric shoulder training [14,15,21,22]. Chaconas et al. found that an eccentric external rotator programme produced favourable outcomes in patients with subacromial pain syndrome, supporting the use of eccentric strengthening as a component of rehabilitation [21].

The present findings therefore do not suggest that eccentric rotator cuff exercise is ineffective. Rather, when both programmes were combined with the same stretching regimen, scapular stabilization produced a larger mean improvement across the measured outcomes. This may be particularly relevant in competitive swimmers, in whom repetitive overhead activity places substantial demands on scapular control and scapulohumeral coordination.

The use of NPRS, SPADI, and goniometric range of motion provided complementary information on pain, self-reported disability, and physical movement. Previous work has supported the clinical utility of NPRS and SPADI in shoulder pain populations [24–26], while goniometric assessment remains a common method for measuring change in shoulder motion [27,33]. The improvement across all three types of outcome supports a consistent pattern of clinical recovery in both groups.

Some findings from the wider literature also emphasize that shoulder symptoms are influenced by multiple factors. Thoracic and scapular mechanics, pain intensity, functional status, and shoulder motion can all contribute to the clinical presentation of subacromial pain [31,32]. This reinforces the value of a rehabilitation programme that addresses movement control and flexibility in addition to isolated muscle strengthening.

5. Limitations and Recommendations

The study included a relatively small sample and was conducted over a six-week treatment period. It was limited to competitive swimmers with subacromial impingement syndrome, and the findings therefore cannot automatically be generalized to other shoulder disorders or non-swimming populations. The statistical summary did not include the exact inferential procedures, p values, standard deviations, or confidence intervals, which limits detailed interpretation of the statistical strength and precision of the observed differences.

Future studies may include larger samples, longer treatment and follow-up periods, and separate analyses for male and female swimmers. Reporting complete statistical information would also strengthen interpretation and facilitate comparison with other clinical trials.

6. Conclusion

Both scapular stabilization exercise with shoulder girdle stretching and eccentric rotator cuff exercise with shoulder girdle stretching improved pain, shoulder disability, and shoulder range of motion in competitive swimmers with subacromial impingement syndrome. However, the scapular stabilization group demonstrated greater mean improvement in NPRS, SPADI, shoulder flexion, abduction, internal rotation, and external rotation. Within the limitations of the available data, scapular stabilization exercise combined with stretching was the more effective of the two rehabilitation approaches evaluated.

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