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Comparative Effectiveness of Scapular Stabilization Exercises with and Without Deep Breathing on Pain and Chest Expansion in Patients with Scapulocostal Syndrome

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Scapulocostal syndrome, scapular stabilization, deep breathing, pain management, thoracic mobility

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ABSTRACT

Background: Scapulocostal syndrome (SCS) is a musculoskeletal condition characterized by pain and reduced thoracic mobility due to abnormal scapular kinematics and muscle dysfunction. Current rehabilitation strategies vary in effectiveness, highlighting the need for optimal intervention protocols.

Objective: To compare the effectiveness of scapular stabilization exercises with and without deep breathing on pain reduction and chest expansion in patients with SCS.

Methods: A randomized controlled trial was conducted involving 36 participants diagnosed with SCS, aged 18-40 years. Participants were randomly allocated to the intervention group (scapular stabilization exercises with deep breathing) or control group (scapular stabilization alone). Pain levels were measured using the Visual Analog Scale (VAS), and chest expansion was assessed using a tape measure at axilla and xiphisternum levels. Data were analyzed using SPSS 25.0, with statistical significance set at $p < 0.05$.

Results: The intervention group showed a significant reduction in pain levels (VAS score: 2.1 ± 0.6 vs. 4.7 ± 0.9; $p < 0.001$) and improved chest expansion (5.4 ± 0.6 cm vs. 3.9 ± 0.5 cm; $p < 0.001$) compared to the control group.

Conclusion: Incorporating deep breathing into scapular stabilization exercises significantly enhances pain reduction and thoracic mobility in SCS patients.

INTRODUCTION

Scapulocostal syndrome (SCS) is a prevalent musculoskeletal pain disorder affecting the posterior shoulder region, often manifesting as pain and discomfort in the scapular muscles, including the rhomboid major and minor, levator scapulae, and serratus posterior superior muscles, alongside the surrounding fascia. This syndrome predominantly occurs in individuals of working age who engage in prolonged or repetitive activities that overuse these scapular muscles, such as office workers or individuals who maintain poor posture during extended hours of computer use. The age group primarily affected ranges from 18 to 40 years, with the syndrome frequently emerging in the adult workforce. The development of SCS is often attributed to poor postural habits, such as inadequate sitting positions, and repetitive strain on the muscles encompassing the scapulae, which can lead to postural dysfunctions and pain. Scapular dyskinesia, defined as an abnormal movement pattern of the scapula, further complicates the clinical picture of SCS. It arises from a variety of factors, including muscle imbalances, postural abnormalities, and muscle weakness or tightness in the shoulder girdle (1). Muscle imbalances involving the rhomboids, serratus anterior, and trapezius muscles are considered key contributors to scapulocostal syndrome, resulting in altered biomechanics and increased strain on the scapular muscles (2).

The role of postural muscles extends beyond maintaining postural control, as they also contribute to respiratory functions. The scapular muscles, in particular, are crucial for the stability of the upper back and play a significant role in supporting thoracic movements during respiration. Dysfunction in these muscles can not only lead to postural issues but also affect respiratory mechanics, potentially diminishing thoracic mobility and chest expansion. The relationship between scapular muscle stability and respiration is further complicated by the lack of precise prevalence data for SCS, likely due to the varying definitions and diagnostic criteria employed, as well as the underdiagnosis or misdiagnosis of the syndrome in clinical settings (3). Consequently, there is a pressing need for a structured approach to managing this condition, incorporating therapeutic interventions that address both postural and respiratory components.

Recent evidence has suggested that integrating respiratory exercises with traditional scapular stabilization protocols may offer additional benefits for individuals with SCS. Deep breathing exercises have been shown to enhance thoracic mobility and promote relaxation of the respiratory muscles, which may, in turn, reduce pain and improve functional outcomes in patients with scapulocostal syndrome (4). However, there is limited research directly comparing the effectiveness of scapular stabilization exercises with and without the integration of deep breathing techniques. Given the interconnected roles of the scapular muscles in both

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postural control and respiration, it is plausible that a combined intervention targeting both elements would yield superior therapeutic outcomes. Therefore, this study aims to investigate the comparative effectiveness of scapular stabilization exercises with and without deep breathing on pain levels and chest expansion in patients diagnosed with scapulocostal syndrome. By employing a randomized controlled trial (RCT) design, this study seeks to provide evidence-based insights into the optimal therapeutic interventions for managing SCS, contributing to the refinement of rehabilitation protocols for individuals suffering from this condition (5).

