International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

Pilates exercise versus, manual lymphatic drainage on axillary web syndrome post mastectomy

Orchid Saber Abd Elfadil[1], Haidy Nady Ashem[1], Mohamed Abdelrahman Hassan Abolkasem[2], Ereny Sobhy Wahba Khalil[1]

[1]*Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Cairo University, Egypt.*

[2]*Department of Clinical Oncology and Nuclear Medicine, Faculty of Medicine, Kasr Alaini, Cairo University, Egypt.*

Abstract

Breast cancer (BC) is the most common malignant tumor in women and a leading cause of mortality. Surgical treatment and post-surgery breast reconstruction represent milestones of BC therapeutic interventions; however, these procedures may lead to post-traumatic stress disorder, wound complications, breast cancer-related lymphedema (BCRL), BC fatigue, and axillary web syndrome. The purpose of the study was to compare the therapeutic efficacy of Pilates exercise versus manual lymphatic drainage on axillary web syndrome post-mastectomy. Sixty-eight patients participated in this study. Their ages ranged from 35 to 55 years. They were selected from National Cancer Institute and divided randomly into two groups equal in number. Group (A): 34 patients received 30 min Pilates exercise 3 times per week in addition to selected physical therapy program for 18 weeks. While, Group (B): 34 patients received 30 min Manual lymphatic drainage massage 3 times per week in addition to selected physical therapy program for 18 weeks. Shoulder pain was evaluated by VAS and Shoulder ROM was evaluated by Electronic goniometer before and after the intervention and measuring disability of the (arm, shoulder and hand) by DASH questionnaire. This study revealed that there was a statistically highly significant improvement in VAS and shoulder ROM of group (B) when compared with its corresponding value in group (A). Manual lymphatic drainage was more effective than Pilates exercise in improvement shoulder pain and ROM in axillary web syndrome post-mastectomy patients.

Keywords: Mastectomy, Pilates exercise, axillary web syndrome, Manual lymphatic drainage.

Full length article **Corresponding Author*, e-mail: orchidello87@gmail.com

1. Introduction

Axillary web syndrome (AWS) is one of the least studied disorders affecting BC survivors. This condition, also known as cording, is clinically characterized by a visible and/or palpable web of string-like structures (i.e., cords) localized at the subcutaneous level of the site of surgery. The most common sites of AWS are the armpit, the ventral side of the arm, along the forearm, the wrist, and hands or on the base of the thumb. The clinical manifestations of AWS might include dull or burning pain, traction sensation, and range of motion (ROM) limitations in flexion and abduction of the shoulder [1-2]. The incidence of AWS after BC surgery is unclear, ranging from 6% to 85.4%. As previously noticed, however, only a handful of studies investigated the prevalence and the main risk factors associated with AWS development. Among these, axillary lymph node dissection (ALND), the number of lymph nodes removed, and the extent of axillary surgery are currently considered risk factors for AWS development [3].

Pilates has been beneficial for breast cancer patients. Despite a lack of scientific evidence, Pilates has been endorsed for the rehabilitation of breast cancer survivors. Pilates is a low-impact workout that aims to develop muscles while additionally enhancing posture stability and flexibility. The primary objective of Pilates is to strengthen the core. Still, patients should expect to notice an increase in muscle bulk in their arms and legs as a result of using their extremities to regulate the core, which can be beneficial in female breast cancer patients [4]. Some studies highlighted that rehabilitation of breast cancer therapy utilizing Pilate exercise, specifically targeting upper extremity functions, has excellent positive benefits such as range of motion than a home exercise program. Similarly, another study has demonstrated an improvement in the range of motion following Pilate's treatment. Pilates is

swiftly gaining recognition as a fitness approach across the world. However, there remained a lack of breast cancer awareness and understanding, in addition to many fallacies concerning etiology, risk factors, and breast cancer management [5].

