Women. Health. Bull. 2024; 11(1)
Published online 2024 January.

Original Article

The Impact of Eight Weeks of Corrective Exercises on Postural Parameters, Range of Motion, and Shoulder Joint Pain in Women with Frozen Shoulder and Upper Cross Syndrome

Ghazaleh Jamali Kohneh Shahri[1], MSc; Ebrahim Mohammad Ali Nasab Firouzjah[1*], PhD

[1]Department of Exercise Physiology and Corrective exercise, Faculty of Sport Sciences, Urmia University, Urmia, Iran

Corresponding author:* Ebrahim Mohammad Ali Nasab Firouzjah, PhD; Department of Exercise Physiology and Corrective exercise, Faculty of Sport Sciences, Urmia University, Postal Code: 5756151818, Urmia, Iran. **Tel: +98 9112152182; **Email:** ebrahim.mzb@gmail.com

Received: September 20, 2023; **Revised:** October 25, 2023; **Accepted:** November 15, 2023

Abstract

Background: Incorrect posture contributes to a frozen shoulder; this study explored the effects of eight weeks of corrective exercises on postural parameters, range of motion, and shoulder joint pain in women with frozen shoulder and upper cross syndrome.
Methods: A quasi-experimental study with a pre-test-post-test design was conducted. Thirty women aged 40 to 60 years with frozen shoulder and upper cross syndrome were purposefully selected and allocated into control and experimental groups. Pre-test assessments included forward head angle (FHA) and forward shoulder angle (FSA) measured using Kinovea software, thoracic curvature assessed with a flexible ruler, range of motion of the shoulder joint (external rotation, abduction, and flexion) measured with a goniometer, and shoulder joint pain evaluated using the visual analog scale (VAS). The experimental group performed corrective exercises for eight weeks, while the control group continued their daily activities. Post-test assessments were conducted, and covariance tests and paired-sample t-test analysis were employed for between-group and within-group comparisons.
Results: The experimental group demonstrated significant improvements in shoulder joint range of motion (P=0.001), FHA (P=0.001), FSA (P=0.008), thoracic curvature (P=0.001), and shoulder joint pain (P=0.001) following corrective exercises.
Conclusions: It is recommended that trainers and therapists utilize the corrective exercises outlined in this study to enhance shoulder joint range of motion posture and alleviate pain in women with frozen shoulders and upper cross syndrome.

Keywords: Frozen Shoulder, Corrective Exercises, Upper Cross Syndrome, Range of Motion, Pain

How to Cite: Jamali Kohneh Shahri G, Mohammad Ali Nasab Firouzjah E. The Impact of Eight Weeks of Corrective Exercises on Postural Parameters, Range of Motion, and Shoulder Joint Pain in Women with Frozen Shoulder and Upper Cross Syndrome. Women. Health. Bull. 2024;11(1):47-56. doi: 10.30476/WHB.2024.101123.1262.

1. Introduction

The shoulder joint represents a pivotal and intricately structured joint in the body, serving as a primary support for bodily functions. Its impairment significantly impedes many activities due to its lack of inherent support (1). Frozen shoulder syndrome, or adhesive capsulitis, is one of the most prevalent causes of shoulder pain and disability, characterized by stiffness and constriction of the shoulder capsule. This condition, defined by the American Association of Shoulder and Elbow Surgeons, manifests initially with pain and restricts shoulder mobility (2). Predominantly affecting individuals aged 40 to 60, its prevalence within the populace ranges from 2 to 5 percent, with a higher occurrence among women and those over 40 (3).

Frozen shoulder is generally categorized into primary and secondary types. The idiopathic form, accounting for 5% of all cases, poses challenges in treatment due to its unknown etiology, prompting ongoing debate among orthopedic surgeons (4). Conversely, secondary frozen shoulder arises from various rheumatological and neurological conditions and is distinguishable from the primary type (5). In particular, people often experience deep shoulder pain that often radiates to the deltoid muscle area and worsens at night. (6). Misalignment, particularly excessive kyphosis, is proposed as a significant contributor to this complication (7). The spine's proper alignment relies on the coordinated function of its muscular, skeletal, and articular structures. Consequently, muscle weakness affecting spinal support structures can disrupt static and dynamic stability, leading to postural deviations (8).

Prolonged improper postures induce widespread maladaptive changes in joints and soft tissues, resulting in muscle shortening and stiffness on the agonist side and weakening and lengthening on the antagonist side. This imbalance, termed muscle imbalance, disrupts natural bodily alignment, predisposing individuals to postural abnormalities and, occasionally, acute and chronic injuries (9). Page and Frank reported that three prominent patterns, classifying them into upper cross syndrome, lower cross syndrome, and layer syndrome. Upper cross syndrome, characterized by forward head posture, rounded shoulders, scapular protraction, and thoracic hyperkyphosis, elicits significant alterations in the upper body (10). This syndrome may underlie abnormal thoracic kyphosis, alterations in glenohumeral biomechanics, and shoulder and chest pain (11).