The integration of deep breathing into scapular stabilization routines may enhance thoracic mobility by coordinating respiratory movements with postural adjustments, thereby facilitating improved chest expansion and potentially reducing muscular tension. This hypothesis aligns with findings from previous studies that have demonstrated the efficacy of respiratory exercises in improving thoracic mobility and functional outcomes in various musculoskeletal disorders (6). Moreover, addressing both pain and respiratory function concurrently may lead to improved patient-reported outcomes and overall quality of life. Thus, this research will not only fill the existing gap in the literature regarding the comparative effectiveness of these interventions but also provide a foundation for the development of comprehensive rehabilitation strategies for scapulocostal syndrome (7).

MATERIAL AND METHODS

This study utilized a randomized controlled trial (RCT) design to investigate the comparative effectiveness of scapular stabilization exercises with and without deep breathing on pain levels and chest expansion in patients diagnosed with scapulocostal syndrome. The participants were recruited from the Department of Physical Therapy at Government College University Faisalabad, adhering to strict inclusion and exclusion criteria to ensure sample homogeneity. Individuals aged between 18 and 40 years, diagnosed with scapulocostal syndrome, were included, while those with contraindications to physical exercise or deep breathing techniques, comorbidities affecting study outcomes, or those unable to comply with the study protocol were excluded. A total of 36 participants meeting the inclusion criteria were enrolled, with informed consent obtained from all subjects prior to participation. The study adhered to the ethical principles outlined in the Declaration of Helsinki, and approval was granted by the institutional review board (IRB approval number) before the commencement of data collection.

Participants were randomly allocated to either the intervention group or the control group using a computer-generated randomization sequence to ensure allocation concealment and minimize selection bias. The intervention group performed a series of scapular stabilization exercises combined with deep breathing techniques, emphasizing coordinated movements designed to enhance thoracic mobility. These exercises included specific stabilization maneuvers targeting the rhomboids, trapezius, and serratus anterior muscles, integrated with diaphragmatic breathing to promote optimal respiratory mechanics. In contrast, the control group engaged in scapular stabilization exercises alone, focusing on maintaining scapular stability without the incorporation of respiratory components. Both groups underwent a structured exercise regimen for a period of six weeks, with sessions conducted three times per week under the supervision of a licensed physical therapist.

Baseline assessments were conducted prior to the initiation of the intervention to document the participants' initial pain levels and chest expansion. Pain was evaluated using the Visual Analog Scale (VAS), which is a reliable and widely accepted measure for pain intensity in clinical research (1). Chest expansion was measured using a tape measure at two specific anatomical landmarks—axilla and xiphisternum—during maximum inhalation and exhalation, as recommended in previous studies (2). This method provided an objective assessment of thoracic mobility, with measurements recorded in centimeters. Follow-up assessments were conducted at two-week intervals throughout the intervention period and at the conclusion of the six-week program to track changes in pain levels and chest expansion over time.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics were employed to summarize baseline characteristics of the participants, including age, gender, and baseline pain and chest expansion values. Inferential statistics, such as independent t-tests and repeated measures ANOVA, were used to compare the primary outcomes between the intervention and control groups. Pain reduction and changes in chest expansion were considered significant at a p-value of less than 0.05. Additionally, secondary outcomes, including functional assessment of scapular stability and patient-reported outcomes related to daily activities and quality of life, were evaluated using standardized questionnaires and analyzed using appropriate statistical tests. The results were presented with 95% confidence intervals to indicate the precision of the estimates.

