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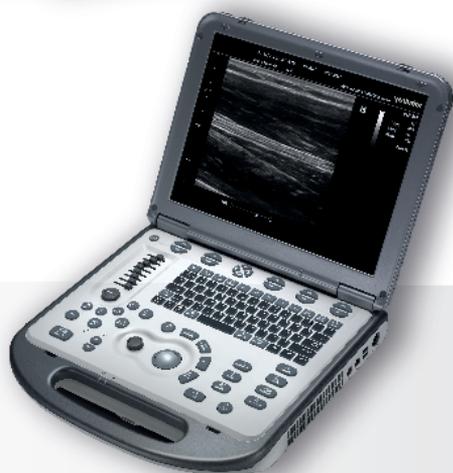
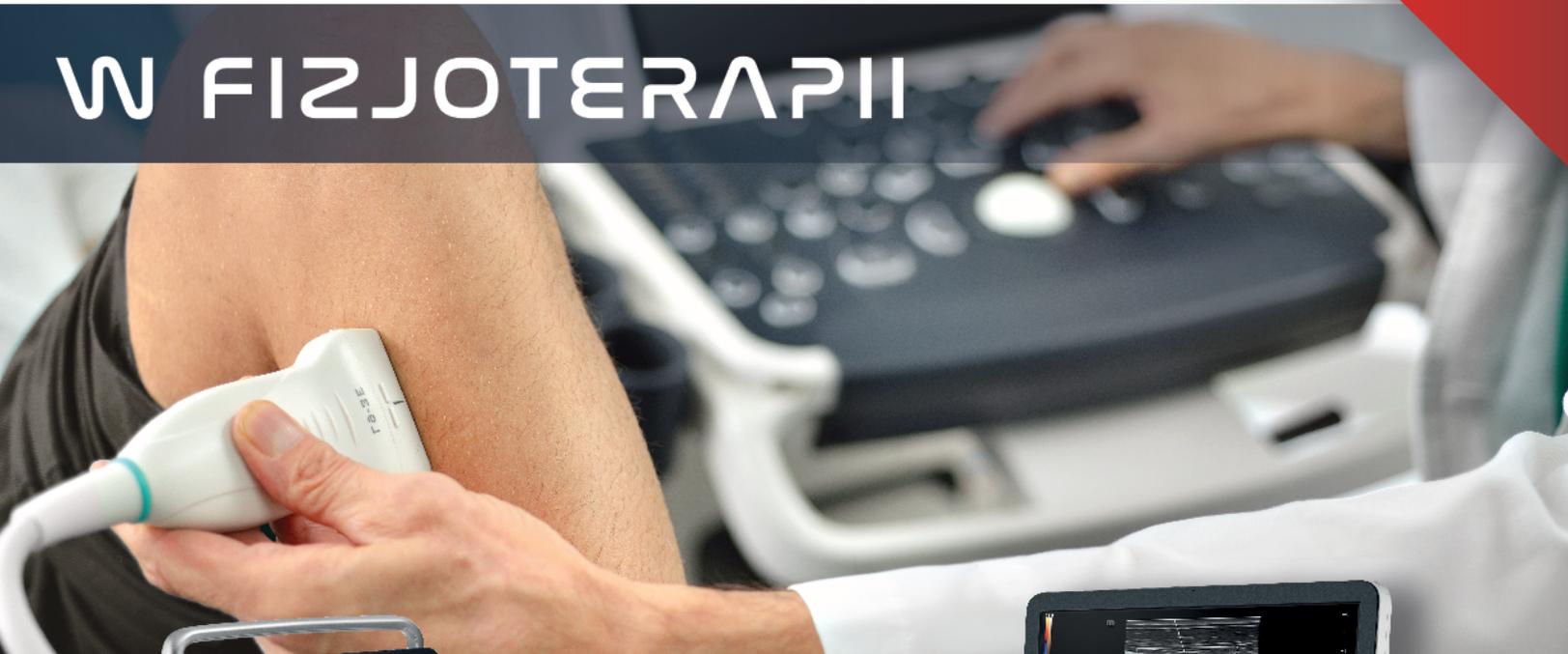


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# Effect of Scapular Stabilization Exercises versus Mulligan Technique on Shoulder Kinematics and Postural Changes Post Mastectomy

*Wpływ ćwiczeń stabilizacji łopatki w porównaniu z techniką Mulligana na kinematykę barku i zmiany postawy po mastektomii*

