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Evaluation of Isokientic Activities of Shoulder Muscles Post Mastectomy in Different Age Groups

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Abstract

Background: *Shoulder movement impairment is a commonly reported consequence of surgery for breast cancer.*

Purpose: *The purpose of this study to investigate the differences in the isokinetic muscle forces of shoulder flexors, extensors, abductors, and adductors between affected and non-affected sides in patients with post unilateral mastectomy.*

Subjects: *One-hundred and fifty female's patient with unilateral post mastectomy assigned into three equal groups. Group (A) consisted of 50 patients with age ranging from (35-45), Group (B) consisted of 50 patients with age ranging from (46-55), and Group (C) consisted of 50 patients with age ranging from (56-65).*

Procedure: *isokinetic peak torque of shoulder flexors, extensors, abductors, and adductors were measured at angular velocity 90 degree/sec for all patients at different age groups.*

The results: Mixed design MANOVA revealed that there was a significant reduction of isokinetic peak torque of shoulder flexors, extensors, abductors, and adductors at affected side compared to non affected side for group A and B (P<0.05). While there was significant reduction of isokinetic peak torque of shoulder abductors and adductors at affected side compared to non affected side for group C and there was no significant difference of isokinetic peak torque of shoulder flexors, extensors between affected and non affected at group C.

Conclusion: *It could be concluded that, there was reduction of isokinetic peak torque of shoulder flexors, extensors, abductors, and adductors at affected side compared to non affected side in patients with post unilateral mastectomy at age from 35-55 years.*

Key words: *Mastectomy, Isokinetic, Shoulder muscles, Breast cancer.*

Introduction

Breast cancer is a disease in which breast cells proliferate abnormally. Breast cancer is a malignant tumor of breast tissue suspected by clinical findings such as a breast lump, breast thickening, or skin change, or changes on mammography. Breast cancer is staged from 0 (earliest) to IV (most advanced) with survival being dependent upon the stage at diagnosis. Breast cancer is the most common cancer worldwide for females, and the 2nd most common cancer overall, with more than 1,676,000 new cases diagnosed in 2012 (25% of female cases and 12% of the total). Breast cancer incidence rates are highest in Western Europe and lowest in Middle Africa, but this partly reflects varying data quality worldwide (Ferlay et al., 2013).

Usually breast cancer either begins in the cells of the lobules, which are the milk-producing glands, or the ducts, the passages that drain milk from the lobules to the nipple. Less commonly, breast cancer can begin in the stromal tissues, which include the fatty and fibrous connective tissues of the breast (Bagheri et al., 2005).

Cancer cells can invade nearby healthy breast tissue and make their way into the under arm lymph nodes, small organs that filter out foreign substances in the body. If cancer cells get into the lymph nodes, they then have a pathway into other parts of the body. The breast cancer's stage refers to how far the cancer cells have spread beyond the original tumor (Trevidic, 1998).

A mastectomy is surgery to remove the entire breast, including the skin, nipple, and areola. It is usually done to treat breast cancer (Giuliano, 2011).Following mastectomy for breast cancer, many women experience impairment in shoulder movements that can substantially affect their everyday function and quality of life (Voogd et al., 2003). Although some symptoms, such as arm swelling due to lymphedema, are easily accounted for, other symptoms, such as chronic ache and pain, which women report in the shoulder and upper trunk months to years after surgery, are not always associated with their physical strength (force-generating capacity) or range of motion at the shoulder (Haid et al., 2002; Merchant et al., 2008). The lack of a relationship between impairments and self-reported function suggests that other factors are likely to contribute to these persisting problems.

Shoulder movement impairment is a commonly reported consequence of surgery for breast cancer (Voogd et al., 2003).The residual effects of surgical scarring and fibrosis following radiotherapy could affect the mechanics of the shoulder region through tethering of soft tissue or pain-inhibited movement (Chiverton & Perry, 1987). The incidence of shoulder morbidity has been found to be significantly and substantially higher in women treated with postsurgical radiotherapy (17%) compared with a group of women who received no radiotherapy (2%) (Højris et al.,2000). Additionally, women who undergo mastectomy are almost 6 times more likely to experience shoulder restriction (Sugden et al., 1998) and impairment than patients who undergo breast-conserving surgery, and, despite improved surgical techniques and postoperative care, pain and functional limitation continue to pose problems (Cheville & Tchou, 2007).

