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EFFECT OF HANDGRIP STRENGTHENING EXERCISES VERSUS ECCENTRIC TRAINING FOR EXTERNAL ROTATORS OF SHOULDER WHEN ADDED TO CONVENTIONAL PHYSIOTHERAPY ON PAIN, ROTATOR CUFF MUSCLE STRENGTH AND FUNCTION OF SHOULDER IN PATIENTS WITH SUBACROMIAL PAIN SYNDROME -A COMPARATIVE STUDY.

Physiotherapy

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ABSTRACT

Background and Objective: Subacromial Pain Syndrome (SAPS) is among the most frequent causes of shoulder pain, often resulting from rotator cuff dysfunction, muscle imbalance, and altered kinematics. While conventional physiotherapy focuses on concentric strengthening and mobility restoration, newer approaches such as handgrip strengthening and eccentric training target neuromuscular activation through kinetic chain enhancement and tendon remodelling. This study aimed to compare the effects of handgrip strengthening and eccentric training for external rotators, when combined with conventional physiotherapy, on pain, rotator cuff strength, and shoulder function in patients with SAPS. **Methods:** A comparative study was conducted on 46 patients aged 18–65 years diagnosed with SAPS, randomly divided into two groups. Group A received handgrip strengthening exercises with conventional physiotherapy, while Group B received eccentric training for external rotators with conventional physiotherapy. Both groups underwent six weeks of intervention. Pain intensity, rotator cuff muscle strength, and shoulder function were assessed using the Visual Analogue Scale (VAS), Hand-Held Dynamometer (HHD), and Shoulder Pain and Disability Index (SPADI). Statistical analysis was performed using paired and unpaired t-tests ($p<0.05$). **Results:** Both groups showed significant improvements in pain reduction, muscle strength, and shoulder function ($p<0.001$). However, the eccentric training group demonstrated greater enhancement in external rotator strength compared to the handgrip group, although pain and function improved comparably between groups. **Conclusion:** Eccentric training for external rotators produced superior gains in internal rotators strength, while both interventions were equally effective in reducing pain and improving shoulder function. Incorporating eccentric loading within physiotherapy may provide greater strength benefits in SAPS rehabilitation.

KEYWORDS

Subacromial Pain Syndrome, Eccentric Training, Handgrip Strengthening, Shoulder Rehabilitation, Rotator Cuff Strength.

1. INTRODUCTION

Globally, shoulder pain is one of the most common reasons for visiting a primary care or orthopedic clinic. The term "subacromial pain syndrome" (SAPS) refers to any non-traumatic, mostly unilateral shoulder issues that cause discomfort in the area of the acromion and frequently get worse when lifting one arm.[1] Because of this, SAPS includes all disorders related to subacromial structures, including tendon cuff degeneration, biceps tendinopathy, rotator cuff tears, subacromial bursitis, calcific tendonitis, and rotator cuff tendinopathy. Previous studies indicate that individuals with SAPS frequently exhibit reduced shoulder abduction and external rotation strength, altered scapular kinematics, and proprioceptive deficits, all contributing to functional limitations and a diminished quality of life.

Evidence-based physiotherapy in SAPS suggests that 6 to 12 weeks of physiotherapy is beneficial for lowering pain and enhancing function.[6] The primary objectives of an exercise program for the shoulder are pain relief, strength building, healing, and restoring pain-free joint range of motion. Handgrip strengthening exercises have been effective in improving shoulder muscle strength without directly loading the shoulder joint and in enhancing internal and external rotation peak torque. Horsley et al. (2016) reported a high relationship between shoulder lateral rotator strength and handgrip strength, indicating that handgrip assessment may serve as a useful tool for monitoring rotator cuff function. Similarly, Lee and Kim (2016) demonstrated that handgrip training increases internal and external rotation peak torque of the shoulder joint.[8,9] The concept of "proximal stability for distal mobility" supports that a firm grasp indirectly activates and stabilizes the proximal shoulder muscles, enhancing glenohumeral stability.[10,11] Studies evaluating handgrip and arm posture interactions under dynamic and isometric conditions demonstrated that greater coactivation of rotator cuff muscles occurs between 90° and 120° of arm elevation, while middle deltoid activation increases from 0° to 30°, and supraspinatus–infraspinatus coactivation decreases from 30° to 60°.[12–15] External rotation with abduction is most effective position for rotator cuff strengthening; however, progression should begin at 30°, advancing to 60°, then 90°, and finally 90° with external rotation once pain-free.[15]

