Immediate Effects of Diaphragmatic Breathing Exercise on Shoulder Pain and Range of Motion in Patients with Adhesive Capsulitis

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Abstract

Background: A degenerative condition called adhesive capsulitis, also known as "frozen shoulder", causes excruciating discomfort when moving and restricts the range of motion (ROM). The purpose of this study is to determine whether diaphragmatic breathing exercises have any immediate impact on pain and joint mobility in individuals with adhesive capsulitis. Patients and procedures A total of 24 patients who reported adhesive capsulitis were included and divided into two equal groups: group A (control) and group B (experimental). Group B underwent one session of 20 minutes of diaphragmatic breathing exercises while group A received no treatment at all and simply rested on a chair for the duration of group A's treatment. A visual analog scale was used to quantify shoulder pain, and a universal goniometer was used to measure the shoulder range of motion. Results: There was a significant difference ($p<0.005$) between pre-and post-test mean values, with the experimental group experiencing a post-treatment significant decrease in pain and an increase in mobility (B). Diaphragmatic breathing exercises had an immediate impact on shoulder discomfort and range of motion in people with adhesive capsulitis. Since most interventions are limited in the early stages of the disease because of the severity of the pain, this result is essential for physiotherapists and patients. Additional longitudinal research is required

Keywords: Adhesive Capsulitis, Diaphragmatic Breathing Exercise, Shoulder Pain, Shoulder Range of Motion.

1. Introduction

Adhesive capsulitis, also known as "frozen shoulder," is a degenerative condition that typically affects persons between the ages of 40 and 60. (Shanahan and Sladek, 2011). Adhesive capsulitis is becoming more common in younger generations. Due to joint adhesion, synovial membrane hyperplasia, diminished joint cavity, tight capsule, and tissue proliferation-related discomfort and hypomobility restrict patients' daily activities (Akpinar, et al., 2003; Loew et al., 2005).

Particularly, adhesive capsulitis reduces the shoulder's ability to abduct, rotate internally, and rotate externally. Patients who are in the early stages of the disease report having severe shoulder joint pains (Hamdan et al., 2003). Additionally, patients with adhesive capsulitis report persistent night pain, which leads to motor control issues, balance issues, a reduction in quality of life, psychological issues, and eventually weakening of the shoulder muscles (Cho et al., 2002; Kim et al., 2011). (You and Jung, 2001). Decreased working productivity, also had enormous economic effects on towns, sectors, and individuals (Sundstrup and Andersen, 2017).

Because each patient should receive tailored care, it is crucial to take into account their symptoms and stage of the ailment when choosing a frozen shoulder treatment strategy (even when they overlap). Unlike stretching in the later stage, the early stage demands treatments to regulate inflammation and ease pain (Murray et al., 2013). In stage 1, Priority should be given to educating the

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patient about activity moderation and positioning. Patients who have stage 2 frozen shoulder respond well to physical therapy and stretching. The capsule should be stretched enough to allow for typical glenohumeral biomechanics. The intensity of this, however, should be determined by the level of pain (Laubscher and Rösch, 2009).

Active exercises are done in the range of pain-free motion and pendulum exercises are more helpful than intensive physiotherapy in alleviating frozen shoulder discomfort than passive stretching and manual mobilization (Diercks and Stevens, 2004). Accordingly, it was proposed and predicted that breathing exercises could reduce discomfort and increase mobility in this disease's early stages without provoking symptoms.

In the pilot, uncontrolled, and case studies, diaphragmatic, abdominal, or deep breathing exercises were found to reduce pain, enhance function, and improve balance in both healthy people and patients with shoulder pain and rotator cuff injuries (Lee, 2015; Stephens et al., 2017; Fernandez-Lopez et al., 2021). However, the authors found no randomized controlled trial in the literature that examines the quick results of diaphragmatic breathing exercises in the management of adhesive capsulitis.

In order to better understand how diaphragmatic breathing exercises affect shoulder discomfort and range of motion in patients with adhesive capsulitis, this study will look at their immediate effects.

2. Patient and Methods

Type of study: The current work is a randomized controlled clinical trial.