In patients with breast cancer, lymphatic abnormalities precede the development of lymphedema. In younger women, obesity appears to be the main factor in developing lymphedema, whereas in older women, improving muscle strength through active exercise can prevent lymphedema. Manual lymphatic drainage is as safe and effective as vigorous exercise in rehabilitation after breast cancer surgery [6]. In addition to physical therapy, manual lymphatic drainage (MLD) may also reduce the development of axillary web syndrome (AWS) because Manual lymphatic drainage is skin stretching massage of the skin Performed to open the lymphatics in unaffected regions to drain fluid from the affected regions and increase lymphatic drainage. Increased clearance reduces local levels of inflammatory mediators, often associated with edema and pain [7].

2. MATERIALS AND METHODS

2.1 Study design

All aspects of the study were disclosed and informed consent was obtained. The patients were randomly assigned into two equal groups via the envelope mode. After patients' agreement to participate in the study, cards with either "Pilates exercises group" or "Manual lymphatic drainage massage group" recorded on them were closed in envelopes; then a blinded physical therapist was asked to select one envelope. According to the selected card, patients were assigned to their corresponding group. Dates for starting the allocated therapy were regulated and the therapy was begun after the first week of randomization. The examiner physical therapist was not included in randomization procedures and was unaware of the therapy allocation. Patients were asked not to disclose their therapy allocation to the physical therapist during assessment. The participants were informed to report any harmful effects throughout the treatment period.

2.2 Sample size determination

Sample size calculation was performed using G*POWER statistical software (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany) and revealed that the required sample size for this study was 34 subjects per group. Calculations were made using α=0.05, power = 80% and effect size =0.74and allocation ratio N2/N1 =1.

2.3 Subjects

Sixty-eight female patients who had unilateral axillary web syndrome post-mastectomy surgery participated in this study. Their ages ranged from 35 and 55 years. The participants were selected from the National Cancer Institute, Cairo University and randomly distributed into two equal groups. Patients were enrolled in the trial if they met the following criteria: (1) both genders with age range between 35 to 55 years participated in this study. (2) Females only participated in the study. (3) No change of arm size. (4) All patients have axillary web syndrome based on clinical examination. The exclusion criteria were:

(1) Lymphedema. (2) Pregnant women. (3) Rheumatoid arthritis.
(4) Osteopenia. (5) Frozen shoulder. (6) Patients have deformity.

2.4 Outcome measures

2.4.1 Visual Analogue Scale (VAS)

The VAS was used for assessing and quantifying pain exhibited by the patients through a 0–10 scale. Each subject was informed to mark the line according to the pain intensity experienced at that particular time where 0 means no pain and 10 means worst conceivable pain.

2.4.2 DASH questionnaire (Disability of the arm, shoulder and hand)

It is a self-administered region-specific outcome instrument developed as a measure of self-rated upper-extremity disability and symptoms. Consists mainly of a 30-item disability/symptom scale, scored 0 (no disability) to 100. The main purpose of DASH was to assess the longitudinal construct validity of the DASH among patients undergoing surgery. The second purpose was to quantify self-rated treatment effectiveness after surgery (DA SILVA N.C et al., 2020)

2.4.3 Electronic Goniometer

The active ROM of the shoulder (flexion, abduction and external rotation on affected side) was measured using the standard, plastic universal digital goniometer when the patient was in a supine or sitting position. By fixing it's fulcrum on the acromion, fixed arm parallel to the arm and it's mobile arm moving with arm direction and then the patient was instructed to do flexion motion in the sagittal plane and abduction motion in the frontal plane. To measure external and internal rotation the fulcrum was fixed on the olecranon process and then the patient was instructed to do external and internal rotation of the arm in the transverse plane. Look at the reading on the digital goniometer before removing it from the patient's body. Ensure that you take an accurate reading of the degree of motion on the electronic goniometer, and that you consistently use the same stationary and movable landmarks on the body when measuring, to ensure consistency. Be sure to record the range of motion for the joint.

2.4.4 Intervention

After receiving medical counseling, patients were randomly assigned to either Group (A): Pilate's exercises (n=34) who were received Pilates exercise with traditional physical therapy exercise program (strength, core stability, flexibility, muscle control, posture and breathing) Duration 30 minutes, Three session per week, daily for 18 weeks and Group (B): Manual lymphatic drainage massage (n=34) who had received Manual lymphatic drainage massage with traditional physical therapy exercise program (strength, core stability, flexibility, muscle control, posture and breathing therapy) Duration 30 minutes, Three session per week, daily for 18 weeks. Patients' full names, ages, addresses, and phone numbers were recorded during the history-taking process. They were also questioned about whether or not they had undergone any surgeries in the past. The current surgical procedure and the patient's medical history,

including the medications actually administered, were thoroughly analyzed.