Individuals afflicted with frozen shoulder can recuperate through rehabilitation programs lasting 4 to 6 months, although in rare instances, recovery may extend up to 3 years. While prevention remains paramount in frozen shoulder management, treatment primarily focuses on pain alleviation, enhancing range of motion, and restoring joint function (12). Various treatment modalities are recommended, including anti-inflammatory medications, intra-articular steroid injections (13), manipulation under anesthesia (14), surgical interventions (15), arthroscopic procedures (16), physiotherapy regimens (17), and corrective exercises encompassing stretching and strengthening exercises (18). Posture correction programs aim to rectify muscle imbalances and normalize joint range of motion (19), with stretching and strengthening exercises targeting pain reduction through posture correction (20). Studies indicated higher forward head and shoulder angles and increased kyphosis in individuals with frozen shoulders compared to healthy counterparts. Additionally, shoulder abduction, flexion, and external rotation restrictions have been observed (21). Moreover, therapeutic exercise courses were shown to reduce pain and enhance the range of motion in frozen shoulder patients (18, 22).

Study of Jürgel and colleagues in 2005 demonstrated significant improvements in pain reduction, strength, endurance, and range of motion following a 4-week rehabilitation program incorporating aquatic therapy, massage, and electrotherapy in frozen shoulder patients with an average age exceeding 50 years. However, no significant effects were observed in the shoulder's internal and external rotation range of motion (23). Given the inconsistent findings in previous studies and the absence of comprehensive research addressing the collective impact of corrective exercises on postural parameters, pain levels, and shoulder joint range of motion in women with frozen shoulder and upper cross syndrome, this study was undertaken.

2. Methods

This study employed a quasi-experimental design with a pre-test-post-test. The population comprised women aged 40 to 60 years residing in Salmas City, Iran with a diagnosis of frozen shoulder and upper cross syndrome, among whom 30 had sought consultation with orthopedic specialists in Salmas, Iran. These participants were purposively selected and randomly assigned into control and experimental groups, each containing 15 individuals. Randomization was achieved by randomly assigning numbers from 1 to 30 and allocating those with even numbers to one group and those with odd numbers to the other. Additionally, a significant difference in baseline characteristics between the two groups confirmed the efficacy of randomization. Written informed consent was obtained from all participants.

Considering a significance level (alpha) of 0.05 and a power (beta) of 0.2, a minimum sample size of 15 individuals per group was determined to achieve a statistical power of 0.8, utilizing G*Power software (24). In addition, after estimating the sample size based on the kyphosis index as the main dependent variable, the number of 10.89 people was estimated using formula 1 (25). To mitigate potential sample loss and to be in line with G*Power estimates, 15 participants were recruited for the study.

Formula 1:

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2 (\delta_1^2 + \delta_2^2)}{(\mu_1 - \mu_2)^2}$$

$$n = \frac{(1.96 - 1.282)^2 \times (2.69^2 + 1.79^2)}{(46.61 - 47.28)^2} = 10.89$$

The inclusion criteria were being female aged 40 to 60 years, concurrently exhibiting three abnormalities including hyper-kyphosis exceeding 42, forward head angle surpassing 46˚, and forward shoulder angle exceeding 52˚ (26), along with a confirmed diagnosis of primary frozen shoulder disorder and significant reduction in shoulder joint mobility (50% reduction in external rotation), inability to sleep on the affected shoulder, nocturnal and activity-related pain, and absence of surgical history or fractures (27, 28). Conversely, exclusion criteria comprised secondary frozen shoulder, history of systemic diseases or shoulder-related issues including diabetes, arthritis, fractures, dislocations, joint instability, muscle tears, prior surgeries, stroke history, nerve disorders, medication use, pain reliever consumption, and prior therapeutic interventions for frozen shoulder management (29, 30).

Pain assessment during activity was conducted using the visual analog scale (VAS), possessing a validity of 0.70 and reliability of 0.97 (31). This scale comprises a 10-cm horizontal bar, with zero representing no pain and 10 denoting severe pain. Participants indicated their perceived pain level in the shoulder joint by marking the corresponding point on the scale (13). Pain intensity was categorized into four levels: none (0-4 mm), slight (5-44 mm), moderate (45-74 mm), and severe (75-100 mm) pain (32).

Shoulder flexion, abduction, and external rotation were assessed using a universal goniometer, with reliability ranging from 0.94 to 0.98 for flexion and abduction and 0.87 to 0.99 for external rotation measurements (33) (Figure 1). For shoulder flexion measurement, the goniometer's center was positioned 2.5 cm anterior to the acromion, with the fixed arm aligned along the trunk midline and the movable arm aligned parallel to the upper arm's lateral aspect. At the same time, participants executed active shoulder flexion (23). Shoulder abduction range was measured with the subject seated; the examiner held the goniometer's fixed arm vertically adjacent to the trunk on the frontal plane and the center positioned at the acromion process. The movable arm paralleled the arm's axis and the lateral epicondyle of the elbow, tracking shoulder abduction movement. The resulting angle represented the abduction range, with a standard range of 180˚ (23). External rotation range was evaluated with the participant supine on a bed, the shoulder abducted at 90˚, and the forearm perpendicular to the bed. The examiner aligned the goniometer's fixed arm with the forearm and centered it on the olecranon process while the movable arm tracked the styloid process. Participants performed active external rotation, and the resulting angle indicated the range, with a standard range of 90˚ (23).