The residual effects of surgery or radiotherapy also may affect the intricate shoulder girdle movements required for arm elevation. Normally, the humerus moves smoothly and in synchrony with respect to the scapula (McClure et al., 2001). This scapulohumeral rhythm is achieved through precise muscle firing of scapulothoracic and scapulohumeral musculature in response to complex proprioceptive information, maintaining the head of the humerus within the glenoid fossa throughout the movement (Belling Sørensen & Jorgensen, 2000).

The asymmetry of both soft tissue motility and mass distribution across the chest wall that arises from loss of a breast potentially could affect upper-limb movements and contribute to trunk or arm symptoms. Previous research has identified that there can be changes in the size and activation of muscles around the upper trunk consequential to surgery for breast cancer, and soft tissue contracture may result from protective posture and movement (Shamley et al., 2009).

A recent study by Shamley et al, (2009) showed significant changes during unilateral arm elevation in scapular kinematics on the operated side following surgery for breast cancer. In that study, however, the sample included women who had undergone mastectomy with or without radiotherapy, wide local excision with or without radiotherapy, or chemotherapy. In addition, participants included women with coexisting shoulder pain on the side of surgery.

Physiotherapy is recommended, in accordance with the surgeons' preferences for post-operative care, to improve the physical recovery of women after breast cancer surgery, by providing appropriate exercise prescription, and assist in the education of women after breast cancer surgery to facilitate their; Recovery of shoulder range of motion (ROM) and physical function of the operated arm; Awareness of lymphoedema, its prevention and early detection. A planned approach to the physiotherapy management of women after breast cancer surgery with the ability to individualized exercise and education programmes is essential to ensure optimal quality of care and best practice (Gutman et al., 1990).

An important confounder in understanding the mechanism underlying long-term shoulder pain in women following mastectomy is the relatively high incidence of idiopathic or posttraumatic shoulder disability that occurs in the same age group (Brue et al., 2007). Seventy percent of people with adhesive capsulitis are women, (Sheridan & Hannafin, 2006) and the point prevalence of shoulder pain has been reported from large population surveys as affecting 8.2% or more of the population aged 45 to 54 years, rising to 13.2% for those aged 75 to 84 years (Badley &Tennant, 1992). Sixty-five percent of women diagnosed with breast cancer are between 40 and 70 years of age (Cho et al., 2006).

Thus, in exploring the kinematics of the shoulder complex in women following mastectomy, it is important to ensure that disturbances cannot be attributed to coexisting joint pathology. As Isokinetic dynamometers are measurement devices providing clinicians with information about the dynamic, i.e moving, mechanical performance of muscle groups (Ellenbecker & Cools, 2010). So the aim of this study to investigate the differences in the isokinetic muscle forces of shoulder flexors, extensors, abductors, and adductors between affected and non-affected sides in patients with post unilateral mastectomy.

Materials and Methods

This study was conduced at the Isokinetic Laboratory, Faculty of Physical Therapy, Cairo University with the practical aspect lasting for 14 months (March 2013-May 2014). The aim of this study was to investigate the difference in the isokinetic muscle forces of shoulder flexors, extensors, abductors, and adductors between affected and non-affected sides in patients with post unilateral mastectomy among different groups.

Subjects

One-hundred and fifty female's patient with unilateral post mastectomy assigned into three equal groups. Group (A) consisted of 50 patients with age ranging from (35-45), Group (B) consisted of 50 patients with age ranging from (46-55), and Group (C) consisted of 50 patients with age ranging from (56-65). Patients were selected from Elshorta Hospital and KASR-Eleiny Teaching Hospital.

Inclusive Criteria:

Patients were included if they had:

- All patients were females.
- All patients undergone unilateral modified radical mastectomy at least one year ago.
- All patients received radiotherapy after surgery.

Exclusion criteria:

Patients were excluded if they had:

- A history of shoulder dislocation.
- A history of impingement syndrome.
- Neurological disorders.
- Severe lymphedema which will limit the range of motion and affect on the measurement.
- Bilateral mastectomy or with radical mastectomy.
- Acute inflammation which affect the range of motion.

Instrumentation:

1. Biodex Isokinetic Dynamometer.
2. Recording Data Sheet.

Biodex Isokinetic Dynamometer:

Biodex System 3 Multi-joint system testing and rehabilitation (Biodex Medical system, Shirely, NY, USA) was used in this study to measure the isokinetic parameters. These parameters involved the peak force of shoulder muscles. The Biodex Isokinetic Dynamometer has been widely used in research, clinical settings and rehabilitation is objectively to assess factors of muscle performance that is otherwise difficult to obtain using the manual testing techniques (Cools, 2002). It offers concentric, eccentric, isometric and passive modes for all joints. It measures the internal torque produced by the muscles while the bony segment is maintaining a constant angular velocity and range of motion. It is provided with many attachments and isolation straps for the trunk, shoulder, knee…etc. Performance measures are being automatically recorded by the system's custom software at different angular velocities. The Biodex Isokinetic Dynamometer used in the current study consists of a dynamometer head, a closed chain attachment, a seat and a control unit.