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## Abstract

**Objective.** To evaluate the effects of scapular stabilization exercises versus Mulligan technique when compared with traditional physical therapy on post-mastectomy shoulder kinematics and body posture. **Design.** Randomized controlled trial. **Participants.** Female patients who were suffering from limitation in shoulder joint motion (abduction and flexion less than 120°), forward head posture and shoulders height asymmetry post mastectomy. **Interventions:** The participants were assigned randomly in 3 different groups: 1- Group (A) scapular stabilization exercises group includes 20 patients received strengthening, scapular stabilization and postural exercises plus a traditional rehabilitation program, 2- Group (B) Mulligan technique group includes 20 patients received Mulligan mobilization with movement for shoulder joint and cervical sustained natural apophyseal glides plus a traditional rehabilitation program. 3- Group (C) Control group includes 20 patients received traditional physical therapy only. **Main Outcome Measures.** Shoulder range of motion (ROM) procedures included measurement of flexion, and abduction active range of motion and posture assessment procedure of cervical angle and acromions' horizontal alignment. They were evaluated at the beginning and after 6 weeks of training. **Results.** All groups showed significant difference in shoulder range of motion (flexion and abduction), there was high percent of clinical improvement in favor of group B compared to the other groups. There was significant increase of cervical angle at post treatment only in group A and no significant difference in group B and C. There was significant reduction in acromions' horizontal alignment in group A and B only and the greatest improvement was in group A compared to group B and C and in group B compared to C. **Conclusions.** Both scapular stabilization exercises and Mulligan technique are considered successful treatment for shoulder AROM limitation post-mastectomy, while Mulligan technique is better. Regarding forward head position and asymmetrical scapular height post mastectomy, scapular stabilization is considered more effective for improving these postural deviations.

## Key words:

scapular stabilization exercises, Mulligan technique, shoulder kinematic, postural changes, mastectomy

## Streszczenie

**Cel.** Ocena wpływu ćwiczeń stabilizacji łopatki w porównaniu z techniką Mulligana w porównaniu z tradycyjną fizjoterapią na kinematykę barku i postawę ciała po mastektomii. **Projekt.** Randomizowana próba kontrolowana. **Uczestnicy.** Pacjentki cierpiące na ograniczenie ruchomości stawu barkowego (odwodzenie i zgięcie poniżej 120°), wysunięcie głowy do przodu i asymetrię wysokości ramion po mastektomii. **Interwencje:** Uczestniczki zostały losowo przydzielone do 3 różnych grup: 1 - grupa (A) grupa wykonująca ćwiczenia stabilizacji łopatki obejmowała 20 pacjentek, które wykonywały ćwiczenia wzmacniające, stabilizujące łopatkę i ćwiczenia postawy oraz tradycyjny program rehabilitacji, 2 - grupa (B) obejmowała 20 pacjentek poddawanych mobilizacji metodą Mulligana z ruchem w stawie barkowym, technice SNAG w zakresie kręgosłupa szyjnego oraz tradycyjnemu programowi rehabilitacji. 3 - grupa (C), tj. grupa kontrolna obejmowała 20 pacjentek, które były poddawane tylko tradycyjnej fizjoterapii. **Główne mierniki wyników.** Procedury zakresu ruchu ramion (ROM) obejmowały pomiar zgięcia i aktywnego zakresu ruchu odwodzenia oraz procedurę oceny kąta szyjnego i poziomego ustawienia wyrostków barkowych. **Oceniano je** na początku i po 6 tygodniach treningu. **Wyniki.** Wszystkie grupy wykazały znaczną różnicę w zakresie ruchu ramion (zgięcie i odwodzenie), zaobserwowano wysoki procent klinicznej poprawy na korzyść grupy B w porównaniu z innymi grupami. Wystąpił istotny wzrost kąta szyi po leczeniu tylko w grupie A i nie zaobserwowano istotnej różnicy w grupie B i C. Wystąpiło istotne zmniejszenie poziomego ustawienia wyrostków barkowych w grupie A i B, a największa poprawa nastąpiła w grupie A w porównaniu z grupą B i C oraz w grupie B w porównaniu z grupą C. **Wnioski.** Zarówno ćwiczenia stabilizujące łopatkę, jak i technika Mulligana są uważane za skuteczne w leczeniu ograniczenia zakresu ruchu barku po mastektomii; technika Mulligan jest lepsza. Jeśli chodzi o wysunięcie głowy do przodu i asymetryczną wysokość łopatki po mastektomii, stabilizacja łopatki jest uważana za bardziej skuteczną w poprawie tych odchyłeń postawy.

