March 11, 2025

MOTOR CONTROL RETRAINING EXERCISES ON SHOULDER DYSFUNCTION POST MASTECTOMY

BY

ESRAA TAREK MOHAMED HASHEM

Submitted in A Partial Fulfillment of the Requirements of Doctoral Degree in Department of Physical Therapy for Surgery
Faculty of Physical Therapy
Cairo University
2025

SUPERVISORS

Prof.Dr. AMAL MOHAMED ABD EL BAKY

Professor of Physical Therapy for Surgery

Faculty of Physical Therapy

Cairo University

Prof.Dr. ASHRAF ELSEBAIE MOHAMED

Professor of General and Plastic Surgery

Faculty of Medicine

Cairo University

Assist. Prof.Dr. KHADRA MOHAMED ALY

Assistant Professor of Physical Therapy for Surgery

Faculty of Physical Therapy

Cairo University

CHAPTER I
INTRODUCTION

Breast cancer is a global public health issue. It is one of the most frequent neoplasms among women. Each year, around 2.3 million new patients are detected worldwide. Breast cancer detection and screening have improved because of increased public attention, breast cancer awareness and advancements in breast imaging **(Łukasiewicz et al., 2021)**.

Breast cancer surgeries can be either lumpectomy or mastectomy. They also include sentinel lymph node biopsy (SLNB) or axillary lymph node dissection (ALND) to determine the axillary lymph node condition **(Loh et al., 2015).** The most common complications following mastectomy are pain, ipsilateral lymphedema of the upper limb (UL), reduced range of motion (ROM) of the shoulder, flexion and abduction is limited to 90°, and external rotation is limited to 40°, and postural changes **(Basilio et al., 2014)**.

Normal pain free ROM of the upper limb demand appropriate movement at the glenohumeral joint and the scapula-thoracic articulation. Synchronization between the muscles functioning across these joints allows for coordinated joint motion, which is necessary for arm raising **(Shamley et al., 2014)**.

Post mastectomy, the possibility of soft tissue changes may disrupt the normal scapular kinematics. It has been associated with greater scapular anterior tilting and internal rotation and reduced upward rotation. There is a relation between soft tissue alterations and shoulder biomechanical changes. Prolonged upper trapezius over-activation and tightness could lead to a muscular imbalance of the upper trapezius-serratus anterior couple. This imbalance would result in decreased upward rotation and increased scapular internal rotation **(Lang et al., 2022).**

Normal pain free motion of the arm and shoulder requires mobility in the scapula-thoracic, glenohumeral, acromioclavicular and sternoclavicular joints. Under healthy conditions elevation of the arm is accompanied by scapula retraction, lateral rotation and posterior tilt. However, when scapula-thoracic motion is disproportionate to glenohumeral motion, the potential exists for microtrauma and long-term pain **(Trundle et al., 2014).**

Motor control retraining refers to neuromuscular control of the body (trunk and limbs) in static postures and functional tasks using the process of initiating, directing, and grading purposeful voluntary movement. It's necessary for the optimization of upper limb movement patterns, which helps the load spread evenly among multiple movement system components. The presence of uncontrolled movement may cause tissue overload that in turn can lead to pain, damage, and various musculoskeletal conditions. **(Śliwiński et al., 2021).**

Statement of the problem:

Do motor control retraining exercises have an effect on shoulder dysfunction post-mastectomy?

Purpose of the study:

The purpose of the study is to evaluate the effect of motor control retraining exercises on shoulder dysfunction post mastectomy.

Significance of the study:

The GH joint significantly depends on muscle control and mid-range stability. To guarantee that functional tasks is performed normally, Glenohumeral and scapulothoracic motions must interact and coordinate during arm raising to prevent the humerus head from striking the coracoacromial arch and seriously jeopardizing the soft tissue tissues around the shoulder from impingement. **(Neto et al., 2018)**.

Motor control and strengthening exercises can improve function in shoulder impingement patients by realigning the scapula and changing muscle recruitment patterns. Peripheral musculoskeletal impairments can be associated with cortical reorganisation. Movement retraining using the principles of motor control retrain muscle recruitment patterns and improve scapular kinematics, reducing subacromial impingement, thus improving function and reducing pain **(Worsley et al., 2013).**

Furthermore, the need of this study is developed from the lack in the quantitative knowledge and information in the published studies about the effect of motor control retraining exercises on shoulder dysfunction post-mastectomy.

Delimitations:

This study will be delimited in the following aspects:

1.Subjects:

Sixty patients suffering from post-mastectomy shoulder dysfunction will be randomly divided into two equal groups (Group A and Group B) each one has 30 patients. Patients' age will range from 40 to 55 years.

2.Equipment and tools:

2.1. Measurement equipment:

- Hand-held dynamometer: for measurement of muscle strength **(Mañago et al., 2017).**
- Digital inclinometer: for measurement of shoulder flexion, abduction and scapular upward rotation **(An et al., 2021).**
- Shoulder Pain and Disability Index (SPADI): for measurement of shoulder disability **(Alsanawi et al., 2015).**

2.2. Therapeutic procedures:

- Motor control retraining exercises of the scapular musculature.
- Traditional physical therapy.

Hypothesis:

It will be hypothesized that:

Motor control retraining exercises have no effect on shoulder dysfunction post-mastectomy.