Procedures:

Preparatory phase for isokinetic testing:

All tests were performed using Biodex System 3 Isokinetic dynamometer. The testing session started with a warming up procedure (Cools et al., 2003) that lasted for three minutes, consisting of shoulder movements in all directions, push up exercises against the wall, and stretching exercises for the rotator cuff and scapular muscles. The affected side was tested firstly followed by the non-affected side.

Isokinetic evaluation for shoulder muscles:

The isokinetic dynamometer (Model: The Biodex System III, Biodex Medical System, Shirley, NY, USA) was used to assess the peak torque of shoulder abductors, adductors, flexors, and extensors. The concentric isokinetic mode was used at angular velocity of 90°/s because it was considered to be more suitable for patients (Hsu et al., 2002). Before applying the test, a demonstration of the testing procedure was performed to the patient. The patient height and weight were recorded before the test, using a universal weight and height scale, as these measurements are basic information required by the isokinetic system.

During the test, the patient was seated on the Biodex system chair. Three straps; one around the patient waist and two crossing the chest, were applied to ensure the proper stabilization of the patients and to perform a selected shoulder movement. The lever arm of the dynamometer was adapted to the extremity length while the rotation axis of the lever was aligned with the rotational axis of the shoulder joint, as described in the Biodex applications manual.

The Biodex chair position, dynamometer tilt, and orientation were determined according to the manufacturer recommendations. Calibration was performed before starting the measurement in which the starting and end position of the shoulder ROM was manually entered. For the shoulder abductors, adductors, flexors, and extensors peak torque, a specific shoulder attachment was used and the torque was detected from 0° to 90° against gravity. A target angle of 90° was chosen, as the muscular force required at that range is the highest. In addition, the 90° is expected to be feasible for most patients as shown in figure (1 and 2). The patient was asked to perform one practice series of five shoulder movements through the whole calibrated range. For each muscle group, three trails were recorded with a five seconds rest in between.

A B

Figure (1): Measurement of shoulder flexors and extensors; a: Starting position b: The end position.

A B

Figure (2): Measurement of shoulder abductors and adductors; a: Starting position b: The end position.

Data analysis

All statistical measures were performed through the Statistical Package for Social Studies (SPSS) version 18 for windows. Prior to final analysis, data were screened for normality assumption, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculation of the analysis of difference and analysis of relationship measures.

The current test involved two independent variables. The first one was the (tested group); between subjects factor which had three levels (group A, group B, and group C). The second one was the (involvement side); within subject factor which had two levels (involved and non-involved). In addition, this test involved four tested dependent variables (peak torques of shoulder abductors, adductors, flexors, and extensors). Accordingly, 3×2 Mixed design MANOVA was used to compare the tested variables of interest at different tested groups and training periods. The MANOVAs were conducted with the initial alpha level set at 0.05.

Results

Statistical analysis using mixed design MANOVA revealed that there were significant within subject effect (F= 59.351, p = 0.000), group*side of involvement (F= 5.813, p= 0.000), and between subject effect (F= 30.37, p= 0.000). Table (1) presents descriptive statistic (mean ± SD) of all detective variables.

In the same context, the multiple pairwise comparison tests revealed that there were significant reductions ($p < 0.05$) in peak torques of shoulder abductors, adductors, flexors, and extensors in the affected side compared with non-affected side in group A and B. While in the group C, there were significant reductions ($p < 0.05$) in peak torques of shoulder abductors and adductors in the affected side compared with non-affected side. Table (2) presents multiple pairwise comparisons between affected and non- affected sides of all detective variables in three groups.

Regarding between subject effects multiple pairwise comparisons revealed that there were significant reduction ($p < 0.05$) in peak torques of shoulder adductors and flexors in-group C compared with group A and B at affected side. In addition, there were significant reduction ($p < 0.05$) in peak torques of shoulder abductors, flexors, and extensors in-group C compared with group A and B at non-affected side. Table (3) presents multiple pairwise comparisons among three groups of all detective variables among three groups.

Table (1): Descriptive statistics for the isokinetic peak torque of the shoulder abductors, adductors, flexors, and extensors at different sides of involvement for three groups.