Study setting: The investigation was conducted at Badr University's outpatient clinic. This study was carried out in accordance with the Declaration of Helsinki's code of ethics and was ethically approved by the faculty of physical therapy at Modern University for Technology and Information (MTI) (No: REC/2111/MTI.PT/2301241). Before taking part, participants had to complete informed consent papers.

Study population

All cases (24), aged 40–60, who were admitted to the Badr University out-clinic period, complained of pain and a restriction in shoulder range of motion and were given an official diagnosis of adhesive capsulitis by a doctor, were included.

Exclusion criteria

Smoking
Neurological pathology.

Respiratory disorders

Cardiological complications.
Shoulder or thoracic surgery.
Shoulder dislocation or subluxation.

Population and study settings

The cases were instructed to select a slip from an envelope containing the group allocation number after the twenty-four patients were randomly split into two equal groups.

First, Group (A) or an untreated control group (only rested on a chair for 20 minutes). Second, study group (B), received diaphragmatic breathing techniques. The patient was told to inhale slowly and deeply through the nose for 4 seconds and expel through the mouth for 6 seconds while in the semi-fowler posture with flexed knees. The patient then placed one hand on the chest and the other on the abdomen. To prevent fainting and dizziness, patients performed cycles of 3–4 repeats repeatedly for 20 minutes, with a break of 2–3 minutes in between. The afflicted shoulder was placed in postures that limited its range of motion while breathing.

According to the research by Mullaney et al., a universal goniometer was adopted to assess the shoulder's range of motion (ROM) in flexion, abduction, and rotation (2010). A cross mark was placed on the lateral aspect of the center of the humeral head just below the acromion process to measure the flexion while the arm was raised vertically from the supine position (fulcrum).

Two cross marks were positioned: one along the midline of the thorax and two along the midshaft of the humerus, aligned with the greater tuberosity and lateral epicondyle of the humerus. The angle of the arm stretched laterally from the position where the upper trunk was fixed and with the thumb pointing up towards the ceiling was used to quantify abduction movement. The coracoid process was given a cross (fulcrum).

Along the humeral shaft, a cross mark was made, and a second cross mark was made along the midline of the thorax. With the upper trunk immobile, the arm abducted by 90 degrees, and the elbow bent by 90 degrees, the internal and external rotations were measured as the maximum angles of moving away and towards the head, respectively. At the olecranon process (fulcrum), a cross mark was made, and a second cross mark was made at the ulnar styloid process.

The intensity of the pain experienced while the shoulder joint was manipulated was measured using a Visual Analog Scale (VAS). It consisted of a straight line of 100 mm in length, with the left end (0 mm) representing a condition of no pain and the right end (100 mm), the highest level of agony (Lunderberg et al., 2001).

Before beginning the diaphragmatic breathing exercise and 20 minutes after the study group's session began, the tests were carried out. Measurements were performed before and after 20 minutes of comfortable chair relaxation in the control group. The participants were screened based on exclusion criteria using their demographic information and past.

3. Statistical Analysis

Unpaired tests and descriptive statistics (Means, Standard Deviations, Counts) were adopted in the current research work to compare subject characteristics (other than sex) and results between groups. The chi-squared test was adopted to evaluate the distribution of gender. The comparison of results between pre-and post-treatment among groups was done using a paired t-test. All statistical tests had a noticeable threshold of $p < 0.05$. The statistical package for social studies (SPSS) version 24 for Windows was adopted for all statistical calculations.

4. Results

All included cases were analyzed with no drops as shown in the flow chart of the patients (Figure 1).

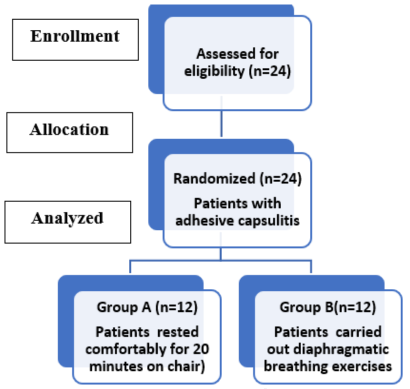

Figure (1): Flow chart of the patients.

The demographic data of both groups' cases were portrayed in (table 1) & (figure 2).