2.5 Statistical analysis

Unpaired t-test was conducted for comparison of age between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Mixed MANOVA was conducted to investigate the effect of treatment on VAS, DASH and shoulder ROM. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

3. RESULTS AND DISCUSSION

3.1 Subject characteristics

Sixty-eight patients with axillary web syndrome post mastectomy participated in this study. Table (1) showed the subject characteristics of group A and B. There was no significant difference between groups in age ($p > 0.05$).

3.2 Effect of treatment on VAS, DASH, flexion, abduction and external rotation ROM

Mixed MANOVA revealed that there was a significant interaction of treatment and time ($F = 24.02$, $p = 0.001$, partial eta squared = 0.81). There was a significant main effect of time ($F = 2728.05$, $p = 0.001$, partial eta squared = 0.99). There was a significant main effect of treatment ($F = 71.39$, $p = 0.001$, partial eta squared = 0.85).

3.2.1 Within group comparison

There was a significant decrease in VAS and DASH in both groups at post II compared with that pretreatment and post I ($p < 0.001$) and a significant decrease at post I compared with pretreatment ($p < 0.001$). (Table 2). There was a significant increase in flexion, abduction and external rotation in both groups at post II compared with that pretreatment and post I ($p < 0.001$) and a significant decrease at post I compared with pretreatment ($p < 0.001$). (Table 3).

3.2.2 Between group comparison

There was no significant difference between groups pre treatemnt ($p > 0.05$). There was a significant decrease in VAS and DASH of group B compared with that of group A at post I and post II ($p < 0.001$). There was a significant increase in flexion, abduction and external rotation of group B compared with that of group A at post I and post II ($p < 0.001$). (Table 2-3).

3.3 Ethical approval

Each patient participated in this study only after signing an informed consent form in which their rights were fully explained. The study was conducted after receiving approval from the Institutional Review Board of the Faculty of Physical Therapy at Cairo University (No. P.T. REC/012/003745). The current study was conducted in accordance with the principles outlined in the Declaration of Helsinki on the treatment of human research subjects.

3.4 Informed consent

Informed consent has been obtained from all individuals included in this study. Axillary web syndrome (AWS) is a common post mastectomy complication in breast cancer patients. AWS usually occurs 5– 8 weeks after surgery and is characterized by visible or palpable cords of subcutaneous tissue in the breast, medial arm, antecubital space, forearm, hand, or chest wall. This syndrome often limits shoulder and elbow range of motion (ROM), causing pain and tightness [8-9]. Pilates is an exercise approach based on Eastern theories of body-mind spirit interaction combined with Western theories of biomechanics, motor learning, and core stability [10]. Pilates have been beneficial for breast cancer patients. Despite a lack of scientific evidence, Pilates has been endorsed for the rehabilitation of breast cancer survivors. Pilates is a low-impact workout that aims to develop muscles while additionally enhancing posture stability and flexibility. Which can be beneficial in female breast cancer patients [11].

In patients with breast cancer, lymphatic abnormalities precede the development of lymphedema. Manual lymphatic drainage is as safe and effective as vigorous exercise in rehabilitation after breast cancer surgery [12]. In addition to physical therapy, manual lymphatic drainage (MLD) may also reduce the development of axillary web syndrome (AWS) because Manual lymphatic drainage is skin stretching massage of the skin Performed to open the lymphatics in unaffected regions to drain fluid from the affected regions and increase lymphatic drainage. Increased clearance is thought to reduce local levels of inflammatory mediators, which are often associated with oedema and pain [13]. So, the purpose of this study was to investigate the therapeutic efficacy of Pilates exercise on axillary web syndrome post mastectomy and evaluate the therapeutic efficacy of manual lymphatic drainage on axillary web syndrome post mastectomy.