Isokinetic PT (Nm)	Group A		Group B		Group C	
	Affected	Non affected	Affected	Non affected	Affected	Non affected
Shoulder abductors PT (Nm)	25.91±5.93	39.4±5.57	16.88±4.41	23.43±7	15.24±3.04	20.78±2.3
Shoulder adductors PT (Nm)	24.15±4.84	31.31±5.1	14.68±4.37	20.64±5	9.55±2.6	13.71±3.19
Shoulder flexors PT (Nm)	31.79±8.64	45±5.56	22.5±5.94	32.21±7.88	14.71±2.49	16±6.02
Shoulder extensors PT (Nm)	24.46±4.29	38.9±7.45	13.51±3.42	20.67±6.23	10.22±2.03	13.57±2.82

Table (2): Multiple pairwise comparison tests (post hoc tests) for shoulder abductors, shoulder adductors, shoulder flexors, and shoulder extensors PT strength between affected and non affected for three groups

	Affected versus non affected			
	Shoulder abductors	Shoulder adductors	Shoulder flexors	Shoulder extensors
Group A	0.000*	0.000*	0.000*	0.000*
Group B	0.000*	0.000*	0.000*	0.000*
Group C	0.007*	0.012*	0.606	0.193

Table (3): Multiple pairwise comparison tests (post hoc tests) for shoulder abductors, shoulder adductors, shoulder flexors, and shoulder extensors PT strength among three groups at affected and non affected side

	Affected				Non affected			
	Shoulder abductors	Shoulder adductors	Shoulder flexors	Shoulder extensors	Shoulder abductors	Shoulder adductors	Shoulder flexors	Shoulder extensors
Group A Vs. B	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Group A Vs. C	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Group B Vs. C	**1.00**	**0.024***	**0.033***	**0.123**	**0.909**	**0.004***	**0.000***	**0.038***

Discussion

We investigated the isokinetic activities of shoulder muscles post-mastectomy in different age groups. The deliberate selection of participants who were no longer considered to be in the recovery phase after surgery and who had stable clinical presentations. It was designed to identify isokinetic changes in the of the shoulder and scapular muscles that might be ascribed to the consequences of their surgery and postoperative activity rather than to shoulder pathology that might have originated from surgery or from other causes. The results of our investigation indicate the rejection of all 3 of our primary hypotheses. There were significant differences among groups for the shoulder movements during shoulder movement, although the discrepancy was almost entirely limited to upward rotation of the scapula, which demonstrated systematic differences from the control group. The magnitude of the differences in upward rotation was substantially greater than the calculated error terms for the movements in question.

Differences recently have been reported in side-to-side movement of the scapula during unilateral arm elevation in the plane of the scapula in women following breast cancer surgery (Shamley 2009). In our study, we found that shoulder muscles were affected in the affected side in the two groups (ages from 35 to 55 years). Scapular and thoracic participation in upper-limb motion is a natural component of the kinematics of the shoulder girdle (Theodoridis & Ruston; 2002 Biryukova et al., 2000) and it frequently is altered in people with problems affecting the shoulder region. (Ludewig & Cook, 2000). In our study, however, none of the women reported current shoulder symptoms, nor did they demonstrate positive shoulder impingement patterns.

The muscles of shoulder flexors, extensors, adductors, and abductors were affected in the operated side compared with the non-affected side in the two groups which ages from 35 to 55 years while the third group from 56 to 65 years did not show great difference between the affected and non-affected side except shoulder adductors and abductors otherwise there was a decrease in all movements of both affected and non-affected side due to physiological weakness with aging. We speculate that the reason for this altered scapular contribution may be a motor control adaptation rising from reduced frequency and amplitude of elevations of the arm following surgery and during everyday activities. The changes to scapulohumeral motion apparently were not attributable to actual shoulder pathology; therefore, the alteration is likely to arise through adaptive changes to motor patterns and learned usage.

One explanation as to why the post mastectomy groups used adaptive strategies may be related to post operative surgical management. (Harmer 2000) Women are encouraged not to elevate their arm above their head in the early postoperative period, as it can cause formation or production of serous fluid. Furthermore, even after drain removal, women are instructed to protect their affected limb to prevent lymphedema. The adaptive changes may simply be a consequence of fewer elevations of the arm past 90 degrees. An observational study of older participants who were healthy determined that their arm moved beyond this position 13 times per hour, (Schurr & Ada, 2006) which suggests that such movement may be necessary to maintain range and synchrony of movement. We also speculate that the reason for this altered shoulder movements affection may be due to scarring or fibrosis of the incision and the technique of the surgery which may limit the range of motion of shoulder girdle.

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