Eccentric exercise has shown to produce superior outcomes in pain reduction, muscle strength, and tendon remodeling compared to conventional physiotherapy.[16–19] The controlled lengthening contractions stimulate collagen synthesis, improve tendon elasticity, and enhance neuromuscular control. Additionally, eccentric loading modulates both peripheral and central pain pathways, increasing pain tolerance and functional capacity. Eccentric training for external rotators (ETER) thus provides targeted mechanical loading that promotes tendon healing and optimizes muscle-tendon performance. Integrating ETER into rehabilitation offers a focused and effective approach for faster and more resilient recovery in SAPS.[20–22]

The purpose of this study is to compare the effects of handgrip strengthening and eccentric training for external rotators, when combined with conventional physiotherapy, on pain, strength, and function in patients with SAPS.[23,24]

2. METHODOLOGY

2.1. Study Design

This comparative randomized controlled trial was conducted over a period of 12 months on 46 individuals diagnosed with SAPS. Participants were selected using a convenience sampling technique from Physiotherapy Musculoskeletal Outpatient Department of a tertiary care hospital. Random allocation into two groups was performed using the chit method with a non-replacement technique to ensure unbiased distribution. Each group consisted of 23 participants.

2.2. Participants and Recruitments

Ethical approval was obtained from the Institutional Ethics Committee. Participants aged 18 to 65 years with Subacromial Pain Syndrome and a VAS score between 3 and 8 were included. Diagnosis required at least three of the following positive tests as per the Dutch Orthopaedic Association Guidelines: Neer impingement, Hawkins–Kennedy, empty can, resisted external rotation, and painful arc tests.[1] Patients with a positive drop arm test, full-thickness rotator cuff tear, adhesive capsulitis, inflammatory joint disease, malignancy, prior shoulder or neck surgery, cervical radiculopathy, or recent steroid injection (within six months) were excluded.[1] 46 eligible participants were recruited after informed consent and randomly allocated into 2 groups. Both the groups received conventional physiotherapy.

Group A received additional handgrip strengthening, and Group B received additional eccentric training for external rotators for 6 weeks.

2.3. Outcome Measures

VAS was used to determine pain intensity experienced by the participant

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Handheld Dynamometer was used to measure strength of external and internal rotators of shoulder. Patients were seated in neutral position in an armless chair with the arm in 0° of abduction, elbow flexed at 90°, and forearm in mid-prone position. The examiner stabilized the hand-held dynamometer against the wall, and patients exerted maximal force for external and internal rotation. Each contraction was held for 3–4 seconds, repeated three times, and the average value was recorded. Verbal encouragement ("push as hard as possible") was provided during each trial.[40]

The Shoulder Pain and Disability Index (SPADI) was used to assess function of shoulder.

2.4. Intervention

2.4.1. Group A: Handgrip Strengthening Exercises + Conventional Physiotherapy

Participants in Group A performed handgrip strengthening exercises using an adjustable heavy-grip hand gripper at their 10-repetition maximum. Exercises were performed in a standing position with the back supported against a wall. Each participant completed three sets of ten squeezes once daily.

The arm position was progressively advanced each week based on patient tolerance—starting at 30° of abduction in the first week, progressing to 60° in the second week, 90° in the third week, and finally 90° of abduction with 90° of external rotation by the sixth week.[8] The resistance was recalibrated weekly to maintain the 10-repetition maximum load. All participants received conventional physiotherapy as well.

Figure 1: Handgrip-strengthening Exercises Using an Adjustable Heavy-grip Hand Gripper at Different sets (30°,60°, 90° Abduction and 90 Abduction with 90° External-rotation.)