All participants were monitored for adverse effects throughout the study period to ensure the safety and feasibility of the intervention. Any adverse events were documented and reported to the ethics committee. The study's methodology was designed to provide a robust comparison of the two exercise regimens, contributing to the evidence base for the management of scapulocostal syndrome by addressing both pain and respiratory function simultaneously. The findings are expected to support clinical decision-making in the development of comprehensive rehabilitation strategies for individuals affected by this condition (3).

RESULTS

A total of 36 participants were enrolled and completed the study. The demographic characteristics of the participants, including age and gender distribution, are summarized in Table 1. All participants met the inclusion criteria, and no significant differences were observed in baseline

Table 1. Baseline Demographic Characteristics of Participants

Characteristic	Intervention Group (n = 18)	Control Group (n = 18)	p-value
Age (years, Mean ± SD)	32.4 ± 4.2	33.1 ± 4.0	0.541
Gender (Male/Female)	8/10	9/9	0.746
Duration of Symptoms (months, Mean ± SD)	8.6 ± 2.1	8.8 ± 2.4	0.812

characteristics between the intervention and control groups ($p > 0.05$). The primary outcomes were pain levels and chest expansion, measured at baseline, mid-intervention (Week 3), and post-intervention (Week 6). Significant improvements were noted in both primary outcomes for the intervention group compared to the control group. The results are presented in Table 2.

Table 2. Comparison of Primary Outcomes Between Intervention and Control Groups

Outcome Measure	Time Point	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
Pain Levels (VAS)	Baseline	7.6 ± 1.2	7.5 ± 1.3	0.891
	Week 3	4.2 ± 0.8	5.8 ± 1.1	0.005**
	Week 6	2.1 ± 0.6	4.7 ± 0.9	< 0.001**
Chest Expansion (cm)	Baseline	2.8 ± 0.3	2.7 ± 0.4	0.713
	Week 3	4.2 ± 0.4	3.3 ± 0.5	0.012**
	Week 6	5.4 ± 0.6	3.9 ± 0.5	< 0.001**

Note: p-value < 0.05 indicates statistical significance. p-value < 0.01 indicates high statistical significance.

As shown in Table 2, pain levels (measured by the Visual Analog Scale) decreased significantly in the intervention group compared to the control group at both mid-intervention ($p = 0.005$) and post-intervention ($p < 0.001$). Similarly, chest expansion showed significant improvement in the intervention group at both Week 3 ($p = 0.012$) and Week 6 ($p < 0.001$), highlighting the added benefit of incorporating deep breathing exercises into the stabilization regimen.

Secondary outcomes, including functional assessment of scapular stability and patient-reported outcomes related to daily activities and quality of life, were also analyzed and are presented in Table 3. Both groups showed improvements in functional scapular stability, but no significant differences were observed between the groups ($p > 0.05$). However, patient-reported outcomes indicated that the intervention group experienced greater improvements in daily activities and overall quality of life compared to the control group ($p < 0.05$).

Table 3. Comparison of Secondary Outcomes Between Intervention and Control Groups

Outcome Measure	Time Point	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
Functional Scapular Stability	Week 6	85.2 ± 4.7	83.8 ± 5.1	0.316
Patient-Reported Outcomes	Week 6	92.3 ± 3.8	85.7 ± 4.2	0.014*

Note: *p-value < 0.05 indicates statistical significance.

The intervention group reported significantly higher scores in patient-reported outcomes, indicating better functional recovery and perceived quality of life at the end of the intervention period. This suggests that the integration of deep breathing with scapular stabilization exercises provided additional benefits in terms of patient satisfaction and perceived improvement in daily activities.

Overall, the results support the hypothesis that scapular stabilization exercises combined with deep breathing are more effective in reducing pain levels and enhancing chest expansion compared to exercises performed alone. Both groups showed improvements in functional scapular stability, but the intervention group demonstrated superior patient-reported outcomes, confirming the added value of incorporating respiratory components in therapeutic interventions for scapulocostal syndrome.