## Słowa kluczowe

ćwiczenia stabilizacji łopatki, technika Mulligana, kinematyka barku, zmiany postawy, mastektomia

## Introduction

The breast cancer can be treated surgically by breast conserving surgery (lumpectomy) and mastectomy. Breast conserving surgery is preferred for most unilateral disease victims, although surgeons have to do mastectomy for many patients. The decision of choice one of both surgeries depends on many factors like the size of the lesion, hormone receptivity and histologic markers, presence or absence of metastasis and patient age [1].

A course of radiation therapy routinely follows surgery for reducing recurrence risk of the disease. Chemotherapy also may be initiated postoperatively to prevent the systemic spread of the disease [1].

Removing lymph nodes in the axilla should accompany breast cancer surgery. It is used for assessment procedure where removal of the sentinel node in the axilla is required for assessing the presence of lymph node affection and for staging the disease, also it is used for treatment where more extensive dissection for metastatic disease removes the nodes under pectoralis muscle or around the clavicle [2].

Postoperative musculoskeletal complications associated with mastectomy could be shoulder pain, restricted glenohumeral range of movement and difficulties with upper limb overhead activities, they were reported as 10-55%, 22-38% and 42-56% in all women done mastectomy respectively [3].

Wide excision will result in scar tissue formation in the anterior chest wall. This scar may limit normal gliding process between skin, fasciae and muscles. The resulting pain and poor posture will produce shoulder girdle mal-alignment and inhibit shoulder motion. Adjuvant radiotherapy has several effects on lung parenchyma, vascular and connective tissues making them thick that in term restrict movement of surrounding fascial planes. Local ischaemia could be developed due to vascular network changes that affect shoulder girdle muscles contraction [4].

Psychological aspects after mastectomy like depression, modesty and shyness may lead women to assume an attitude of closure as a protective posture and also make them decreasing their activity level. Spinal alignment alterations such as increased kyphosis, asymmetry between acromion, and greater trochanter that may cause trunk rotation and scoliosis were documented in the literature. Lymphedema may increase the asymmetries and postural deviations [5].

One of the compensatory postural mechanisms used post unilateral mastectomy is shoulder elevation to compensate the missing breast weight. Ipsilateral shoulder elevation was observed in most of the studies, whereas Serel et al. [6] observed contralateral elevation, also they documented acquired scoliosis of more than 100 of deviation in structural curves of the spine.

Scapular stabilization exercise was documented to be an effective therapeutic tool for many shoulder conditions. Recently it is used widely in shoulder and spinal rehabilitation. The idea of scapular stabilization is to restore the normal scapular position, make it well set on the thoracic cage through correcting deformities like scapular winging or excess scapular tilting and making the humeral head more central within glenoid cavity so it makes glenohumeral joint also stable and not susceptible to mechanical impingement [7].

Scapular stabilization exercises consist of postural training, muscle groups balance restoration, muscle length normalization and muscle groups coordination which are improved through isometric, concentric and eccentric contraction of scapular muscles and reeducating the scapula to move correctly [8].

There is great evidence that scapular stabilization (Strengthening of the lower trapezius fibers) has positive effects on scapular tipping in patients with Diabetic frozen shoulder and thoracic kyphosis that in term could improve body posture as all [9]. Brian Mulligan had developed mobilization with movement (MWM) for correcting joint tracking from a positional fault by using sustained mobilization applied by a therapist and the patient makes pain free active movement to end range. Passive end range overpressure is then applied without causing pain [2].

It is thought that for treating movement dysfunction with mechanical instability, physical therapists should use a strategy to improve proprioception via joint and muscle receptor input to assist this functional adjustment which may aid in changing the patient posture and dysfunctional movement. Mobilization with movement is used to treat shoulder dysfunction and cervical spine movement restriction with posture defect by an articular glide applied to an active corrected movement pattern which can provide proprioceptive input for motor re-education [10].