The body profile view technique was employed to measure the angles of the forward head and forward shoulder (Figure 2). This method exhibits suitable reproducibility, as confirmed by Ruivo and colleagues, who reported intra- and inter-examiner reliability for forward head angle (ICC=0.87, 0.66) and forward shoulder angle (ICC=0.96, 0.78) (34). Anatomical landmarks were identified and marked, including the ear tragus, right acromion, and spinous process of the C7 vertebra. Participants were then positioned next to a wall at a distance of 23 cm, with their left arm closer to the wall. A photographic tripod housing a digital camera was placed 265 cm from the wall at the subject's right shoulder level. Participants were instructed to perform three forward bends and raise their arms above their heads three times before assuming a comfortable, natural stance and focusing on an

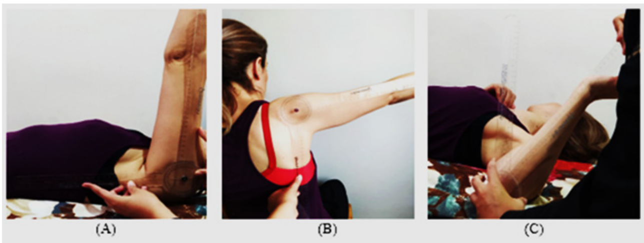

Figure 1: The figure shows the assessment method of the range of motion of flexion (A), abduction (B) and external rotation (C) of the shoulder joint.

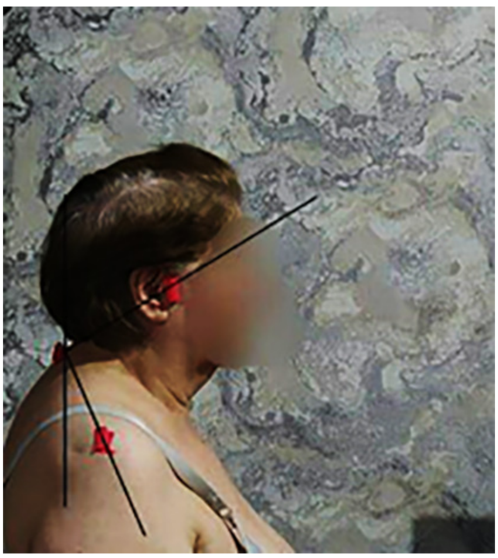

Figure 2: The figure shows the assessment method of forward head (A) and forward shoulder (B) angles.

imaginary point on the opposite wall (eyes aligned with the horizon). After a 5-second pause, a profile photograph was captured. Subsequently, the photograph was transferred to a computer, using AutoCAD software; the angles formed by the line connecting the tragus and C7 with the horizon line (forward head) and the line connecting C7 and the acromion process with the horizon line (forward shoulder) were measured. The average of three angles obtained for each anomaly was recorded as the respective forward head and forward shoulder angle (35, 36).

Kyphosis assessment utilized a flexible ruler with reliability ranging from 0.89 to 0.92 and a validity of 0.91 (Figure 3). Participants stood facing the evaluator naturally without obscuring their upper body. Measurements were conducted in a relaxed standing position with equal weight distribution on both legs and forward gaze. The evaluator marked the spinous processes of the second (T2) and twelfth dorsal (T12) vertebrae. Subsequently, a flexible ruler was positioned along the spinous processes of spine, forming an arc, and the curvature of the spine was delineated. This measurement was repeated three times. Finally, the formula $\Theta=4\arctan 2H/L$ was applied to compute the angle (37).

The training program spanned eight weeks, with sessions held thrice weekly, each lasting approximately one hour under the examiner's supervision (26). Each session comprised five minutes of warm-up exercises, followed by 20-40 minutes of main research exercises, and concluded with five minutes of cool-down exercises. The exercises aimed to restore normal shoulder joint range of motion, alleviate shoulder joint pain, and rectify postural abnormalities. Post-test evaluations were conducted after eight weeks to assess the exercises' effectiveness. The exercise protocol is detailed in Table 1, and the corrective exercises utilized in this study are depicted in Figure 4 (26, 38).

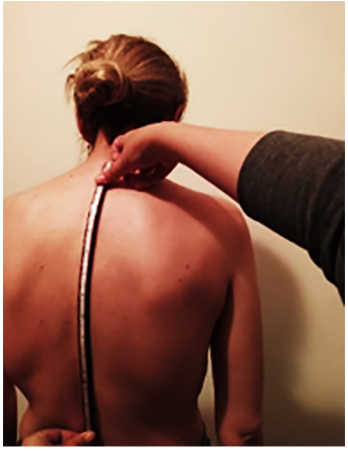

Figure 3: The figure shows the assessment method of dorsal kyphosis.