Basic Assumptions:

It will be assumed that:

- All patients will continue in the study.
- All patients will follow the instructions during the treatment.
- All patients are free from any chronic impairment.
- The clinical method of measurement will be reliable and valid.

Definitions of terms:

The following terms will be defined for the clear understanding of the terminology that will be used in the present study:

Mastectomy:

Mastectomy is a procedure consisting of invasive breast removal due to some anatomical and functional changes previously diagnosed. Surgical treatment ranges from lumpectomy to mastectomy, with or without removal of axillary lymph nodes **(Basilio et al., 2014)**.

Motor control:

Motor control is defined as the ability of the nervous system to control posture and movement for a given motor task and encompasses all the motor, sensory and integrative processes associated with the planning and execution of the task **(van Dieën et al., 2018).**

Shoulder Pain and Disability Index (SPADI):

The SPADI is a self-administered questionnaire that contains thirteen items which assess two domains (pain and disability) **(Shamley et al., 2012)**. It has an

8-item subscale to evaluate disability and a 5-item subscale to measure pain. Each subscale is summed and transformed to a score out of 100. A mean is taken of the two subscales to give a total score out of 100, higher score indicating greater impairment or disability **(Breckenridge and McAuley, 2011)**. The Arabic version of SPADI has excellent validity and reliability **(Alsanawi et al., 2015)**

Instrumented digital hand-held dynamometer:

It is an ergonomic hand-held device for objectively providing reliable, accurate readings that conform to most manual muscle testing protocols. It has good to excellent validity and reliability for most measures of isometric muscle strength particularly for proximal muscle groups. It has a large, easy-to-read LCD screen that displays results in both pounds and kilograms **(mentiplay et al., 2015).**

Digital inclinometer:

A digital inclinometer is used to measure shoulder flexion, abduction and upward rotation of scapula. It has digital screen that display the angle at which the inclinometer is situated allowing direct joint angle measurements **(An et al., 2021).**

CHAPTER II
REVIEW OF RELATED LITERATURES

The review of the related studies and literature of the main concept of this study will be presented under the following headings:

1.Mastectomy:

1.1. Definition:

Mastectomy is a surgical procedure in which all or part of the breast is removed. The term is derived from the Greek word mastos, which means "woman's breast" and the Latin term ectomia, which means "excision of"(**Goethals and Rose, 2022)**. Excision of the in-breast neoplasia and a reduction in the likelihood of local recurrence (LR), regional recurrence (RR), or the development of a new primary breast tumour are the goals of surgical treatment for breast cancer **(Kaidar et al., 2020)**.

1.2. Types and techniques.

There are several types of mastectomy procedures **(Lazaraviciute and Chaturvedi, 2017):**

- **Halsted's Radical Mastectomy:** A radical (Halsted) mastectomy is a type of mastectomy in which all axillary tissue, breast tissue, and Pectoralis major and minor muscles are removed.
- **Patey's Mastectomy:** A modified radical (Patey) mastectomy is a type of mastectomy in which breast tissue and the axillary nodes, are removed.
- **Total or Simple Mastectomy**: A total or simple mastectomy is a type of mastectomy that involves the removal of breast tissue and the involved skin with or without axillary surgery. The pectoralis fascia is usually preserved, but the axillary tail is removed.

- **Skin Sparing Mastectomy ±Nipple Sparing Mastectomy:** It is a type of mastectomy in which the breast tissue is removed but the skin envelope is left intact.

1.3. Mastectomy complications:

1.3.a Post mastectomy pain syndrome (PMPS):

The PMPS is a neuropathic pain condition that occurs in and around the surgical site and lasts for more than three months after the procedure **(Basilio et al., 2014)**.

1.3.b Lymphoedema:

Lymphoedema occurs due to accumulation of protein-rich fluid in the extracellular spaces. It occurs because of the physical trauma caused by radiotherapy and surgery, which hinder the lymphatic system and cause chronic or recurrent swelling of the affected side. the most common region is the arm, but chest and upper back are also often involved. Women state symptoms like pain, stiffness, heaviness, loss of sensation, movement restrictions and weakness of the upper limb **(Celenay et al., 2020)**.

1.3.c Axillary Web Syndrome:

Axillary web syndrome (AWS), also known as cording, usually appears during the 1st: 5th weeks post breast cancer surgery. During shoulder flexion or abduction, a palpable, clearly visible, painful stretched band is seen beneath the skin. The cords are always seen in the axilla and may cross the antecubital fossa and extend down into the medial ipsilateral arm, into the forearm, and occasionally to the radial aspect of the wrist and into the base of the thumb **(Da Luz et al., 2017)**.

1.3.d Musculoskeletal complications:

The musculoskeletal complications involve reduced shoulder flexion, abduction ROM to 90°, and external rotation to 40° and Postural alterations, especially in vertebral column and scapular area. These alterations involve elevated and abducted scapula and increased thoracic kyphosis and cervical lordosis. Forward head and slight trunk rotation, and structural scoliosis may also occur **(Basilio et al., 2014)**.

After breast cancer treatment, the shoulder range of motion (ROM) is restricted in 1.5%-50% of women and the pain is present in 12 % -51% (with up to one third experiencing some pain after 5 years) and the quality of life (QOL) is also compromised (**Ibrahim et al., 2018)**.

1.4 Radiotherapy complications (de França et al., 2015):

- Breast and axillary fibrosis.
- Glenohumeral Joint limitation.
- Neuropathy, chronic pain in the breast area.
- The scar adherence.