By using three various methods of evaluation: visual analogue scale (VAS), electronic goniometer and (Disability of the arm, shoulder and hand) (DASH). This study was conducted on 68 female patients who had mastectomy surgery, they were selected randomly from out clinic of (Al kasr Al Ayni hospital and National cancer institute) and agreed to participate in the study; their ages ranged from 35 to 55years old.

They were divided into two equal groups, matched for measured variables:

- The first group; group (A) (Pilates Exercise group): consisted of 34 patients, their ages ranged from 35 to 55 years old with mean of (45.41 ± 6.55) years, received 3 sessions/week for 18 weeks with Pilates exercise with traditional physical therapy exercise program (strength, core stability, flexibility, muscle control, posture and breathing).
- The second group; group (B) (Manual Lymphatic Drainage): consisted of 34 patients, their ages ranged from 35 to 55 years old with mean of (45.41 ± 6.55) years, received 3 sessions/week for 18 weeks with Manual lymphatic drainage massage with traditional physical therapy exercise program (strength, core stability, flexibility, muscle control, posture and breathing).

By comparison between post 1 and post 2 mean values of VAS for both groups the analysis of the results of the current study revealed that:

• The mean difference between the groups was 0.94. There was a significant decrease in VAS of group B compared with that of group A at post I (p = 0.001).
• The mean difference between the groups was 0.56. There was a significant decrease in VAS of group B compared with that of group A at post II (p = 0.001).
This means that Pilate's exercises and Manual Lymphatic Massage has significant effect on decreasing and controlling pain post mastectomy.

This finding is in consistent with that reported by: (Koehler et al., 2019, Yeung et al., 2015, Luz et al., 2017, Cho et al., 2016, Ezzo et al., 2015, Devoogdt et al., 2018, Ha et al., 2017). Koehler et al. (2019) physical therapy techniques that have a positive effect on the outcome of AWS include compression bandaging, manual lymphatic drainage, scar release manipulation, massage of adhesion, joint mobilization, stretching and strengthening exercises, and at-home program. Yeung et al. (2015) A systemic review done by Yeung WM et al. suggested that AWS frequency was reported in up to 85.4% of patients. Biopsies identified venous and lymphatic etiopathology, while five studies suggested lymphatic involvement. Twenty-one studies reported AWS occurrence within eight weeks postoperatively, but late occurrence of later than 3 months is possible. Pain was commonly reported along with shoulder abduction being more restricted than flexion. AWS symptoms usually resolve within 3 months but may persist. The risk factors might include extensiveness of surgery, younger age, lower body mass index, ethnicity, and healing complications. Low-quality studies suggested that conservative approaches, including analgesics, non-steroidal anti-inflammatory drugs, and/or physiotherapy may be safe and effective for early symptom reduction.

Luz et al. (2017) Physical therapy is recommended as a safe and effective primary treatment for AWS. Physical therapy treatment consists of an initial process of patient education, supervised and at-home exercises, and tissue "manipulations", including a variety of adjunctive rehabilitation interventions, to improve range of motion and decrease pain. Cho et al. (2016) One of the treatment modalities for AWS includes manual lymphatic drainage. Manual drainage could help resolve this issue. Cho Y et al. applied lymphatic drainage to 41 patients with AWS initially by health professionals and from the second week onwards by trained family members, 3 to 5 times a week for 4 weeks. This convenient and effective method significantly reduced the pain, increased the mobility and muscle strength, and reduced the risk of postoperative lymphedema in the affected limb.

Devoogdt et al. (2018) Lymphatic Massage due to its ability to reduce pain and swelling associated with removal of lymph nodes during breast cancer treatment. If received regularly, it may also enhance the function of healthy breast tissue with improved lymph flow. By comparison between post, I and II treatments mean values of active shoulder ROM (flexion, abduction, and external rotation) for both groups the analysis of the results of the current study revealed that:
For flexion:
• There was a significant increase in flexion ROM of group B compared with that of group A at post I (p = 0.001).
•There was a significant increase in flexion ROM of group B compared with that of group A at post II (p = 0.001).
For abduction:
•There was a significant increase in abduction ROM of group B compared with that of group A at post I (p = 0.001).
•There was a significant increase in abduction ROM of group B compared with that of group A at post II (p = 0.001).
For external rotation:
•There was a significant increase in external rotation ROM of group B compared with that of group A at post I (p = 0.001).
•There was a significant increase in external rotation ROM of group B compared with that of group A at post II (p = 0.001).