Table (1): Comparison of age and sex distribution between groups.

Variable	Groups	$\bar{X}$ ± SD	p-value
Age (years)	Group (A)	49.6 ± 4.9	1
	Group (B)	49.5 ± 4.8	
Sex distribution (male/female)	Group (A)	6/6	1
	Group (B)	6/6	

$\bar{X}$: Mean. SD: Standard Deviation p-value: Probability value.

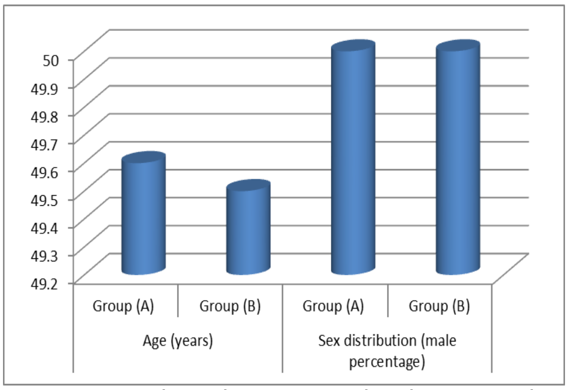

Figure (2): Chart showing sex distribution (male percentage) and mean values of age in both groups.

Within-groups comparison

$\bar{X}$ ± SD values of the visual analog scale (VAS) in the pre-and post-test of both groups were presented in (table 2) and (figure 3). There was no clear disparity (p= 1) when comparing pre and post-test mean values in the control group. Nevertheless, there was a clear difference (p<0.001) in the study group with a marked reduction of pain post-treatment (table 2) and (figure 3).

(b) Between-groups comparison:

When comparing the two groups (A and B) before treatment, there was no marked disparity (p= 1). While there were clear variances post-test (p= 0.000) in favor of the study group (table 2) and (figure 2).

Shoulder pain

Table (2): Comparison of shoulder pain within and between groups.

Shoulder pain	$\bar{X}$ ± SD		MD	p-value
	Pre-treatment	Post-Treatment		
Group (A)	4.83 ± 0.84	4.83 ± 0.94	0	1
Group (B)	4.83 ± 0.94	2.6 ± 1.1	2.25	0.000*
MD	0	2.25		
p-value	1	0.000*		

$\bar{X}$: Mean. SD: Standard Deviation. MD: Mean Difference. p-value: Probability value

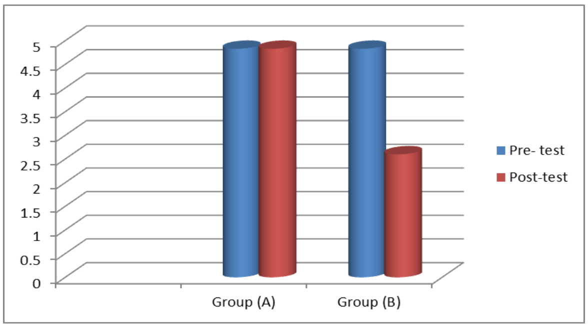

Figure (3): pre-and post-treatment mean values of shoulder pain in both groups.

Shoulder range of motion:

Within-groups comparison:

$\bar{X}$ ± SD values of shoulder range of motion (ROM) of external rotation, abduction, internal rotation, and flexion pre-and post-treatment in both groups were presented in (table 3) and (figure 4). There was no noticeable disparity (p>0.27) when comparing pre-and post-test mean values in the control group. However, there were marked differences in shoulder ROM (p<0.005) in the study group with a clear increase in ROM post-treatment (table 3) and (figure 4).

(b) Between-groups comparison:

There was no clear variances pre-test between groups in shoulder ROM values (p>0.51). As well, there was no clear disparity between groups post-test in shoulder ROM (p>0.063) except external rotation ROM (p=0.033) which was markedly higher in favor of group B (study) (table 3) and (figure 4).

Table (3): Comparison of shoulder ROM within and between groups.