1.5 Chemotherapy complications (de França et al., 2015):

- Fatigue.
- Ataxia.
- Neurotoxicity.

2. Shoulder complex:

2.1. Anatomy:

The shoulder complex is composed of 4 small joints, primarily the glenohumeral (GH) joint, the acromioclavicular (AC), sternoclavicular (SC), and scapulothoracic (ST) joints. the glenohumeral (GH) joint is thought to be the most mobile joint and primarily depends on muscle control and mid-range stability **(Bakhsh and Nicandri, 2018)**.

As shown in figure (1), A complex network of muscular anatomy provides multiple functions of the shoulder. Rotator cuff muscles constitute of the supraspinatus, infraspinatus, teres minor, and subscapularis. These muscles allow synergistic co-contraction to guide movement and anchor the scapula **(Bakhsh and Nicandri, 2018)**. **Fig. (1)**

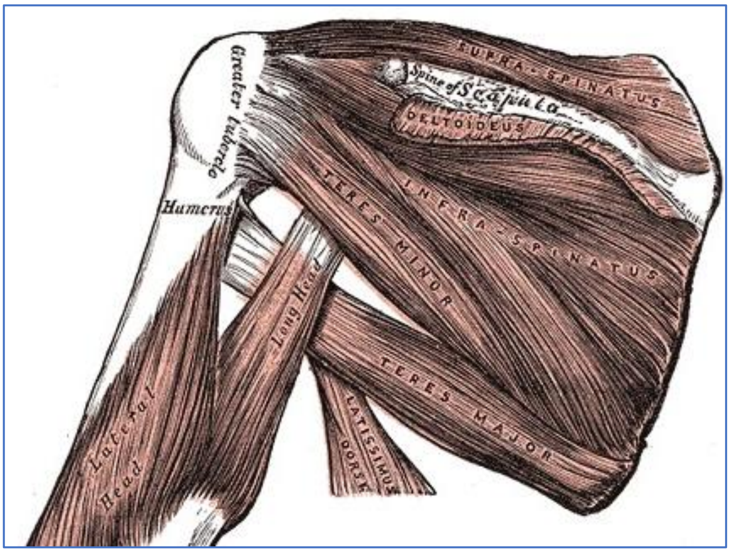


Fig. (1): Muscles and Fascia of the Shoulder **(Adopted from Lam and Bordoni, 2021).**

There are numerous muscles attached to the scapula. The trapezius, the levator scapulae, the rhomboids, the serratus anterior, the pectoralis minor and the subclavius muscles achieve significant contribution to scapulothoracic motion. The serratus anterior supports the medial angle against the chest wall, and the trapezius rotates and elevates the scapula in synchronization with glenohumeral movement **(Ribeiro et al., 2016)**.

2.2. Biomechanics:

Glenohumeral joint stability is impacted by the musculature functioning far from the shoulder itself. Large torques can be generated about the shoulder joint by the action of latissimus dorsi, serratus anterior, pectoralis major, and deltoid due to their cross-sectional anatomy and distance from the joint centre of rotation **(Levine and Rigby, 2018)**.

The scapulothoracic articulation consists of a space between the posterior surface of the thoracic rib cage and the anterior surface of the scapula. The movement of the scapula on thorax is smooth due to the neurovascular, muscular, and bursal structures **(Ribeiro et al., 2016)**.

Arm raising depends on coordination between glenohumeral and scapulothoracic motions, which ensures that functional tasks can be performed without the humerus' head striking the coracoacromial arch and putting the soft tissue structures surrounding the shoulder joint at risk of impingement. Shoulder muscles, which are functionally classified as stabilizers and prime movers, make up the dynamic structures. Timed interaction between these two groups of muscles is essential to achieve a smooth and physiologic scapulohumeral rhythm **(Neto et al., 2018)**.

Scapulohumeral rhythm refers to the relationship between the glenohumeral and scapular components with a ratio of 2:1, respectively. The first 30–60° of arm elevation occur at the glenohumeral joint, during which the scapula remains fixed or moves side to side on the chest wall (setting phase). During full shoulder elevation from 0° to 180°, glenohumeral movement is 120° and scapular motion is 60° (**Rizzi et al., 2016)**.

2.3. Shoulder dysfunction post mastectomy:

The mechanics of the shoulder joint can be impacted by fibrosis following radiotherapy and surgical scars due to anchoring of soft tissue or pain-inhibited mobility. Females who received postsurgical radiotherapy experienced considerably higher shoulder morbidity (17%) compared to a group who didn't receive radiotherapy (2%) **(De Groef et al., 2015)**.

Additionally, patients who undergo mastectomy are nearly six times more likely to have shoulder limitations than patients who undergo breast-conserving surgery and despite advances in surgical techniques and postoperative care, pain and functional limitation continue to pose problems **(De Groef et al., 2015)**.

Decreased scapular upward rotation, reduced posterior tilting, and excessive scapular internal rotation have been identified as altered scapular positioning patterns in patients with shoulder disorders **(Struyf et al., 2011).**

It was reported that after mastectomy there is increased scapular internal rotation in the involved shoulder which decreases the width of the subacromial space, so it increases the risk of rotator cuff compression and tendinopathy and disrupt the shoulder motion **(Borstad and Szucs, 2012)**.