This means that Manual Lymphatic Massage has a significant effect on increasing shoulder ROM more than Pilate's exercises post mastectomy. This finding is in consistent with that reported by: (Cho et al., 2016, Ha et al., 2017, Devoogdt et al., 2018, Muller et al., 2018, Zengin Alpozgen et al., 2017 Şener et al., 2017,). Cho et al. (2016) One of the treatment modalities for AWS includes manual lymphatic drainage. AWS is caused mainly by poor lymphatic drainage and accumulation of proteins and inhibitors (e.g. NO synthase inhibitors). Manual drainage could help resolve this issue. Cho Y et al. applied lymphatic drainage to 41 patients with AWS initially by health professionals and from the second week onwards by trained family members, 3 to 5 times a week for 4 weeks. This convenient and effective method significantly reduced the pain, increased the mobility and muscle strength, and reduced the risk of postoperative lymphedema in the affected limb.

Ha et al. (2017) Manual Lymphatic Drainage Massage can help strengthen the immune system. As manual lymph drainage also assists with stimulating the parasympathetic response in the body, it's beneficial in situations where the nervous system has been compromised, such as with anxiety and post-traumatic stress disorder. Individuals can benefit from general stress reduction, detoxification and enhanced immune function. Devoogdt et al. (2018) Manual Lymphatic Drainage Massage can be beneficial in keeping the lymph pathways open and flowing. Some studies have shown that physical therapy can shorten the natural course of AWS by up to 6 to 8 weeks. In addition to physical therapy, manual lymphatic drainage (MLD) may also reduce the development of AWS. Increased clearance is thought to reduce local levels of inflammatory mediators, which are often associated with edema and pain. Muller et al. (2018) Manual Lymphatic Drainage stimulates the lymphatic vessels which carry substances vital to the defense of the body and removes waste products.

Zengin et al. (2017) stated that Pilates has been beneficial for breast cancer patients. Despite a lack of scientific evidence, Pilates has been endorsed for the rehabilitation of breast cancer survivors. Pilates is a low-impact workout that aims to develop muscles while additionally enhancing posture stability and flexibility.

Table 1: Basic characteristics of participants

	Group A	Group B			
	Mean ± SD	**Mean ± SD**	**MD**	**t-value**	**p-value**
Age (years)	45.41 ± 6.55	45.05 ± 6.03	0.36	0.23	0.81