Shoulder ROM	$\overline{X}$ ± SD		MD	p-value
	Pre	Post		
Shoulder external rotation				
Group (A)	44.25 ± 10.74	44.7 ± 13.7	-0.42	0.85
Group (B)	44.6 ± 13.7	57 ± 12.6	-12.25	0.000*
MD	-0.42	-12.25		
p-value	0.94	0.033*		
Shoulder abduction				
Group (A)	73.7 ± 13.7	78.2 ± 18.9	-4.5	0.27
Group (B)	78 ± 20	85.7 ± 20.7	-7.5	0.008*
MD	-4.5	-7.5		
p-value	0.51	0.37		
Shoulder internal rotation				
Group (A)	49.3 ± 15.71	50.9 ± 17.3	-1.5	0.58
Group (B)	51 ± 17	64 ± 15.6	-13.1	0.006*
MD	-1.6	-13		
p-value	0.82	0.065		
Shoulder flexion				
Group (A)	126.4 ± 11.52	127.9 ± 12.24	-1.5	0.46
Group (B)	128 ± 12	136.8 ± 9.94	-8.9	0.005*
MD	-1.5	-8.92		
p-value	0.76	0.063		

$\overline{X}$: Mean. SD: Standard Deviation. MD: Mean Difference. p-value: Probability value

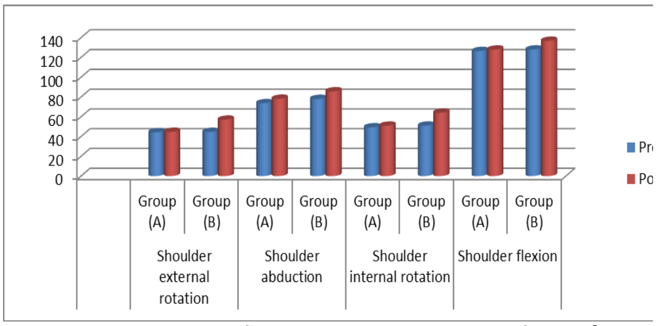

Figure (4): Pre- and post-treatment mean values of shoulder ROM in both groups.

5. Discussion

Due to degenerative changes in the shoulder joint and its surrounding tissues, adhesive capsulitis is a musculoskeletal condition with adherence to the surface of the joint. This alteration is accompanied by severe discomfort, which gradually reduces the shoulder range of motion and muscle strength and seriously impairs the patient's everyday activities (Neviaser and Hannafin 2010; Donatelli et al., 2014; Ryan et al., 2016).

In the currently proposed investigation, it was discovered that 20-minute sessions of deep breathing exercises considerably reduced shoulder pain and increased range of motion, particularly in the external rotation, in patients with adhesive capsulitis.

The current study's consequences were consistent with previous research (Friesner et al., 2006; Schaffer and Yucha, 2004; Lee, 2015; ahin and Kocamaz, 2021) that found that deep breathing exercises helped patients' shoulder pain, mobility, and everyday activities.

Exercises that involve slow, deep breathing have been shown to be useful in easing pain sufferers' tense muscles (Busch et al., 2012). According to the earlier study by Hyun and Kang (2002), breathing exercises can help improve patients' shoulder flexibility and ease discomfort. The patients were middle-aged female patients. Additionally, three 30-minute sessions of deep breathing techniques were used over the course of three weeks. The study's findings led to an improvement in the patient's typical range of motion and a reduction in pain (Lee, 2015).

Diaphragm exercise can enhance proprioception in the lumbosacral muscles (Nobre e Souza et al., 2013). Respiratory capacity is impacted by diaphragm activity, which also generally alters how people perceive pain. Additionally, a healthy posture and body position are maintained by promoting deep breathing and enhancing the diaphragm's effectiveness (Bordoni and Marelli, 2016; Bordoni et al., 2016).

The autonomic nervous system and the respiratory system are closely related to one another. The vagus (parasympathetic) nerve is related to the phrenic nerve, which innervates the movement of the diaphragm muscle (Kocjan et al., 2017). Exercises involving diaphragmatic breathing stimulate the parasympathetic nervous system and the gamma-aminobutyric acid pathways while decreasing the sympathetic nervous system (Ambrosino, et al., 1981; Chang et al., 2013). This technique lessens anxiety and pain while enhancing brain and cardiovascular function (Jerath et al., 2015).