Many researches confirmed clearly abnormal posture in women after mastectomy that appeared in all three planes: sagittal, coronal and transverse. The change in body posture after mastectomy due to the weight differences after losing a breast is significant as compared with healthy women. The asymmetry of the buttocks after radical mastectomy was later defined to be related to the position of the shoulders and scapulae. Also there is asymmetry of the trunk and shoulder girdle and a greater forward leaning of the trunk in women after mastectomy compared with healthy women with increased tendency to exhibit kyphotic posture and tilt the head forward while the shoulder on the operated side is lifted, ejected forward and medially [11].

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 scapular stabilization exercises or Mulligan technique on shoulder kinematics and body posture post-mastectomy.

This study was designed to provide a guideline about the effect of scapular stabilization exercises versus Mulligan technique in improving shoulder kinematics and body posture post-mastectomy and to assist in planning an ideal treatment regimen for reducing these pathological changes.

## Materials and methods

### Design

A randomized trial was carried out in the department of physiotherapy and rehabilitation, Pharos University, Alexandria, Egypt. All participants were informed of the study nature and signed a consent form. The study was approved by the Ethical Committee for Human Research at the Faculty of Physical Therapy, Cairo University, Egypt (Reference number: P.T. REC/012/002064).

## Participants

Sixty female patients who had limitation in shoulder motion (abduction and flexion less than 120°) and changes in cervical and shoulder posture in form of (cervical angle less than 50° and asymmetrical scapular height) post mastectomy participated in this study. Their ages ranged from 40 to 55 years. Any participant was excluded if she met one of these criteria; Neurological conditions, shoulder girdle or spine pathology due to trauma or did a surgery, any autoimmune disease affects the structure of the shoulder joint and the spine.

## Interventions

The participants were randomly separated into three study groups: scapular stabilization exercises group, Mulligan technique group and control group. They were assigned equally (20 patients for each group). Group A (scapular stabilization exercises group) included 20 patients received 6 weeks of strengthening, scapular stabilization and postural exercises plus a traditional rehabilitation program in the form of pendulum and ROM exercises for the shoulder (Scaption, Abduction, Flexion and Rotations), ROM exercises for cervical spine (flexion, extension, side bending and rotations), stretching exercises for sternocleidomastoid and pectoralis major muscles, and ultrasound therapy was applied on the subacromial region for 3 sessions per week. This protocol was a Strength training with thera band consisted of exercises for rotator cuffs, scapular retractors, diagonal 2 proprioceptive neuromuscular facilitation pattern and Serratus anterior punches. Tubing exercises were done as 3 sets of 10 repetitions with a 60 seconds rest period between each set. Another exercises were applied targeting scapular muscles. These exercises were done on a swiss ball [12].

Group B (Mulligan technique group) included 20 patients received 6 weeks of shoulder mobilization with movement and cervical sustained natural apophyseal glide (SNAG) plus a traditional rehabilitation program for 3 sessions per week. Shoulder mobilizations were done in sitting position; the therapist placed a belt around the humeral head to glide it appropriately. The therapist pressed on the scapula in a counter direction. Gliding was maintained during active shoulder movement through the range. The procedure was performed for 10 repetitions [13]. The second technique was Cervical SNAG that was done as follows: the therapist was standing behind the patient and glided each vertebrae by applying a force to the spinous process with a thumb over thumb technique. Cervical SNAG for flexion and extension was performed by the patient actively repeated flexion or extension of their necks and returning back to the neutral position. The application of the passive gliding was maintained in the anterosuperior direction along the facet joints line while flexing or extending the neck all over the range [14].

Group C (Control group) included 20 patients received 6 weeks of traditional rehabilitation program for 3 sessions per week. This protocol consisted of pendulum and shoulder active exercises (scaption, abduction, flexion and rotations), ROM exercises for cervical spine (flexion, extension, side bending and rotations), stretching exercises for sternocleidomastoid and pectoralis major muscles, and ultrasound therapy

was done using Gymna Pulson 400 device (Gymna Uniphy, Bilzen, Belgium 2011), it was applied on the subacromial region (US frequency: 1 MHz; US mode: continuous; time: 5 minutes and an intensity of 1 W/cm<sup>2</sup>).

## Outcome measures

Assessing shoulder flexion and abduction, and posture assessment procedure of cervical angle, and acromions' horizontal alignment were recorded at the beginning and 6 weeks of after training.

Active shoulder flexion and abduction were measured by a digital inclinometer [15]. Measurement of flexion ROM was done with the participant seated upright. The patient actively elevated her arm in pure flexion or pure abduction to available end range and the measurement was recorded. The instrument was placed on the distal upper arm for both procedures.