SD, standard deviation; p-value, level of significance

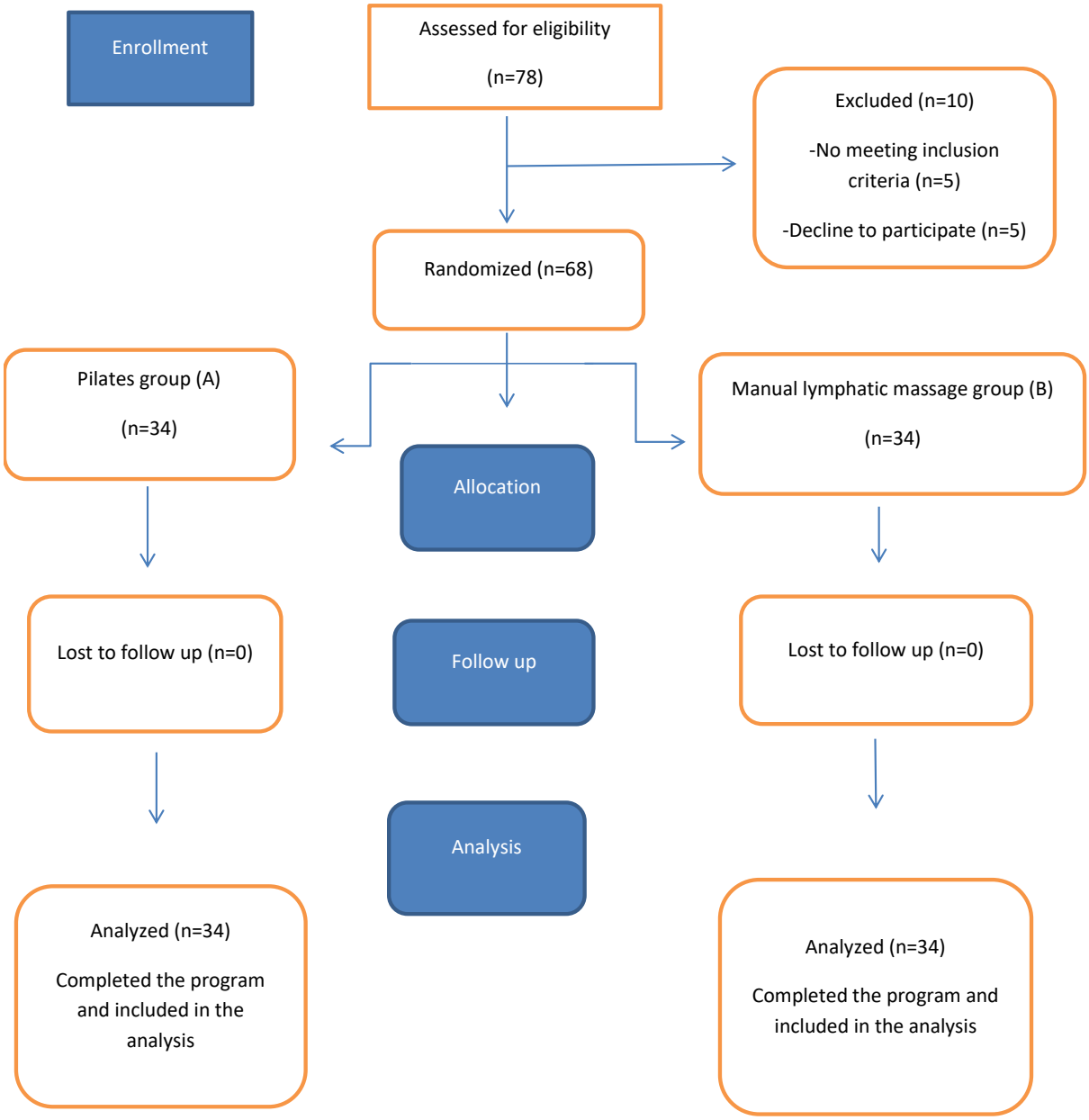

Fig 1: Flow chart of the study

Table 2: Mean VAS and DASH at pre treatment, post I and post II of group A and B

	Group A	Group B		
	mean ± SD	**mean ± SD**	**MD**	**p-value**
VAS				
Pre treatment	9.23 ± 0.43	9.26 ± 0.44	-0.03	0.78
Post I	5.91 ± 0.83 [a, b]	4.97 ± 0.72[a, b]	0.94	0.001
Post II	2.85 ± 0.65[a, b]	2.29 ± 0.57[a, b]	0.56	0.001
	p = 0.001	***p = 0.001***		
DASH				
Pre treatment	90.88 ± 3.15	89.85 ± 2.96	1.03	0.17
Post I	59.08 ± 8.89 [a, b]	39.05 ± 7.84 [a, b]	20.03	0.001
Post II	29.58 ± 5.03[a, b]	19.11 ± 4.97 [a, b]	10.47	0.001
	p = 0.001	***p = 0.001***		

SD, standard deviation; MD, mean difference; p-value, level of significance, [a] significant difference with pre treatment; [b] significant difference between post I and post II.

Şener et al. (2017) Some studies highlighted that rehabilitation of breast cancer therapy utilizing Pilate's exercise, specifically targeting upper extremity functions, has excellent positive benefits such as range of motion than a home exercise program.

4. CONCLUSION

Manual Lymphatic has significant effect more than Pilates Exercises on increasing shoulder ROM post mastectomy and decreasing pain in shoulder joint.