The current research supports Ahin and Kocamaz's (2021) findings that shoulder pain sufferers can improve their quality of life and reduce discomfort by engaging in diaphragmatic breathing exercises and mobilization. This can be explained by the obvious anatomical link and myofascial connection between the diaphragm and the shoulder.

The major limitations of the study are related to

Small sample size.
Short treatment period.
No follow-up.
Single-center study.

6. Conclusion

Diaphragmatic breathing techniques helped frozen shoulder patients with their shoulder pain and mobility. Therefore, it is necessary to add intervention to the standard protocols for treating these patients.

Summary

Due to pain, adhesive capsulitis, a common musculoskeletal ailment, limits shoulder motion and interferes with patients' daily activities. In the current study, 24 patients with adhesive capsulitis were enrolled and randomly assigned to 1 of 2 groups, group A, or the control group, which received merely 20 minutes of pleasant chair rest, and group B, the study group, which received 20 minutes of deep breathing exercises. Before and after the 20 minutes, the shoulders of all patients were evaluated for discomfort and mobility. None of the outcomes for patients in the control group improved. While after the 20-minute session of deep breathing exercises, the study group significantly (or tended to be significant) improved. In addition, the study group significantly outperformed the control group in terms of discomfort and mobility (apart from abduction).

References

Shanahan EM, Sladek R. Shoulder pain at the workplace. Best Pract Res Clin Rheumatol 2011;25:59-68.

Akpinar S, Ozalay M, Hersekli MA, Ozkoc G, Tandogan RN. Arthroscopic capsular release for frozen shoulder. Acta Orthop Traumatol Turc 2003;37:213-218.

Loew M, Heichel TO, Lehner B. Intraarticular lesions in primary frozen shoulder after manipulation under general anesthesia. J Shoulder Elbow Surg 2005;14:16-21.

Hamdan TA and Al-Essa KA. Manipulation under anaesthesia for the treatment of frozen shoulder. Int Orthop 2003;27:107-109.

Cho KH, Song JY, Lee H, Kim JS, Rhee YG. The effect of subacromial bursa injection of hyaluronate in patients with adhesive capsulitis of shoulder joint. J Korean Acad Rehabil Med 2002;26:73-80.

Kim SR, Lee JH, Ahn SH. The Effects of a Functional Movement Screen on Pain and Performance Ability in Professional Fencing Players. J Korean Phys Soc 2011;23:21-28.

You JE, Jung EH. The effects of traditional physical therapy on pain reduction and depression level of patients with chronic low back pain. J Korean Phys Soc 2001;13:677-683

Sundstrup, E., & Andersen, L. L. (2017). Hard Physical Work Intensifies the Occupational Consequence of Physician-Diagnosed Back Disorder: Prospective Cohort Study with Register Follow-Up among 10,000 Workers. International journal of rheumatology, 2017, 1037051.

Murray, C. J., Atkinson, C., Bhalla, K., Birbeck, G., Burstein, R., Chou, D., Dellavalle, R., Danaei, G., Ezzati, M., Fahimi, A., Flaxman, D., Foreman, Gabriel, S., Gakidou, E., Kassebaum, N., Khatibzadeh, S., Lim, S., Lipshultz, . E., London, ., Lopez, … U. . Burden of Disease Collaborators (2013). The state of US health, 1990-2010: burden of diseases, injuries, and risk factors. JAMA, 310(6), 591-608.

Laubscher PH and Rösch TG: Frozen shoulder: A review. SA Orthopaedic Journal Spring 2009. P:24-29

Diercks RL, Stevens M. Gentle thawing of the frozen shoulder: a prospective study of supervised neglect versus intensive physical therapy in seventy seven patients with frozen shoulder syndrome followed up for two years. J Shoulder Elbow Surg 2004;13:499-502.

Lee B. K. (2015). Effects of the combined PNF and deep breathing exercises on the ROM and the VAS score of a frozen shoulder patient: Single case study. Journal of exercise rehabilitation, 11(5), 276–281.

Stephens, R. J., Haas, M., Moore, W. L., 3rd, Emmil, J. R., Sipress, J. A., & Williams, A. (2017). Effects of Diaphragmatic Breathing Patterns on Balance: A Preliminary Clinical Trial. Journal of manipulative and physiological therapeutics, 40(3), 169–175.