2.4.2. Group B: Eccentric Training For External Rotators of Shoulder + Conventional Physiotherapy

Participants in Group B performed eccentric training for the shoulder external rotators using a four-foot-long TheraBand™. Progressive resistance was applied using color-coded bands in increasing order—yellow, red, green, blue, black, silver, gold.

Each repetition was performed only in the eccentric phase. The participant's arm was assisted by the therapist through the concentric phase to reach the end-range of external rotation. At this position, a 2-second isometric hold was maintained, followed by a controlled 3-second eccentric return to the starting position. Each session consisted of three sets of fifteen repetitions, performed twice per week for six weeks in addition to conventional physiotherapy.[17]

Figure 2: Eccentric Training for External Rotators of Shoulder

2.4.3. Conventional Protocol

All participants in both groups received a standardized 6-week conventional physiotherapy program. The regimen included wand exercises, posture correction exercises, and Codman pendular exercises, performed as 1 set of 10 repetitions each. Strengthening exercises targeting the scapular stabilizers, rotator cuff, and deltoid muscles were carried out using resistance bands for 3 sets of 10 repetitions, with a one-minute rest between sets. Resistance was progressively increased by changing the band colour once the participant could complete all sets comfortably.

Stretching exercises for the pectoralis minor, posterior capsule, levator scapulae, upper trapezius, and latissimus dorsi were performed daily in 3 sets of 5 repetitions, each held for 30 seconds.[17] Additionally, Transcutaneous Electrical Nerve Stimulation (TENS) was applied to the affected shoulder for 20 minutes for first 3 sessions to aid in pain reduction and muscle relaxation.

3. RESULTS

A total of 46 participants were included in the study, with 23 in each group. The baseline characteristics were comparable between the two groups, indicating homogeneity of the sample. The mean age of the 46 participants was 37.39 years for Group A and 36.00 years for Group B. Other demographic variables, such as mean weight (59.22 kg for Group A and 5.87 kg for Group B), mean height (156.70 cm for Group A and 156.61 cm for Group B), and mean BMI (24.294 for Group A and 24.527 for Group B), were similar for both groups. In both groups, the right side was primarily impacted; 15 participants in Group A and 16 in Group B had symptoms on the right side. The reason for right side more affected could be involvement of the dominant extremity more in daily activities and occupational setting as compared to that of the non-dominant extremity.

Table 1: Pre Mean (SD), Post Mean (SD), Pre- ost Mean Difference and p-values for GROUP A and GROUP B for all outcomes.

Variable	Group	Pre Mean (SD)	Post Mean (SD)	Difference (Pre-Post)	Within Group P value	Between Group P value
VAS	A	6.891 (1.196)	2.87 (0.986)	4.021	< 0.001	0.109
	B	6.235 (1.195)	2.404 (0.945)	3.831	< 0.001	
Strength of External Rotators	A	4.939 (2.555)	9.317 (2.037)	-4.378	< 0.001 ##	0.938 ##
	B	4.87 (1.934)	9.304 (1.841)	-4.434	< 0.001 ##	
Strength of Internal Rotators	A	9.948 (2.209)	11.013 (1.956)	-1.065	< 0.001 ##	0.013##
	B	8.296 (1.812)	10.122 (1.353)	-1.826	< 0.001 ##	
SPADI	A	55.02 (16.12)	26.07 (12.26)	28.95	< 0.001	0.079##
	B	60.74 (14.26)	32.24 (11.28)	28.5	< 0.001	

non-parametric test, P value < 0.001 indicate highly significant. Difference (Pre-Post): Calculated as Pre Mean - Post Mean. Negative values indicate an increase (STRENGTH OF EXTERNAL ROTATORS and INTERNAL ROTATORS), while positive values indicate a decrease (VAS, SPADI). This table provides an overview of the statistical outcomes, highlighting significant within-group improvements and notable between-group differences.