ACKNOWLEDGEMENTS

The authors thank the staff members for their effort and support and all the participants in this study for their cooperation.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

References

[1] P.V.G. Figueira, C.A.S. Haddad, S.K.L. de Almeida Rizzi, G. Facina & A.C.P. Nazario. (2018). Diagnosis of Axillary Web Syndrome in Patients After Breast Cancer Surgery: Epidemiology, Risk Factors, and Clinical Aspects: A Prospective Study. American journal of clinical oncology. 41(10), 992–996.

[2] K. Dinas, M. Kalder, L. Zepiridis, G. Mavromatidis & G. Pratilas. (2019). Axillary web syndrome: Incidence, pathogenesis, and management. Current problems in cancer. 43(6), 100470.

[3] S.R. Harris. (2018). Axillary Web Syndrome in Breast Cancer: A Prevalent But Under-Recognized Postoperative Complication. Breast care (Basel, Switzerland). 13(2), 132–135.

[4] A.Z. Alpozgen, A. R. Ozdincler, H. Karanlik, F.Y. Agaoglu & A.N. Narin. (2017). Effectiveness of Pilates-based exercises on upper extremity disorders related with breast cancer treatment. European journal of cancer care. 26(6).

[5] H.O. Şener, M. Malkoç, G. Ergin, D. Karadibak & T. Yavuzşen. (2017). Effects of Clinical Pilates Exercises on Patients Developing Lymphedema after Breast Cancer Treatment: A Randomized Clinical Trial. The journal of breast health. 13(1), 16–22.

[6] M.M.F. Oliveira, M.S.C. Gurgel, B.J. Amorim, C.D. Ramos, S. Derchain, N. Furlan-Santos, C.C.D. Santos & L.O. Sarian. (2018). Long term effects of manual lymphatic drainage and active exercises on physical morbidities, lymphoscintigraphy parameters and lymphedema formation in patients operated due to breast cancer: A clinical trial. PloS one. 13(1), e0189176.

[7] J. Ezzo, E. Manheimer, M.L. McNeely, D.M. Howell, R. Weiss, K.I. Johansson, T. Bao, L. Bily, C.M. Tuppo, A.F. Williams & D. Karadibak. (2015). Manual lymphatic drainage for lymphedema following breast cancer treatment. The Cochrane database of systematic reviews. (5), CD003475.

[8] A. de Sire, M. Invernizzi, L. Lippi, C. Cisari, L. Özçakar & F. Franchignoni. (2020). Blurred lines between axillary web syndrome and Mondor's

disease after breast cancer surgery: A case report. Annals of physical and rehabilitation medicine. 63(4), 365–367.

[9] L.A. Koehler, T.C. Haddad, D.W. Hunter & T.M. Tuttle. (2018). Axillary web syndrome following breast cancer surgery: symptoms, complications, and management strategies. Breast cancer (Dove Medical Press).11, 13–19.

[10] S. Eyigor, H. Karapolat, H. Yesil, R. Uslu & B. Durmaz. (2010). Effects of pilates exercises on functional capacity, flexibility, fatigue, depression and quality of life in female breast cancer patients: a randomized controlled study. European journal of physical and rehabilitation medicine. 46(4), 481–487.

[11] M. Ghorbani, Y. Sokhangouei & H. Sadeghi. (2013). Effect of Pilates exercise on range of motion and edema of upper limb in mastectomy side. Journal of Ardabil University of Medical Sciences. 13(3), 297-304..

[12] T.C. Siqueira, S.P. Frágoas, A. Pelegrini, A.R. de Oliveira & C.M. da Luz. (2021). Factors associated with upper limb dysfunction in breast cancer survivors. Supportive care in cancer. Official journal of the Multinational Association of Supportive Care in Cancer. 29(4), 1933–1940..

[13] A. Corduneanu, K. Hrazdilová, A.D. Sándor, I.A. Matei, A.M. Ionică, L. Barti, M.A. Ciocănău, D.S. Măntoiu, I. Coroiu, S. Hornok, H.P. Fuehrer, N. Leitner, Z. Bagó, K. Stefke, D. Modrý & A.D. Mihalca. (2017). Babesia vesperuginis, a neglected piroplasmid: new host and geographical records, and phylogenetic relations. Parasites & vectors. 10(1), 598.