Fernandez-Lopez I. et al. Effects of diaphragm muscle treatment in shoulder pain and mobility in subjects with rotator cuff injuries: A dataset derived from a pilot clinical trial Data Brief 2021, 35: 106867.

Mullaney MJ, Mchugh MP, Johnson CP. Tyler TF. Reliability of shouler range of maotioncomparing a goniometer to a digital level. Physiother Theory Pract 2010,; 26: 327-333.

Lunderberg T, Lund E, Dahlin L, Borg E, Gustfsson S, Rosen A, Kwabk J and Ericksson S. (2001). Reliability and responsiveness of three different pain assessment. J Rehabilitation MED; 33(6):279-283,.

Neviaser, A. S., & Hannafin, J. A. (2010). Adhesive capsulitis: a review of current treatment. The American journal of sports medicine, 38(11), 2346–2356.

Donatelli R, Ruivo RM, Thurner M, Ibrahim MI. New concepts in restoring shoulder elevation in a stiff and painful shoulder patient. Phys Ther Sport 2014;15:3-14

Ryan, V., Brown, H., Minns Lowe, C. J., & Lewis, J. S. (2016). The pathophysiology associated with primary (idiopathic) frozen shoulder: A systematic review. BMC musculoskeletal disorders, 17(1), 340.

Friesner, S. A., Curry, D. M., & Moddeman, G. R. (2006). Comparison of two painmanagement strategies during chest tube removal: relaxation exercise with opioids and opioids alone. Heart & lung: the journal of critical care, 35(4), 269–276.

Schaffer, S. D., & Yucha, C. B. (2004). Relaxation & pain management: the relaxation response can play a role in managing chronic and acute pain. The American journal of nursing, 104(8), 75–82.

Hyun KS, Kang HS. Effect of dan-jun breathing exercise program experienced by women in midlife. J Korean Acad Fundam Nurs 2002;9:180- 189

Busch V, Magerl W, Kern U, Haas J, Hajak G, Eichhammer P. The effect of deep and slow breathing on pain perception, autonomic activity, and mood processing--an experimental study. Pain Med 2012;13:215- 228.

Nobre e Souza, M. Â., Lima, M. J., Martins, G. B., Nobre, R. A., Souza, M. H., de Oliveira, R. B., & dos Santos, A. A. (2013). Inspiratory muscle training improves antireflux barrier in GERD patients. American journal of physiology. Gastrointestinal and liver physiology, 305(11), G862–G867.

Bordoni, B., & Marelli, F. (2016). Failed back surgery syndrome: review and new hypotheses. Journal of pain research, 9, 17– 22

Bordoni, B., Marelli, F., & Bordoni, G. (2016). A review of analgesic and emotive breathing: a multidisciplinary approach. Journal of multidisciplinary healthcare, 9, 97–102.

Kocjan, J., Adamek, M., Gzik-Zroska, B., Czyżewski, D., & Rydel, M. (2017). Network of breathing. Multifunctional role of the diaphragm: a review. Advances in respiratory medicine, 85(4), 224–232.

Ambrosino, N., Paggiaro, P. L., Macchi, M., Filieri, M., Toma, G., Lombardi, F. A., Del Cesta, F., Parlanti, A., Loi, A. M., & Baschieri, L. (1981). A study of short-term effect of rehabilitative therapy in chronic obstructive pulmonary disease. Respiration; international review of thoracic diseases, 41(1), 40–44.

Chang, Q., Liu, R., & Shen, Z. (2013). Effects of slow breathing rate on blood pressure and heart rate variabilities. International journal of cardiology, 169(1), e6–e8.

Jerath, R., Crawford, M. W., Barnes, V. A., & Harden, K. (2015). Self-regulation of breathing as a primary treatment for anxiety. Applied psychophysiology and biofeedback, 40(2), 107–115.

Şahin and Kocamaz., (2021): Effects of Diaphragmatic Mobilization and Diaphragmatic Breathing Exercises on Pain and Quality of Life in Individuals with Shoulder Pain: A Randomized Controlled Trial. Int J Disabil Sports Health Sci; 4(2):113-123