Descriptive and inferential statistical methods were employed in the analysis. The Shapiro-Wilk test assessed the normality of data distribution. Analysis of covariance and paired-sample t-tests were used for between-group and within-group comparisons, respectively. Statistical analysis was conducted using SPSS version 24.

Independent t-tests confirmed the homogeneity of descriptive variables between the two groups, except for the pain variable, which was determined to deviate from normal distribution by the Shapiro-Wilk test; analysis of covariance and paired-sample t-tests were utilized for between-group and within-group comparisons, respectively. Inter- and intra-group comparisons were performed using the Mann Whitney U Test and Wilcoxon tests for the pain variable.

3. Results

Table 2 presents the mean and standard deviation of individual characteristics of the subjects, including age, height, weight, and body mass index (BMI).

The results of the paired-sample t-test revealed a significant effect of the training program on shoulder abduction range of motion (P=0.001), shoulder flexion range of motion (P=0.001), shoulder external rotation range of motion (P=0.001), forward head angle (P=0.001), kyphosis

Table 1: Exercise Protocol

	Exercise 1	Exercise 2	Exercise 3	Exercise 4	Exercise 5	Exercise 6	Exercise 7	Exercise 8	Exercise 9	Exercise 10
Week 1-2	3*8	3*8	3*8	3*8	3*8	3*8	3*8	3*8		
Week 3-4	3*12	3*12	3*12	3*12	3*12	3*10	3*10	3*10	3*10	3*10
Week 5-6	3*16	3*16	3*16	3*16	3*16	3*12	3*12	3*12	3*12	3*12
Week 7-8	3*20	3*20	3*20	3*20	3*20	3*15	3*15	3*15	3*15	3*15

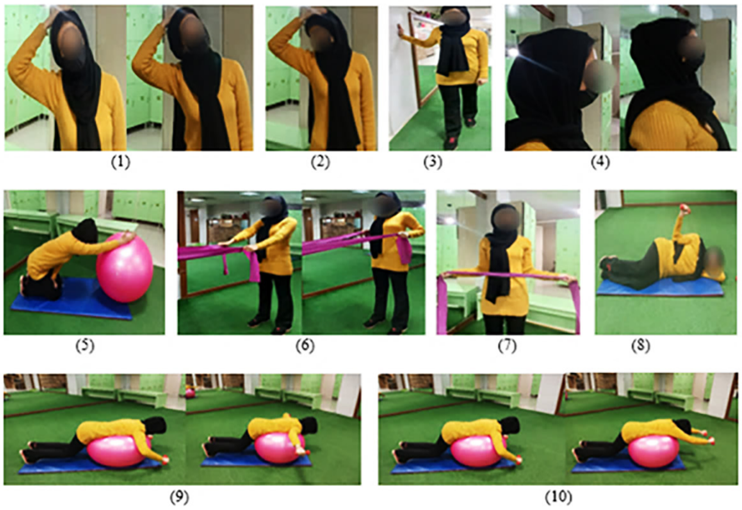

Figure 4: The figure shows the corrective exercise of the current study include: Stretching the Sternocleidomastoid and upper trapezius muscles by the subject (exercise 1); stretching levator scapulae muscle (exercise 2); stretching pectoral muscles (exercise 3); stretching splenius cervicis and flexor muscles of the lower part of the neck (exercise 4); stretching latissimus dorsi muscle (exercise 5); strengthening retraction muscles including middle and lower trapezius and rhomboid (exercises 6 & 7); External rotation of the shoulders with dumbbells (exercise 8); strengthening retraction muscles (exercise 9); strengthening dorsal muscles (exercise 10).

Table 2: Demographic features of the participants

Indicator	Group	No.	mean±SD	P
Age (year)	Control	15	50.66±6.84	0.88
	Training	15	51.66±5.54	
Height (M)	Control	15	1.68±0.02	0.16
	Training	15	1.69±0.03	
Weight (Kg)	Control	15	72.80±2.45	0.89
	Training	15	73.00±5.14	
Body mass index (Kg/M²)	Control	15	25.79±0.70	0.48
	Training	15	25.44±1.38	

Table 3: Paired-Sample T test results for intra-group comparison of shoulder range of motion, forward head, kyphosis and rounded shoulder

Group	Control group				Training group			
	Pre-test	Post-test	T	P	Pre-test	Post-test	T	P
Shoulder abduction range of motion (degree)	76.66±6.37	76.80±6.03	0.56	0.58	76.86±5.34	81.06±6.08	-8.74	0.001**
Shoulder flexion range of motion (degree)	75.80±8.23	76.13±7.98	-1.09	0.29	78.46±5.52	82.53±4.89	-10.59	0.001**
Shoulder external rotation range of motion (degree)	48.33±7.24	48.53±6.98	-1.00	0.33	50.73±5.52	55.26±5.83	-12.04	0/001**
Forward head (degree)	49.53±1.59	49.80±1.52	-1.29	0.21	50.00±2.03	46.33±1.83	10.55	0.001**
Kyphosis (degree)	45.06±1.90	44.66±1.87	2.10	0.05	44.40±1.50	40.93±1.16	14.66	0.001**
Rounded shoulder (degree)	54.93±1.75	54.53±1.88	1.38	0.18	55.53±1.84	54.86±1.64	3.16	0.007**

**Significant at P<0.01

angle (P=0.001), and rounded shoulder angle (P=0.007) among participants in the training group (Table 3). Additionally, the Wilcoxon test indicated a significant reduction in shoulder pain among subjects following the exercise program (P=0.001). Conversely, no significant difference was observed between pre- and post-tests in the control group (P<0.05).