3.motor control retraining exercises:

3.1. definition:

Motor control is defined as the ability of the nervous system to control posture and movement for a given motor task and encompasses all the motor, sensory and integrative processes associated with the planning and execution of the task **(van Dieën et al., 2018).**

3.2. components:

The motor control retraining package was targeted at correcting movement impairments of the scapula by re-educating muscle recruitment. There were two components to the package **(Worsley et al., 2013)**:

1. Motor control exercises to correct alignment and coordination, which involve a) learning optimal scapular orientation at rest and then controlling optimal orientation during active arm movements; b) muscle specific exercises for trapezius and serratus anterior
2. Manual therapy techniques commonly used in clinical practice to manage symptoms, e.g. used to lengthen tight muscles or reduce active trigger point pain presentations.

3.3. physiological effect:

Improper control is characterized by changes in muscle activation levels. More specifically, lower activity of the serratus anterior, higher activity of the upper and lower trapezius, and lack of coordination between the different parts of the trapezius have been observed. This inadequate muscle control is believed to contribute to a reduction of amplitude in posterior tilting and lateral rotation of the scapula during arm elevation. Lower activity of the infraspinatus and subscapularis as well as inadequate coactivation of the scapulohumeral muscles have also been reported. This abnormal muscle control is most likely associated with a reduction of the subacromial space leading to impingement **(Hawkes et al., 2019).**

Motor control include production of reflexive, automatic, adaptive and voluntary movements and the performance of efficient, coordinated, goal-directed movement patterns which involves multiple body systems (input, output, and central processing). Evidence suggests exercise program mainly focusing on motor control principle for the scapulothoracic joint has been a promising treatment option for shoulder impingement **(Hara, 2020).**

CHAPTER III

SUBJECTS, MATERIALS AND METHODS

In this part of the study, the materials and methods will be presented under the following headings: subjects, equipment, procedures of the study and the statistical procedures.

1-Subjects:

1.1.Sample size:

Sample size calculation was done using, shoulder function as reported in **(Mohite and Kanase, 2014)**, with 90% power at α = 0.05 level, number of measurements 2, for 2 groups and effect size = 0.45 using F-test MANOVA repeated measures within and between interaction. The minimum proper sample size is 54 subjects, adding 6 (11%) subjects as drop out, so total sample size is 60 subjects 30 in each group. The sample size was calculated using the G*Power software (version 3.0.10) **(figure 2)**.

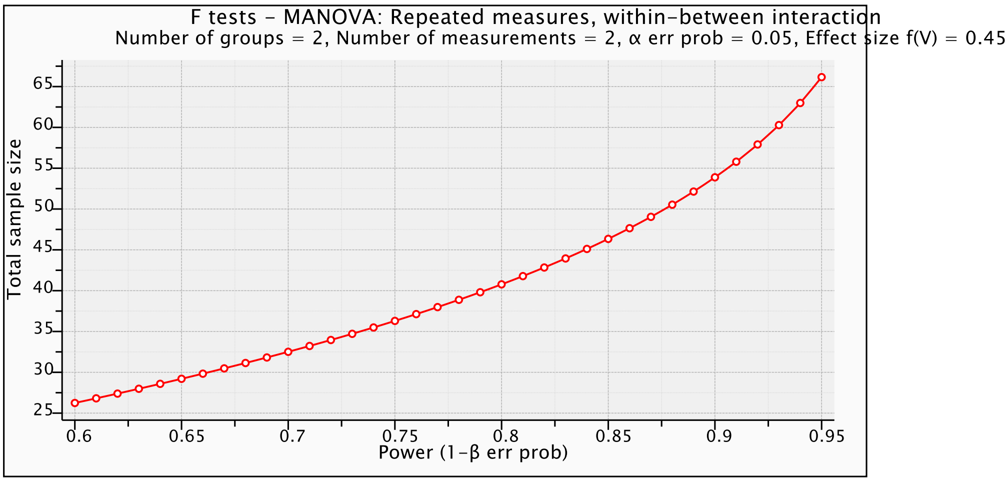


Figure (2): sample size calculation

sixty patients suffering from post-mastectomy shoulder dysfunction will participate in this study. Their ages will range from 40 to 55 years. The participants will be selected from Cairo university hospitals.

1.2. Design of the study:

In this randomised controlled trial study (RCT), the patients will be randomly assigned into two equal groups (30 patients for each group):

1.2.a. Group A (study group):

This group will include 30 patients with post mastectomy shoulder dysfunction who will receive motor control retraining exercises in addition to their conventional physical therapy program, three sessions per week for 8 weeks, for 45:60 minutes according to patient's ability **(Bae et al.,2011).**

***1.2.b. Group B (control group)**:*

This group will include 30 patients with post mastectomy shoulder dysfunction who will receive conventional physical therapy program in the form of shoulder joint mobilization, posterior capsule stretching and shoulder range of motion exercise (ROM) (Codman's pendulum exercises) for 30 minutes according to patient's ability, three sessions per week for 8 weeks **(Duzgun et al., 2019; Yiasemides et al., 2011)**.

1.3. Criteria for the patient selection:

1.3.a -Inclusion Criteria:

The subject selection will be according to the following criteria:

- Female patients with age range between 40-55 years.
- All patients have shoulder dysfunction.
- Patients were 2 months to 4 months post modified radical mastectomy or axillary lymph node dissection.
- Patients received their radiotherapy or chemotherapy or both.