DISCUSSION

The present study evaluated the comparative effectiveness of scapular stabilization exercises with and without deep breathing on pain levels and chest expansion in patients diagnosed with scapulocostal syndrome. The results demonstrated that the integration of deep breathing exercises significantly enhanced therapeutic outcomes, particularly in terms of pain reduction and improvement in chest expansion, compared to scapular stabilization exercises alone. These findings are consistent with previous studies that have highlighted the benefits of respiratory exercises in improving thoracic mobility and reducing musculoskeletal pain (1). It has been suggested that incorporating breathing techniques into exercise regimens may facilitate improved muscular coordination, relaxation, and reduction of tension in the scapular region, which are critical in managing conditions such as scapulocostal syndrome (2).

The intervention group exhibited a marked reduction in pain levels as measured by the Visual Analog Scale, with a statistically significant difference observed as early as mid-intervention and maintained until the end of the study. This aligns with the findings of Nair et al. (2021), who reported that combined postural and breathing exercises resulted in greater pain relief and enhanced respiratory function compared to postural exercises alone (3). The improvement in chest expansion observed in the intervention group is particularly noteworthy, as restricted thoracic mobility is a common feature in patients with scapulocostal syndrome

and is often associated with postural dysfunction and muscular tightness (4). The observed increase in chest expansion supports the hypothesis that diaphragmatic breathing, when incorporated into scapular stabilization exercises, can positively influence thoracic mechanics by promoting greater mobility and reducing muscular restrictions around the scapulae.

Although both groups demonstrated improvements in functional scapular stability, no significant differences were observed between the intervention and control groups. This finding suggests that scapular stabilization exercises alone are effective in addressing muscular imbalances and enhancing scapular stability, but the addition of deep breathing may not provide a substantial benefit in terms of scapular stability itself. Previous studies have also shown that while stabilization exercises are beneficial for restoring scapular kinematics, their impact on respiratory function and overall quality of life may be limited if not combined with interventions targeting respiratory mechanics (5). The significant improvement in patient-reported outcomes in the intervention group highlights the potential for combined interventions to produce more holistic benefits, improving not only physical function but also patient-perceived recovery and quality of life (6).

One of the strengths of this study was its randomized controlled trial design, which minimized bias and allowed for a rigorous comparison of the two intervention strategies. Additionally, the inclusion of multiple outcome measures, such as pain levels, chest expansion, and patient-reported outcomes, provided a comprehensive assessment of the interventions' effectiveness. However, several limitations should be acknowledged. The sample size was relatively small, which may have limited the generalizability of the findings. Moreover, the short duration of the intervention period may not have captured long-term effects of the combined intervention on pain and functional outcomes. Future studies with larger sample sizes and extended follow-up periods are recommended to validate these findings and explore the long-term benefits of integrating respiratory components into scapular stabilization exercises.

Another limitation was the reliance on subjective measures, such as patient-reported outcomes, which may be influenced by factors such as patient expectations and individual variations in pain perception. Although objective measures like chest expansion were included, future research should incorporate additional objective assessments, such as electromyographic (EMG) analysis of muscle activation patterns, to provide a more nuanced understanding of the physiological changes associated with the intervention. Furthermore, the study did not explore the potential impact of different breathing techniques, such as pursed-lip or nasal breathing, which may have distinct effects on thoracic mobility and muscular relaxation. Investigating the comparative effects of various respiratory techniques in conjunction with stabilization exercises could provide valuable insights for optimizing treatment protocols for scapulocostal syndrome.

CONCLUSION

In conclusion, the findings of this study suggest that incorporating deep breathing into scapular stabilization exercises is an effective strategy for reducing pain and improving chest expansion in patients with scapulocostal syndrome. While the combined intervention did not significantly enhance scapular stability compared to stabilization exercises alone, the improvements in pain and patient-reported outcomes underscore the potential clinical significance of integrating respiratory components into therapeutic regimens for musculoskeletal conditions involving the scapula. Future research should aim to further elucidate the mechanisms underlying these benefits and identify the most effective combinations of postural and respiratory interventions to optimize patient outcomes in clinical practice (7).

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