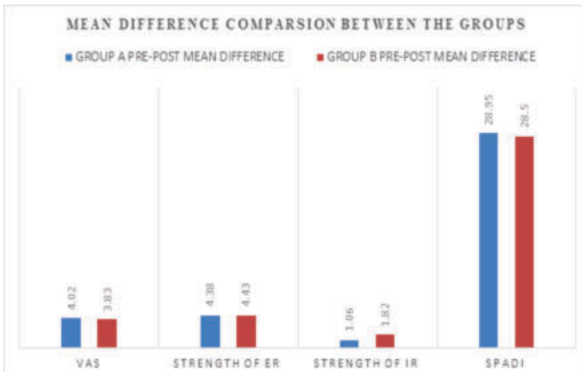

Figure 3: Mean Values for Pre-post Differences of Group A and Group B for VAS, Strength of ER, Strength of IR, SPADI.

Both groups demonstrated significant improvements in pain, rotator cuff muscle strength, and shoulder function after six weeks of intervention ($p < 0.001$). Pain intensity (VAS) and functional outcomes (SPADI) improved significantly in both groups, with no statistically significant differences between groups (VAS, $p = 0.109$; SPADI, $p = 0.079$). Muscle strength of both external and internal rotators increased in both groups; external rotator gains were comparable, while internal rotator strength improved significantly more in the eccentric training group ($p = 0.013$)

3.1. Statistical Analysis

The Shapiro–Wilk test confirmed normal data distribution ($p > 0.05$); hence, parametric tests were applied. Paired t-test for within-group and independent t-test for between-group analyses was done using SPSS version 25.

4. DISSCUSSION

In total 46 individuals were included in the study, 23 in group A and 23 in group B. Based on the prevalence of subacromial pain syndrome (SAPS), a major cause of shoulder discomfort, the age range of 18 to 65 years was chosen for this investigation. Although SAPS can affect people of all ages, its frequency is noticeably higher in adults of working age. Due to characteristics that are frequently linked to the development of the illness, such as repetitive overhead activities in recreational or occupational settings, this age group is especially vulnerable. This discussion explores how these results should be interpreted, their implications, and their significance in relation to how well these protocols work in treatment subacromial pain syndrome.

4.1 Effect on Pain

The analysis of VAS (Visual Analogue Scale) scores demonstrated a significant reduction in pain for both Group A and Group B following their respective interventions, indicating that both protocols were effective in managing pain associated with subacromial pain syndrome. A paired t-test confirmed this significant reduction within each group ($p < 0.001$). However, the independent samples t-test showed no statistically significant difference in post-intervention VAS scores between Group A and Group B ($t(44) = 1.63$, $p = 0.109$), suggesting that both interventions were equally effective in reducing pain. Pain reduction in Group A, which received handgrip strengthening in addition to conventional treatment, may be attributed to enhanced upper limb kinetic chain stability and improved motor control. A stronger and more stable hand–wrist complex provides a better support base, potentially reducing strain on the shoulder and compensatory movements during daily activities. Gripping activates muscles and proprioceptors throughout the arm,[14,43] exerting a neuro-modulatory effect on the central nervous system that can alter pain perception via the pain gate mechanism, where non-painful handgrip signals compete with shoulder pain signals.[13,44] Group B also demonstrated significant pain reduction following eccentric training for external rotators, likely due to controlled muscle loading during the return phase, which minimizes stress on impinged structures.[17]

4.2 Effect on Strength of External Rotators

The Mann–Whitney U test revealed no statistically significant difference in post-intervention external rotator strength between Group A and Group B ($p = 0.938$), indicating that both interventions effectively improved strength. Both groups achieved comparable outcomes after treatment. The improvement in Group A, which received handgrip strengthening in addition to conventional therapy, can be explained by the principle of irradiation or "overflow," where a strong contraction in one muscle group induces a synergistic contraction in other muscles of the kinetic chain.[11,15] High-intensity handgrip activity produces forceful contractions in the forearm and hand that "overflow" to the shoulder girdle, facilitating low-level co-contraction of the rotator cuff and enhancing neuromuscular activation and motor control efficiency.[15,43,44]