1.3.b- Exclusion Criteria:

The potential participants will be excluded if they meet one of the following criteria:

- Rheumatoid arthritis.
- History of trauma or accidental injuries.
- Neurological involvement (stroke, Parkinsonism).
- History of surgery on involved shoulder.
- Diabetic patient.
- Moderate and severe lymphoedema.

2-Tools and equipment:

2.1. Measurement tools and equipment:

All Measurements will be taken before the treatment (pre-treatment) and after 8 weeks (post-treatment).

2.1.a- Shoulder Pain and Disability Index (SPADI):

The SPADI is a self-administered questionnaire that contains thirteen items which assess two domains (pain and disability) **(Shamley et al., 2012)**. It has an 8-item subscale to evaluate disability and a 5-item subscale to measure pain. Each subscale is summed and transformed to a score out of 100. A mean is taken of the two subscales to give a total score out of 100, higher score indicating greater impairment or disability **(Breckenridge and McAuley, 2011)**. The Arabic version of SPADI has excellent validity and reliability **(Alsanawi et al., 2015)**

2.1.b- Instrumented digital hand-held dynamometer:

Hand-held dynamometry (Lafayette manual muscle tester) will be used to measure isometric strength of shoulder flexion and abduction. It is an ergonomic hand-held device for objectively providing reliable, accurate readings that conform to most manual muscle testing protocols. It has good to excellent validity and reliability for most measures of isometric muscle strength particularly for proximal muscle groups. It has a large, easy-to-read LCD screen that displays results in both pounds and kilograms. It also has a weight capacity of up to 300 lbs. **(mentiplay et al., 2015). Fig. (3)**.

Fig. (3) Lafayette hand-held dynamometer

2.1.c- Digital inclinometer:

A digital inclinometer is used to measure shoulder flexion, abduction and upward rotation of scapula. It has digital screen that display the angle at which the inclinometer is situated allowing direct joint angle measurements **(An et al., 2021).**

2.2. Therapeutic Equipment and Tools:

Motor control retraining exercises for scapular muscles.

3-Procedures of the study:

3.1. Measurement procedures:

3.1.a. The Shoulder Pain and Disability Index (SPADI):

To answer the questions, the patient is instructed to place a mark on the 100mm straight line, this line represents a continuum between "no pain" (zero) and "the worst pain that the patient could feel" (ten) for pain dimension and "no difficulty" (zero) and "so difficult it requires help" (ten) for the disability dimension, respectively. To calculate a final percentage score for assessing shoulder dysfunction, a mean is taken of the two subscales to give a total score out of 100, higher score indicating greater impairment or disability **(Brindisino et al., 2021)**. The Arabic version of SPADI has excellent validity and reliability **(Alsanawi et al., 2015)**

3.1.b- Instrumented digital hand-held dynamometer:

A handheld dynamometer will be used to assess maximal strength pre-treatment and post treatment. Maximal strength tests for shoulder flexion and abduction will be measured. When applying the manual resistance for each test the handheld dynamometer is used to obtain force measures. Two trials were performed for each shoulder motion **(Scibek and Carcia, 2012).**

Each test consisted of the subject maximally contracting against the external force until this external force, applied by the tester, caused a “break” in the test position of the subject. The force required to break the test position was then recorded as the relative strength of the specific muscle **(Scibek and Carcia, 2012). Fig. (5)**

Fig. (5)

3.1.c- Digital inclinometer:

Digital inclinometer provides a real-time digital reading of angles with respect to either a horizontal or vertical reference **(An et al., 2021).**

Scapular upward rotation will be measured with subjects in the resting position and then with the shoulder elevated to 60 and 120 in the scapular plane. The angle between the scapular spine root and posterolateral acromion will be measured in the resting position and with the shoulder joint elevated 60 and 120 Scapular upward rotation will be measured similarly **(An et al., 2021). Fig. (6)**

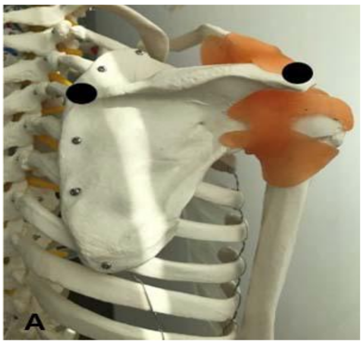
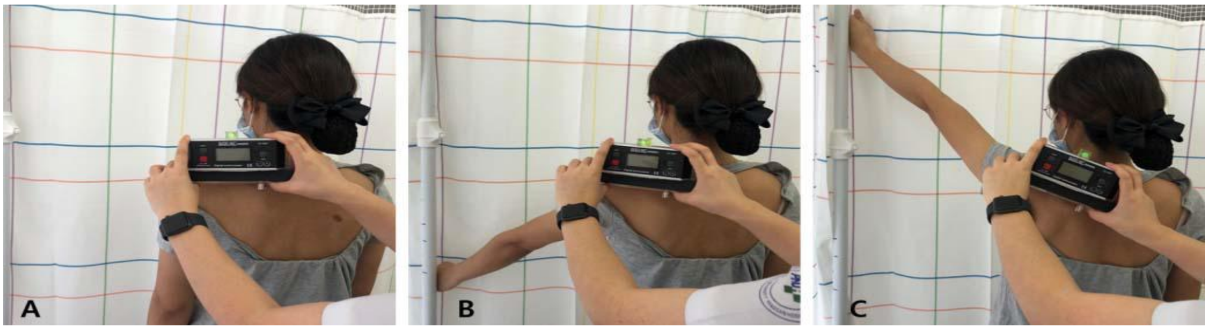


fig. (6)