Posture was assessed by the postural assessment software (PAS/SAPO). The photographs were taken after markers were placed on specific anatomical points. The anatomical points included the tragus and both acromions were marked and women stood in a comfortable posture and were photographed. The photographs of each participant were analysed by PAS/SAPO software [16]. We recorded cervical angle and the acromions' horizontal alignment. Acromions' horizontal alignment is the angle between the two acromions and a horizontal line [17]. Cervical angle is the angle between a horizontal line through the spinous process of C7 and a line running through the tragus of the ear and spinous process C7. It is used to assess forward head position and is considered very reliable. We considered women to have forward head position if the angle was less than 50° [18].

## Statistical analysis

Descriptive statistics include the mean and standard deviation of post treatment data (ROM of shoulder flexion, abduction, cervical angle and horizontal alignment of acromions) as compared to pre one. 3 x 2 mixed design Multivariate Analysis of Variance (MANOVA) was used to compare the effects of scapular stabilization exercises versus Mulligan technique when compared with conventional physical therapy on post-mastectomy shoulder kinematics and body posture. The study included two independent variables. The first independent variable (between subject factor) was the tested group with three levels: experimental group (A), experimental group (B), and control group (C). The second independent variable (within subject factor) was the testing time with two levels: pre-testing and post-testing. The four dependent variables were the ROM of shoulder flexion, abduction, cervical angle and horizontal alignment of acromions. All statistical measures were performed using SPSS version 23 for Windows. The level of significance for all statistical tests was set at  $p < 0.05$ .

## Results

Statistical tests revealed no violations of the assumptions of normality and homogeneity of variance for any of the dependent variables. Results revealed non-significant differences ( $P > 0.05$ ) between the three groups regarding to demographic characteristics as shown in Table 1.

**Table 1. Demographic and clinical characteristics of participants in all groups**

Variables	Group A (N = 20)	Group B (N = 20)	Group C (N = 20)	F-value	P-value
Age [year]	46.12 ± 4.29	45.37 ± 4.24	45.62 ± 4.2	0.065	0.938
Gender [female]	72.37 ± 7.87	73.5 ± 8.22	65.12 ± 10.97	1.983	0.163
Height [cm]	1.57 ± 0.07	1.57 ± 0.05	1.53 ± 0.09	0.615	0.55
Weight [kg]	29.29 ± 2.28	29.59 ± 3.9	27.49 ± 3.64	0.922	0.413
BMI [kg/m <sup>2</sup> ]	46.12 ± 4.29	45.37 ± 4.24	45.62 ± 4.2	0.065	0.938

Data are represented as (Mean ± SD); BMI = Body Mass Index; Level of significance at  $P \leq 0.05$

### 3 × 2 mixed design MANOVA

Multivariate tests for outcome measures indicate a statistically significant effects for group ( $F = 2.901$ ,  $p = 0.017$ , Partial  $\eta^2 = 0.392$ ), time ( $F = 53.153$ ,  $p = 0.001$ , Partial  $\eta^2 = 0.922$ ), and group-by-time interaction ( $F = 8.966$ ,  $p = 0.001$ , Partial  $\eta^2 = 0.666$ ). Within group analysis revealed a statistical significant increase ( $p < 0.05$ ) for ROM of shoulder flexion and ROM of shoulder abduction for three groups while there was significant increase ( $p < 0.05$ ) for cervical angle in the groups (A and C) and significant reduction ( $p < 0.05$ ) in horizontal alignment of acromials at groups (A and B). Comparing the results among the three te-

sted groups, it was revealed that there was a significant improvement ( $p < 0.05$ ) (high percent of improvement) in the post-testing mean values of ROM of shoulder flexion and abduction in the experimental group (B) compared with the group (C). As well as, there was a significant improvement ( $p < 0.05$ ) (high percent of improvement) in the post-testing mean values of cervical angle in the experimental group (A and B) compared with the group (C). While, there was no significant difference ( $p > 0.05$ ) in the post-testing mean values of horizontal alignment of acromials among three groups as shown in Table 2.