The outcomes of the analysis of the covariance test for intergroup comparison are presented in Table 4. These results demonstrated a significant disparity between the two groups in shoulder abduction range of motion (P=0.001), shoulder

Table 4: Analysis of covariance test outcomes for inter-group evaluation of shoulder range of motion, forward head, kyphosis and rounded shoulder

Variable	Test stage	Group	Mean ¥	P	Eta squared
Shoulder abduction range of motion (degree)	Post-test	Control	76.90	0.001**	0.67
	Post-test	Training	80.96		
Shoulder flexion range of motion (degree)	Post-test	Control	77.36	0.001**	0.72
	Post-test	Training	81.29		
Shoulder external rotation range of motion (degree)	Post-test	Control	49.69	0.001**	0.79
	Post-test	Training	54.11		
Forward head (degree)	Post-test	Control	49.97	0.001**	0.79
	Post-test	Training	46.16		
Kyphosis (degree)	Post-test	Control	44.40	0.001**	0.82
	Post-test	Training	41.19		
Rounded shoulder (degree)	Post-test	Control	54.73	0.008**	0.64
	Post-test	Training	51.53		

¥ adjusted based on pre-test values; **Significant at P<0.01

Table 5: Results of Mann Whitney U test to investigate the difference inter-groups in shoulder pain variable

Variable	Time	U	Median	W	Z	P
Pain	Pre-test	96.50	5	216.50	-0.71	0.51
	Post-test	36.00	4	156.00	-3.32	0.001**

**Significant at P<0.01; U: Mann–Whitney U; W: W-score; Z: Z-score

flexion range of motion (P=0.001), shoulder external rotation range of motion (P=0.001), forward head angle (P=0.001), kyphosis angle (P=0.001), and rounded shoulder angle (P=0.008).

Furthermore, the results of the Mann Whitney U Test indicated a significant difference in the post-test pain variable between the control and training groups (P=0.001). Specifically, the training group exhibited a marked improvement in these components compared to the control group (Table 5).

4. Discussion

This study aimed to examine the impact of an eight-week regimen of corrective exercises on specific postural metrics, range of motion (ROM), and shoulder joint pain in women afflicted with frozen shoulders accompanied by upper cross syndrome. The findings indicated a significant improvement in shoulder pain and ROM, forward head and shoulder posture, and back curvature among participants in the exercise group compared to those in the control group after the eight-week program.

The results of pain levels and shoulder ROM underscored the effectiveness of corrective exercises in alleviating pain and enhancing shoulder ROM in women with frozen shoulder and upper cross syndrome. Individuals with frozen shoulder experience pain, restricted movement, and diminished ROM in both active and passive motions. Improvement in pain and ROM is crucial for restoring normal shoulder functions and treatments (14, 39). The shoulder's complex functionality is severely hampered by various complications, leading to significant movement restrictions affecting the entire upper limb (18). As Simpson and Budge suggested, managing pain, which intensifies during activity, is a critical initial step in treating a frozen shoulder, emphasizing pain relief and control as fundamental (40). Effective management of pain and ROM is essential, as reduced ROM can lead to joint capsule adhesion, a potential pain source. Thus, prioritizing the restoration of ROM in frozen shoulder management is logical. Previous studies showed the beneficial effects of stretching and flexibility exercises in alleviating shoulder limitations, highlighting the importance of incorporating these exercises into treatment protocols to enhance shoulder ROM (17). The exercise regimen in this study focused on increasing ROM and soft tissue flexibility around the joint, aiming to enhance shoulder flexibility, ROM, and strength, reduce joint stiffness and adhesions, and alleviate pain (18). The positive outcomes suggested that such exercises could benefit women with frozen shoulders, offering a valuable tool for trainers, occupational therapists, and physiotherapists in improving patient outcomes.

Furthermore, the study's findings on postural indicators revealed the corrective exercises' efficacy in improving forward head, shoulder posture, and back curvature in women with frozen shoulder and upper cross syndrome. Upper cross syndrome is characterized by shortening the neck's upper posterior and anterior muscles (tonic muscles) and the inhibition and weakening of the cervical spine's anterior deep muscles and the shoulder girdle's lower posterior muscles (phasic muscles) (41). These postural changes compromise the stability of the glenohumeral joint, with the scapula's glenoid cavity adopting a more vertical position due to serratus anterior muscle weakness, leading to scapular abduction and elevation. This instability necessitates increased activation of the levator scapula and upper trapezius muscles to maintain joint centrality (42). The primary cause of this condition is poor posture, particularly in individuals with a kyphotic posture.