Shoulder flexion ROM will be measured with the patient elevating the arm as high as possible in the sagittal plane without any extension of the spine **(Clausen et al., 2017). Fig. (7a)**

Shoulder Abduction ROM will be measured with the patient elevating the arm as high as possible in the frontal plane without lateral flexion of the spine **(Clausen et al., 2017). Fig. (7b)**

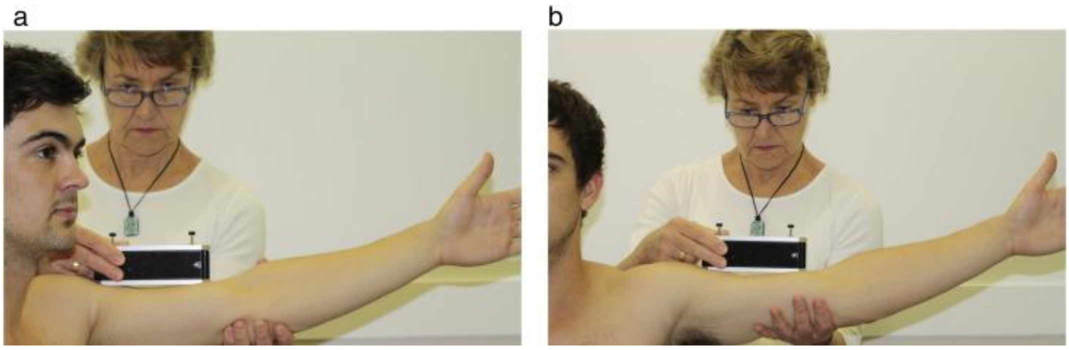


Fig. (7)

3.2. Therapeutic procedures:

3.2.a- Motor control retraining exercises:

The motor control retraining package was targeted at correcting movement impairments of the scapula by re-educating muscle recruitment. There were two components to the package: **(Worsley et al., 2013).**

1. Motor control exercises to correct alignment and coordination, which involve a) learning optimal scapular orientation at rest and then controlling optimal orientation during active arm movements; b) muscle specific exercises for trapezius and serratus anterior
2. Manual therapy techniques commonly used in clinical practice to manage symptoms, as trigger point therapy and pectoralis minor supine manual stretch will be performed as necessary.

During the motor control exercises, scapular position is optimised in relation to the thorax, initially by being altered manually by the therapist on a subject specific basis. This involved the therapist using observation and palpation to alter orientation/alignment of the scapula and clavicle using the following guidelines **(Worsley et al., 2013).**

- Acromion should be higher than the superior medial border of scapula.
- the spine of the scapula should be 15-25° rotated in the coronal plane, medial border and inferior angle of scapula should be tight against the rib cage and the clavicle should have a slight posterior rotation in the frontal plane.
- The participant is then taught to actively reproduce this orientation using visual (in a mirror), auditory (from therapist) and kinaesthetic cues such as palpation.

Once the scapula is placed into an optimal position, the participant is asked to control the orientation of the scapula whilst lifting their arm to 90° humeral elevation in the frontal, sagittal, and scapular planes **(Worsley et al., 2013).**

- Movements is performed at a slow, controlled pace and repeated for 2 minutes (i.e. 10 times).
- Once the participant regains sufficient control of scapular orientation during arm movements, muscle specific motor control exercises will be introduced.
- These exercises require the participant to initiate and maintain the optimal scapular orientation whilst muscle specific recruitment of serratus anterior and lower trapezius **(Worsley et al., 2013).**

3.2.b- ***Conventional physical therapy program for both groups:***

- **Joint mobilization exercises:**

Distraction of the glenohumeral joint, posterior glide and caudal glide is applied to the patients in a supine lying position at a frequency of two to three oscillations/ second for one to two minutes. At the resting position rhythmic oscillations grade I and II were applied. Resting position is position in which the joint capsule and ligaments are most relaxed and with the maximum play **(Joshi et al., 2020)**.

- **Posterior capsule stretching:**

The patient is lying on her side. With the arm in a 90° flexion, the scapula is fixed at the lateral side. Stretching is performed at the elbow with a downward force. each stretch is repeated ten times for 20 seconds, between each stretching A 30-second break was given **(Duzgun et al., 2019)**.

- **Codman/ pendulum exercise:**

These are self-mobilization techniques that use the effects of gravity to distract the humerus from the glenoid fossa. They help relieve pain through gentle traction and oscillating movements and provide early motion of joint structures and synovial fluid. No weight will be used initially. When the patient will tolerate stretching, a weight will be added to the hand or as wrist cuffs to cause further distraction force. To direct the stretch force to glenohumeral joint, stabilize the scapula against the thorax manually or with a belt **(Patel, 2022).**

4.Statistical procedures:

The collected data will be statistically analysed using:

- Descriptive statistics (mean and standard deviations).
- Inferential statistics: unpaired t-test will be used to compare subjects' characteristics of the two groups.
- Repeated measures MANOVA will be used to compare all dependent variables within and between groups.
- Statistical analysis will be conducted using SPSS for Windows, version 20 (SPSS, Inc., Chicago, IL). Statistical significance will be set at the ($p < 0.05$).