**Table 2. The 3x2 mixed design Multivariate Analysis of Variance (MANOVA) for all dependent variables at different**

		Group (A) (n = 20)	Group (B) (n = 20)	Group (C) (n = 20)	Group A Vs. B p- value*	Group A Vs. C p- value*	Group B Vs. C p- value*
<b>ROM of shoulder flexion (°)</b>	Pre-treatment	90 ± 14.67	89.5 ± 18.11	91.62 ± 18.8			0.99 <sup>NS</sup>
	Post-treatment	123.62 ± 24.39	145.5 ± 19.07	107.75 ± 17.21			0.133 <sup>NS</sup>
	p- value** (% of change)	0.001 <sup>S</sup> (37.35)	0.001 <sup>S</sup> (62.56)	0.009 <sup>S</sup> (17.6)			0.98 <sup>NS</sup>
<b>ROM of shoulder abduction (°)</b>	Pre-treatment	89.62 ± 20.81	89 ± 14.49	95.75 ± 14.45			0.121 <sup>NS</sup>
	Post-treatment	125.12 ± 22.49	147 ± 21.66	117.75 ± 15			0.826 <sup>NS</sup>
	p- value** (% of change)	0.001 <sup>S</sup> (37.35)	0.001 <sup>S</sup> (65.16)	0.001 <sup>S</sup> (22.97)			0.003 <sup>S</sup>
<b>Cervical angle (°)</b>	Pre-treatment	42.35 ± 5.26	39.42 ± 4.44	35.57 ± 5.86			0.98 <sup>NS</sup>
	Post-treatment	55.22 ± 5.4	43.06 ± 6.42	39.86 ± 7.27			0.141 <sup>NS</sup>
	p- value** (% of change)	0.001 <sup>S</sup> (30.38)	0.117 <sup>NS</sup> (9.23)	0.001 <sup>NS</sup> (068)			
<b>Horizontal alignment of acromials</b>	Pre-treatment	2.9 ± 1.18	3.15 ± 1.57	2.3 ± 1.62			0.98 <sup>NS</sup>
	Post-treatment	0.87 ± 0.6	2.35 ± 1.7	2.21 ± 1.5			0.407 <sup>NS</sup>
	p- value** (% of change)	0.001 <sup>S</sup> (70)	0.002 <sup>S</sup> (25.39)	0.707 <sup>NS</sup> (4.09)			

\* Inter-group comparison; \*\* intra-group comparison of the results pre- and post-treatment. Data expressed by mean ± SD, <sup>NS</sup>  $p > 0.05$  = non-significant, <sup>S</sup>  $p < 0.05$  = significant,  $p$  = Probability

### Discussion

The present study was done to examine the therapeutic efficiency of scapular stabilization protocol versus Mulligan techniques in improving shoulder function and body posture post-mastectomy. We conducted our study on sixty female patients done mastectomy and had limitation in shoulder motion

(abduction and flexion less than 120°) and changes in posture in form of forward head position detected by a cervical angle less than 50° and asymmetrical scapular height.

Many posture changes were documented in the literature in the frontal, sagittal and transverse planes in women post mastectomy. Deviations of scapular position, shoulder height and spine

curvature changes were obvious. We selected cervical angle to determine the amount of forward head and the acromions' horizontal alignment to determine inclination angle of the line of shoulders and the asymmetry of scapular height as these factors may predispose to shoulder joint dysfunction and limitation.

Rostkowska et al. [19] found that the posture of women after mastectomy compared to healthy women are characterised by statistically significant alterations in form of greater asymmetry of scapula position. The higher position in the frontal plane of the scapula was on the operated side.

The statistical analysis of the current study results showed that there was significant increase of ROM of shoulder flexion at post treatment in compare to pre-treatment in all groups. Among groups, the mean values of the "pre" test among (group A versus B), (group A versus C), and (group B versus C) showed no significant differences. There was no significant difference post treatment among (group A versus B) and (group A versus C). In spite of there wasn't significant statistical difference between group A and group B, there was clinical difference and high percent of improvement in favor to group B. As well, in spite of there wasn't significant statistical difference between group A and group C, there was clinical difference and high percent of improvement in favor to group A. While, there was statistical significant increase between (group B versus C) and this significant increase in favour to group B.

There was significant increase of ROM of shoulder abduction at post treatment in compare to pre-treatment in all groups. Among groups, the mean values of the "pre" test among (group A versus B), (group A versus C), and (group B versus C) showed no significant differences. There was no significant difference post treatment among (group A versus B) and (group A versus C). In spite of there was no statistical significant difference between group A and group B, there was clinical difference and high percent of improvement in favor to group B. As well, in spite of there was no statistical significant difference between group A and group C, there was clinical difference and high percent of improvement in favor of group A. While, there was statistical significant increase between (group B versus C) and this significant increase in favour to group B.