Additionally, patients with shoulder pain often exhibit an increased forward head posture (protraction of the cervical spine), which, in turn, affects scapular rotation and humeral head compression. This leads to a loss of static stability, necessitating compensation by dynamic stabilizers like the rotator cuff and trapezius muscles, resulting in joint capsule stiffness (7). Adopting kinesiopathological approach of Sahrmann and colleagues (43), this study aimed to restore muscle balance through a focused corrective exercise program, thereby addressing the initial symptoms of a frozen shoulder. The program's design and implementation, emphasizing targeted corrective movements, stretching, and strengthening activities, significantly contributed to correcting deformities in affected individuals. For example, the chin tuck exercise increased the length of shortened neck muscles and strengthened the anterior neck muscles, reducing forward head posture complications. Similarly, exercises promoting arm external rotation and scapular retraction stretched the arm and chest muscles, facilitating spine extension. The training program's effectiveness in reducing forward head and shoulder angles and kyphosis was evident.

4.1. Limitations

The study was limited by the inability to control participants' physical activity levels, nutrition, rest, and sleep. Future research should explore the impact of these exercises on shoulder muscle strength and proprioception.

5. Conclusions

This study suggested that individuals with primary frozen shoulders exhibit poor upper body posture, mainly characterized by forward shoulder posture and scapular protraction, alongside muscle imbalance around the scapula. Addressing pain and restoring normal ROM necessitates focusing on the entire shoulder girdle, especially the scapula, as a pivotal point in the glenohumeral joint's function. The effectiveness of corrective exercises for upper cross syndrome on pain, ROM, and certain postural aspects in women with frozen shoulders was demonstrated, highlighting these exercises as a viable treatment option. The study also acknowledged limitations in controlling the participants' daily activities, nutrition, and mental conditions. Future research should investigate the effects of corrective exercises on secondary frozen shoulders and compare outcomes between men and women.

Acknowledgment

This article was extracted from the thesis of Ms. Ghazaleh Jamali Kohneh Shahri in Department of exercise Physiology and Corrective exercise, Faculty of Sport Sciences, Urmia University, Urmia, Iran. We are grateful to all the esteemed participants who, by participating in this project, helped us in the implementation and advancement of the programs.

Ethical Approval

The study was approved by the Research Ethics Committee of the Urmia University With the code of IR.URMIA.REC.1402.001. Also, written informed consent was obtained from the participants.

Authors' Contribution

Ghazaleh Jamali Kohneh Shahri: Substantial contributions to the conception and design of the work; the acquisition, analysis, and interpretation of data for the work, drafting the work. Ebrahim Mohammad Ali Nasab Firouzjah: Contributions to the conceptualization, supervision, validation, visualization and contributed to statistical analysis of the study, drafting the work and reviewing it critically for important intellectual content. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work, such that the questions related to the accuracy or integrity of any part of the work.

Funding: No funding.

Conflict of interest: None declared.