References

Alsanawi, H. A., Alghadir, A., Anwer, S., Roach, K. E., and Alawaji, A. (2015). Cross-cultural adaptation and psychometric properties of an Arabic version of the Shoulder Pain and Disability Index. *International journal of rehabilitation research. Internationale Zeitschrift fur Rehabilitationsforschung. Revue internationale de recherches de readaptation*, *38*(3): 270–275.

An, D. I., Park, J. E., Lee, C. H., & Kim, S. Y. (2021). Reliability of scapular upward rotation and anterior-posterior tilt measurements using a modified digital inclinometer in patients with subacromial impingement syndrome. *Journal of Back and Musculoskeletal Rehabilitation*, *34*(5), 837-843.

Bae, Y. H., Lee, G. C., Shin, W. S., Kim, T. H., & Lee, S. M. (2011). Effect of motor control and strengthening exercises on pain, function, strength and the range of motion of patients with shoulder impingement syndrome. Journal of Physical Therapy Science, 23(4), 687-692.

Bakhsh W., and Nicandri G. (2018): "Anatomy and physical examination of the shoulder". Sports medicine and arthroscopy review; 26(3): e10-e22.

Basilio F.B, Anjos R.M.M, Medeiros E.P, Melo E. M.F and Silva R.M.V (2014): "Effects of manual therapy techniques in the treatment of pain in post mastectomy patients: systematic review". MTP& Rehab Journal; 12(190): 196-201.

Borstad J. D., and Szucs K. A. (2012): "Three-dimensional scapula kinematics and shoulder function examined before and after surgical treatment for breast cancer". Human movement science; 31(2): 408-418.

Breckenridge J. D., and McAuley J. H. (2011): "Shoulder pain and disability index (SPADI)". *Journal of physiotherapy*; *57*(3): 197-197.

Brindisino F., Indaco T., Giovannico G., Ristori D., Maistrello L., and Turolla A. (2021): "Shoulder Pain and Disability Index: Italian cross-cultural validation in patients with non-specific shoulder pain". *Shoulder & Elbow*; *13*(4): 433-444.

Celenay S. T., Ucurum S. G., and Kaya D. O. (2020): "Comparison of spinal alignment and mobility in women with and without post modified radical mastectomy unilateral lymphoedema". Clinical Breast Cancer; 20(3): e295-e300.

Clausen, M. B., Witten, A., Holm, K., Christensen, K. B., Attrup, M. L., Hölmich, P., & Thorborg, K. (2017). Glenohumeral and scapulothoracic strength impairments exists in patients with subacromial impingement, but these are not reflected in the shoulder pain and disability index. *BMC Musculoskeletal Disorders*, *18*, 1-10.

Da Luz C. M., Deitos J., Siqueira T. C., Palú M., and Heck A. P. F. (2017): "Management of axillary web syndrome after breast cancer: evidence-based practice". Revista Brasileira de Ginecologia e Obstetrícia; 39(11): 632-639.

De França Rêgo L. M., Revoredo M. M. P., Basilio F. B., da Silva R. M. V., and de Almeida Lins C. A. (2015): "Effects of Kinesio Taping® on range of motion and shoulder pain relief in mastectomy patients". Manual Therapy, Posturology & Rehabilitation Journal; 1-5.

De Groef A., Van Kampen M., Dieltjens E., Christiaens M. R., Neven P., Geraerts I., and Devoogdt N. (2015): "Effectiveness of postoperative physical therapy for upper-limb impairments after breast cancer treatment: a systematic review". Archives of physical medicine and rehabilitation; 96(6): 1140-1153.

Dieën, J., Reeves, N. P., & Kawchuk, G. (2018). Analysis of motor control in low-back pain patients: a key to personalized care. *J Orthop Sport Phys Ther*, 1-24.

Duzgun I., Turgut E., Eraslan L., Elbasan B., Oskay D., and Atay O. A. (2019): "Which method for frozen shoulder mobilization: manual posterior capsule stretching or scapular mobilization?" Journal of musculoskeletal & neuronal interactions; 19(3): 311-316.

Goethals A., and Rose J. (2022). Mastectomy. In StatPearls [Internet]. StatPearls Publishing.

Hara, H. (2020). Effects of Scapular Motor Control Training versus Scapular Retraining Along with Mobilization on Pain and Functional Status among Construction Workers.

Hawkes, D. H., Khaiyat, O. A., Howard, A. J., Kemp, G. J., & Frostick, S. P. (2019). Patterns of muscle coordination during dynamic glenohumeral joint elevation: An EMG study. PLoS One, 14(2), e0211800.

Hinton PR. (2004)." Statistics Explained" (2nd Edition). New York: Routledge.

Ibrahim M., Muanza T., Smirnow N., Sateren W., Fournier B., Kavan P., et al (2018): "A pilot randomized controlled trial on the effects of a progressive exercise program on the range of motion and upper extremity grip strength in young adults with breast cancer". Clinical breast cancer; 18(1): e55-e64.

Joshi Y. S., Shridhar S., Jayaram M., and Sharath U. R. (2020): "A Comparative Study on the Effect of Scapular Proprioceptive Neuromuscular Facilitation and Maitland Glenohumeral Mobilization Versus Scapular Mobilization and Maitland Glenohumeral Mobilization in Adhesive Capsulitis". International Journal of Health Sciences and Research; 10(11): 135-143.