Regarding cervical angle measurement there was significant increase at post treatment in compare to pre-treatment in group (A) only with no significant difference in the group (B) or (C). Among groups, the mean values of the "pre" test among (group A versus B), (group A versus C), and (group B versus C) showed no significant differences. There was significant difference among (group A versus B) and (group A versus C) and this significant increase in favor of group (A), and no significant difference between (group B versus C).

There was significant reduction in the horizontal alignment of acromials at post treatment in compare to pre-treatment in group (A) and (B) with no significant difference in group (C). Among groups, the mean values of the "pre" test among (group A versus B), (group A versus C), and (group B versus C) showed no significant differences. Also the mean values of the "post" test among all the groups showed no statistical si-

gnificant differences. In spite of there was no statistical significant difference among the three groups, there was clinical difference and high percent of improvement in favor of group A in compared groups (B and C) and in favor of group B in compared group C.

The finding of this study indicated that both scapular stabilization exercises and Mulligan technique are considered effective treatment for shoulder AROM limitation post-mastectomy, while Mulligan technique is more effective. Regarding forward head position and asymmetrical acromions height post mastectomy, scapular stabilization are considered more effective for improving this postural deviation than Mulligan techniques or the traditional physical therapy.

A few clinical trials were done to compare the effect of scapular stabilization with Mulligan MWMs on shoulder function, one of these trials was done by Chilgar et al. [20] they recruited 60 patients having shoulder impingement and divided them into two equal groups. Group A received exercises for scapular stabilization whereas group B received Mulligan's mobilizations for 6 weeks (3 times in a week). The results of this study come in agree with our study that there was statistically significant improvement in shoulder ROM in both groups. The results of this study came in contrary to our results regarding intergroup comparison, Chilger and his colleagues showed that the improvement was more in scapular stabilization group as compared to mulligan group, whereas in our study mulligan MWMS was more effective.

Haveela et al. [21] investigated the effect of mulligans technique MWM on shoulder ROM restriction and compare it to spencer's technique and conventional therapy. They recruited 90 subjects diagnosed as frozen shoulder. The subjects were randomly assigned into 3 groups. Pre-treatment evaluation of shoulder range of motion ROM was done on the first day, at the end of 3rd week and 6th week. The findings of the study indicated that shoulder flexion, abduction, internal rotation, external rotation and extension have improved significantly in all three groups.

Moezy et al. [12] did a clinical trial on 68 patients with shoulder impingement. They examined the effect of a six-week program (three times per week) of scapular stabilization on pain, shoulder ROM, shoulder protraction, scapular rotation and symmetry, and body posture. They compare it to a conventional physical therapy which performed three sessions per week for six weeks. They found that scapular stabilization was effective at reducing the pain, increasing shoulder ROM and decreasing forward head and shoulder posture asymmetry.

In a study done by Boyoung et al. [22] a total of 15 patients suffered from neck pain and craniovertebral angle of forty-four degrees or less were participated. Subjects in the experimental group performed exercises for scapular stabilization for thirty minutes per session, three days a week for four weeks while control group practice relaxation techniques for the same period. The craniovertebral angle increased significantly in scapular stabilization group after training compared to control group.

The results of our study came in contrary to a study done by Kim et al. [14] and another study done by Siddapur et al. [23]. They investigated the effect of mulligan cervical SNAG on

forward head posture by measuring craniovertebral angle and they found a significant statistical improvement in the craniovertebral angle in both studies which is opposite to our results.

There may be some possible limitations in our study include limited sample size, results are applicable to subjects belonging to age group of 40–55 years only, short duration study (6 weeks) and limited posture assessment variables. Additional future researches are also necessary to compare the effectiveness of further manual therapy methods and therapeutic exercises protocols post mastectomy while adding more posture analysis angles and electromyography assessments. Also we recommend long term follow up of the patients.

## Conclusion

Both scapular stabilization exercises and Mulligan technique are considered effective treatment for shoulder AROM limitation post-mastectomy, while Mulligan technique is more effective. Regarding forward head posture and asymmetrical scapular height post mastectomy, scapular stabilization exercises are considered more effective for improving these postural deviations.

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