References

1. Itoi E. Pathophysiology and treatment of atraumatic instability of the shoulder. J Orthop Sci. 2004;9(2):208-13. doi: 10.1007/s00776-003-0748-1. PubMed PMID: 15045553.
2. Lo M-Y, Wu C-H, Luh J-J, Wang T-G, Fu L-C, Lin J-G, et al. The effect of electroacupuncture merged with rehabilitation for frozen shoulder syndrome: a single-blind randomized sham-acupuncture controlled study. J Formos Med Assoc. 2020;119:81-88. doi: 10.1016/j.jfma.2019.03.012. PubMed PMID: 31097283.
3. Wolf JM, Green A. Influence of comorbidity on self-assessment instrument scores of patients with idiopathic adhesive capsulitis. J Bone Joint Surg Am. 2002;84(7):1167-73. PubMed PMID: 12107317.
4. Hand G, Athanasou N, Matthews T, Carr A. The pathology of frozen shoulder. J Bone Joint Surg Br. 2007;89(7):928-32. doi: 10.1302/0301-620X.89B7.19097. PubMed PMID: 17673588.
5. Robinson C, Seah KM, Chee Y, Hindle P, Murray I. Frozen shoulder. J Bone Joint Surg Br. 2012;94(1):1-9. doi: 10.1302/0301-620X.94B1.27093. PubMed PMID: 22219239.
6. Cho N-J, Park J-W. Effect of Pain and Shoulder Joint Function on Extracorporeal Shock Wave Therapy of Patients with Frozen Shoulder. The Journal of Korean Academy of Orthopedic Manual Physical Therapy. 2007;13(2):69-78.
7. Hertling D, Kessler RM. Management of common musculoskeletal disorders: physical therapy principles and methods: Lippincott Williams & Wilkins; 2006.
8. Kashuba V, Andrieieva O, Goncharova N, Kyrychenko V, Karp I, Lopatskyi S, et al. Physical activity for prevention and correction of postural abnormalities in young women. Journal of Physical Education and Sport. 2019;19:500-506.
9. Ambegaonkar JP, Mettinger LM, Caswell SV, Burtt A, Cortes N. Relationships between core endurance, hip strength, and balance in collegiate female athletes. Int J Sports Phys Ther. 2014;9(5):604-16. PubMed PMID: 25328823; PubMed Central PMCID: PMC4196325.
10. Page P, Frank CC, Lardner R. Assessment and treatment of muscle imbalance; 2010.
11. Dunning JR, Butts R, Mourad F, Young I, Fernandez-de-Las Peñas C, Hagins M, et al. Upper cervical and upper thoracic manipulation versus mobilization and exercise in patients with cervicogenic headache: a multi-center randomized clinical trial. BMC Musculoskelet Disord. 2016;17:64. doi: 10.1186/s12891-016-0912-3. PubMed PMID: 26852024; PubMed Central PMCID: PMC4744384.
12. Homsi C, Bordalo-Rodrigues M, Da Silva JJ, Stump XMGRG. Ultrasound in adhesive capsulitis of the shoulder: is assessment of the coracohumeral ligament a valuable diagnostic tool? Skeletal Radiol. 2006;35(9):673-8. doi: 10.1007/s00256-006-0136-y. PubMed PMID: 16724200.
13. Ryans I, Montgomery A, Galway R, Kernohan W, McKane R. A randomized controlled trial of intra-articular triamcinolone and/or physiotherapy in shoulder capsulitis. Rheumatology. 2005;44(4):529-35. doi: 10.1093/rheumatology/keh535. PubMed PMID: 15657070.
14. Ng C, Amin A, Narborough S, McMullan L, Cook R, Brenkel I. Manipulation under anaesthesia and early physiotherapy facilitate recovery of patients with frozen shoulder syndrome. Scott Med J. 2009;54(1):29-31. doi: 10.1258/rsmsmj.54.1.29. PubMed PMID: 19291933.
15. Omari A, Bunker TD. Open surgical release for frozen shoulder: surgical findings and results of the release. J Shoulder Elbow Surg. 2001;10(4):353-7. doi: 10.1067/mse.2001.115986. PubMed PMID: 11517365.
16. Berghs BM, Sole-Molins X, Bunker TD. Arthroscopic release of adhesive capsulitis. J Shoulder Elbow Surg. 2004;13(2):180-5. doi: 10.1016/j.jse.2003.12.004. PubMed PMID: 14997096.

17. Vermeulen HM, Rozing PM, Obermann WR, Le Cessie S, Vliet Vlieland TPMV. Comparison of high-grade and low-grade mobilization techniques in the management of adhesive capsulitis of the shoulder: randomized controlled trial. Phys Ther. 2006;86(3):355-68. PubMed PMID: 16506872.
18. Dini R, Ghiamirad A, Rouhani A. The Effectiveness of Training Therapy with and without Complementary Shock Wave Therapy on the Pain and Range of Motion in Patients with Frozen Shoulder. Journal of Paramedical Sciences & Rehabilitation. 2022;11(2):56-67. doi: 10.22038/jpsr.2022.58058.2261. Pesian.
19. Sahrmann S. Movement system impairment syndromes of the extremities, cervical and thoracic spines. Elsevier Health Sciences; 2010.
20. El-Hamalawy FA. Forward head correction exercises for management of myogenic tempromandibular joint dysfunction; 2011.
21. Sali F, Ghani Zadeh Hesar N, Mohamadi M, Roshani S. Comparison of upper body posture and shoulder range of motion in women with and without frozen shoulder. Studies in Sport Medicine. 2020;12(28):149-64. doi: 10.22089/smj.2021.10567.1500.
22. Celik D. Comparison of the outcomes of two different exercise programs on frozen shoulder. Acta Orthop Traumatol Turc. 2010;44(4):285-92. doi: 10.3944/AOTT.2010.2367. PubMed PMID: 21252605.
23. Jürgel J, Rannama L, Gapeyeva H, Ereline J, Kolts I, Pääsuke M. Shoulder function in patients with frozen shoulder before and after 4-week rehabilitation. Medicina (Kaunas). 2005;41(1):30-8. PubMed PMID: 15687748.
24. Kang H. Sample size determination and power analysis using the G* Power software. J Educ Eval Health Prof. 2021;18:17. doi: 10.3352/jeehp.2021.18.17. PubMed PMID: 34325496; PubMed Central PMCID: PMC8441096.
25. Firouzjah MH, Firouzjah EMAN, Ebrahimi Z. The effect of a course of selected corrective exercises on posture, scapula-humeral rhythm and performance of adolescent volleyball players with upper cross syndrome. BMC Musculoskelet Disord. 2023;24(1):489. doi: 10.1186/s12891-023-06592-7. PubMed PMID: 37316911; PubMed Central PMCID: PMC10265808.
26. Seidi F, Bayattork M, Minoonejad H, Andersen LL, Page P. Comprehensive corrective exercise program improves alignment, muscle activation and movement pattern of men with upper crossed syndrome: randomized controlled trial. Sci Rep. 2020;10(1):20688. doi: 10.1038/s41598-020-77571-4. PubMed PMID: 33244045; PubMed Central PMCID: PMC7692548.
27. Challoumas D, Biddle M, McLean M, Millar NL. Comparison of treatments for frozen shoulder: a systematic review and meta-analysis. JAMA Netw Open. 2020;3(12):e2029581. doi: 10.1001/jamanetworkopen.2020.29581. PubMed PMID: 33326025; PubMed Central PMCID: PMC7745103.
28. Struyf F, Meeus M. Current evidence on physical therapy in patients with adhesive capsulitis: what are we missing? Clin Rheumatol. 2014;33(5):593-600. doi: 10.1007/s10067-013-2464-3. PubMed PMID: 24374758.
29. Cao D-Z, Wang C-L, Qing Z, Liu L-D. Effectiveness of extracorporeal shock-wave therapy for frozen shoulder: a protocol for a systematic review of randomized controlled trial. Medicine. 2019;98(7):e14506. doi: 10.1097/MD.0000000000014506. PubMed PMID: 30762780; PubMed Central PMCID: PMC6408004.
30. Miccinilli S, Bravi M, Morrone M, Manco D, Bressi F, Campi S, et al. The effectiveness of extracorporeal shock wave therapy on adhesive capsulitis of the shoulder: a systematic review and meta-analysis. Medicina dello Sport. 2020;73(2):341-71. doi: 10.23736/S0025-7826.20.03667-4.
31. Bijur PE, Silver W, Gallagher EJ. Reliability of the visual analog scale for measurement of acute pain. Acad Emerg Med. 2001;8(12):1153-7. doi: 10.1111/j.1553-2712.2001.tb01132.x. PubMed PMID: 11733293.
32. Jensen MP, Chen C, Brugger AM. Interpretation of visual analog scale ratings and change scores: a reanalysis of two clinical trials of postoperative pain. J Pain. 2003;4(7):407-14. doi: 10.1016/s1526-5900(03)00716-8. PubMed PMID: 14622683.
33. Riddle DL, Rothstein JM, Lamb RL. Goniometric reliability in a clinical setting: shoulder measurements. Phys Ther. 1987;67(5):668-73. doi: 10.1093/ptj/67.5.668. PubMed PMID: 3575423.
34. Ruivo RM, Pezarat-Correia P, Carita AI. Intrarater and interrater reliability of