In Group B, which received eccentric training for the external rotators (ETER) with conventional physiotherapy, strength improvement resulted from controlled lengthening contractions that impose greater mechanical load on the tendon than concentric or isometric actions. Vetter et al. (2023) reported that six weeks of eccentric isokinetic training significantly improved eccentric strength, range of motion, and muscle architecture in external rotators.[33] Eccentric loading promotes tendon remodelling via mechano-transduction, enhancing collagen synthesis and joint stability while reducing subacromial impingement.[18,21]

4.3 Effect on Strength of Internal Rotation

The statistical analysis revealed a significant difference in post-intervention internal rotator strength between Group A and Group B ($p = 0.013$), with Group B demonstrating greater improvement. Eccentric training of the external rotators not only enhanced the strength of the targeted muscles but also resulted in notable gains in the internal rotators when combined with conventional physiotherapy. This effect can be attributed to the agonist–antagonist relationship, where strengthening of the external rotators improves neuromuscular coordination and facilitates reciprocal activation of the internal rotators. During eccentric loading, co-contraction of internal rotators is required to maintain glenohumeral stability, leading to indirect strengthening of these muscles. Neural adaptations such as improved motor unit recruitment, enhanced synchronization, and cross-education effects may also contribute to the observed increase in internal rotator strength.[17,33,45] Furthermore, the additional benefits of eccentric training are likely linked to improved tendon properties through mechano-transduction, promoting collagen realignment and structural resilience. The resulting enhancement in shoulder joint control and dynamic stability may have amplified internal rotator activation during functional movements.

In Group A, which received handgrip strengthening with conventional therapy, improvement in internal rotation strength may be explained by neural overflow and synergistic activation. Strong handgrip contractions increase excitability in motor neuron pools supplying proximal muscles, thereby facilitating internal rotator activity. Horsley et al. reported strong associations between grip and shoulder rotator strength across various joint positions, highlighting distal-to-proximal neuromuscular linkage.[43,46] Interventional studies demonstrate that isolated handgrip training can increase both internal and external rotation torque, reinforcing the role of kinetic chain facilitation in shoulder strength improvement.[43]

4.4 Effect on Shoulder Function (SPADI)

The comparison of post-intervention SPADI scores between Group A and Group B using the Mann–Whitney U test showed no statistically significant difference ($U = 184.500$, $Z = -1.758$, $p = 0.079$), indicating that both interventions effectively reduced pain and disability in patients with subacromial pain syndrome. These findings suggest that eccentric training of the external rotators (ETER) and handgrip strengthening, when combined with conventional physiotherapy, are equally beneficial for improving functional outcomes.

The greater improvement in SPADI scores observed in Group B may be attributed to ETER's direct influence on shoulder mechanics. Strengthening the external rotators under eccentric loading enhances dynamic glenohumeral stability, restores scapulohumeral rhythm, and reduces subacromial compression, improving daily functional tasks such as lifting and reaching. Eccentric exercise also promotes tendon remodeling and exerts analgesic effects, contributing to pain reduction.[20,35]

Group A, which received handgrip strengthening with conventional therapy, demonstrated similar functional gains. Grip activity enhances rotator cuff and scapular stabilizer co-activation, improving shoulder stability and neuromuscular efficiency. Bohannon et al. (2019) identified grip strength as a biomarker of overall functional capacity, linking distal grip force to proximal shoulder performance and reduced disability.[15,34]

5. CONCLUSION

The current study examined how pain, rotator cuff strength, and shoulder function were affected in people with subacromial pain syndrome by handgrip strengthening with conventional physiotherapy and eccentric training for external rotators with conventional physiotherapy. Both strategies showed significant improvement in all outcomes; however, a key observation was that eccentric training of the external rotators not only improved external rotator strength but also led to a significant gain in internal rotator strength. This additional benefit highlights the potential carryover effect of eccentric external rotator training and emphasizes its value as a comprehensive rehabilitation approach. These findings suggest that both interventions may be incorporated into rehabilitation programs based on clinical goals, equipment availability, and patient needs.

6. Limitations

- Short intervention period (6 weeks) may not have been sufficient to capture long-term adaptations, particularly tendon remodeling from eccentric loading.

- Participants were restricted to 18–65 years of age, which limits generalizability to older adults or athletic populations.

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