Kaidar-Person O., Poortmans P., Offersen B. V., Siesling S., Sklair-Levy M., Meattini I., ... and Boersma L. J. (2020): "Spatial location of local recurrences after mastectomy: a systematic review". Breast cancer research and treatment; 183(2): 263-273.

Lam J. H., and Bordoni B. (2021). "Anatomy, Shoulder and Upper Limb, Arm Abductor Muscles". In StatPearls [Internet]. StatPearls Publishing.

Lang, A. E., Milosavljevic, S., Dickerson, C. R., Trask, C. M., & Kim, S. Y. (2022). Evidence of rotator cuff disease after breast cancer treatment: Scapular kinematics of post-mastectomy and post-reconstruction breast cancer survivors. *Annals of Medicine*, *54*(1), 1058-1066.

Lazaraviciute, G. and Chaturvedi, S. (2017): "Mastectomy—A Critical Review." Open Journal of Clinical Diagnostics; 7(2): 58-66.

Levine N. A., and Rigby B. R. (2018): "Thoracic outlet syndrome: biomechanical and exercise considerations". Multidisciplinary Digital Publishing Institute. In Healthcare; 2(6): 68.

Loh S. Y., and Musa A. N. (2015): "Methods to improve rehabilitation of patients following breast cancer surgery: a review of systematic reviews". Breast Cancer: Targets and Therapy; 7: 81-98.

Łukasiewicz S., Czeczelewski M., Forma A., Baj J., Sitarz, R., and Stanisławek A. (2021): "Breast cancer-epidemiology, risk factors, classification, prognostic markers, and current treatment strategies—an updated review". Cancers (Basel); 13 (17): 4287.

Mañago, M. M., Hebert, J. R., & Schenkman, M. (2017). Psychometric properties of a clinical strength assessment protocol in people with multiple sclerosis. International journal of MS care, 19(5), 253-262.

Mentiplay, B. F., Perraton, L. G., Bower, K. J., Adair, B., Pua, Y. H., Williams, G. P., ... & Clark, R. A. (2015). Assessment of lower limb muscle strength and power using hand-held and fixed dynamometry: a reliability and validity study. PloS one, 10(10), e0140822

Neto C., Pezarat P., and Oliveira R. (2018): "Effects of breast cancer treatment on shoulder Function: What to expect and how to treat". *Int. J. Phys. Ther. Rehabil*; 4, 1-4.

Patel, B. (2022). Effectiveness of muscle energy technique and movement with mobilization in adhesive capsulitis of shoulder. IJAR, 8(3), 395-403.

Ribeiro D. C., de Castro M. P., Sole G., and Vicenzino B. (2016): "The initial effects of a sustained glenohumeral postero-lateral glide during elevation on shoulder muscle activity: A repeated measures study on asymptomatic shoulders". Manual therapy; 22: 101-108.

Rizzi S. K. L. D. A., Haddad C. A. S., Giron P. S., Pinheiro T. L., Nazário A. C. P., and Facina G. (2016): "Winged scapula incidence and upper limb morbidity after surgery for breast cancer with axillary dissection". Supportive Care in Cancer; 24(6): 2707-2715.

Scibek, J. S., & Carcia, C. R. (2012). Assessment of scapulohumeral rhythm for scapular plane shoulder elevation using a modified digital inclinometer. World journal of orthopedics, 3(6), 87.

Shamley D., Lascurain-Aguirrebeña I., and Oskrochi R. (2014): "Clinical anatomy of the shoulder after treatment for breast cancer". Clinical anatomy; 27(3): 467-477.

Shamley D., Lascurain-Aguirrebeña I., Oskrochi R., and Srinaganathan R. (2012): "Shoulder morbidity after treatment for breast cancer is bilateral and greater after mastectomy". *Acta Oncologica*; 51(8): 1045-1053.

Śliwiński, M., Wąż, P., Zaręba, W., & Hansdorfer-Korzon, R. (2021). Motor Control Evaluation as a Significant Component in Upper Limb Function Assessment in Female Breast Cancer Patients after Mastectomy. *Healthcare*, *9*(8), 973. https://doi.org/10.3390/healthcare9080973

Struyf, F., Nijs, J., Horsten, S., Mottram, S., Truijen, S., & Meeusen, R. (2011). Scapular positioning and motor control in children and adults: a laboratory study using clinical measures. Manual therapy, 16(2), 155-160.

Trundle, T. (2014). 21 Orthopedic Management of the Shoulder. Fundamental Orthopedic Management for the Physical Therapist Assistant-E-Book, 348.

Worsley, P., Warner, M., Mottram, S., Gadola, S., Veeger, H. E., Hermens, H., Morrissey, D., Little, P., Cooper, C., Carr, A., & Stokes, M. (2013). Motor control retraining exercises for shoulder impingement: effects on function, muscle activation, and biomechanics in young adults. Journal of shoulder and elbow surgery, 22(4), e11–e19. https://doi.org/10.1016/j.jse.2012.06.010

Yiasemides R., Halaki M., Cathers I., and Ginn K. A. (2011): "Does passive mobilization of shoulder region joints provide additional benefit over advice and exercise alone for people who have shoulder pain and minimal movement restriction? A randomized controlled trial". Physical therapy; 91(2): 178-189.