photographic measurement of upper-body standing posture of adolescents. J Manipulative Physiol Ther. 2015;38(1):74-80. doi: 10.1016/j.jmpt.2014.10.009. PubMed PMID: 25467608.
35. Thigpen CA, Padua DA, Michener LA, Guskiewicz K, Giuliani C, Keener JD, et al. Head and shoulder posture affect scapular mechanics and muscle activity in overhead tasks. J Electromyogr Kinesiol. 2010;20(4):701-9. doi: 10.1016/j.jelekin.2009.12.003. PubMed PMID: 20097090.
36. Lynch SS, Thigpen CA, Mihalik JP, Prentice WE, Padua D. The effects of an exercise intervention on forward head and rounded shoulder postures in elite swimmers. Br J Sports Med. 2010;44(5):376-81. doi: 10.1136/bjsm.2009.066837. PubMed PMID: 20371564.
37. Seidi F, Rajabi R, Ebrahimi I, Alizadeh MH, Minoonejad H. The efficiency of corrective exercise interventions on thoracic hyper-kyphosis angle. J Back Musculoskelet Rehabil. 2014;27(1):7-16. doi: 10.3233/BMR-130411. PubMed PMID: 23948845.
38. Clark M, Lucett S. NASM essentials of corrective exercise training. Lippincott Williams & Wilkins; 2010.
39. Flannery O, Mullett H, Colville J. Adhesive shoulder capsulitis: does the timing of manipulation influence outcome? Acta Orthop Belg. 2007;73(1):21-5. PubMed PMID: 17441653.
40. Simpson JK, Budge R. Treatment of frozen shoulder using distension arthrography (hydrodilatation): a case series. Australas Chiropr Osteopathy. 2004;12(1):25-35. PubMed PMID: 17987207; PubMed Central PMCID: PMC2051310.
41. Moore MK. Upper crossed syndrome and its relationship to cervicogenic headache. J Manipulative Physiol Ther. 2004;27(6):414-20. doi: 10.1016/j.jmpt.2004.05.007. PubMed PMID: 15319765.
42. Janda V. Muscle and cervicogenic pain syndromes. In Grant R, editors. Physical Therapy of the Cervical and Thoracic Spine. New York: Churchill Livingstone; 1988.
43. Sahrmann S, Azevedo DC, Van Dillen L. Diagnosis and treatment of movement system impairment syndromes. Braz J Phys Ther. 2017;21(6):391-399. doi: 10.1016/j.bjpt.2017.08.001. PubMed PMID: 29097026; PubMed Central PMCID: PMC5693453.