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Original Research

Scapular Dyskinesia After Modified Radical Mastectomy Surgery and Breast Conserving Surgery

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Abstract

Objectives: The pectoralis minor muscle is negatively affected by mastectomy surgery, and this negative effect may be broken scapular kinematics. Aimed of this study was to evaluate present of the scapular dyskinesia (SD) in Modified Radical Mastectomy Surgery (MRMS) and Breast Conserving Surgery (BCS). **Materials and Methods:** Forty patients who had MRMS or BCS participated in the present study. Pain, SD, and upper extremity disabilities were evaluated. **Results:** There were no differences in age, body mass index, pain, upper extremity disabilities, Lateral Scapular Slide Test (LSST), and Scapular Assistance Test (SAT) between BCS and MRMS ($p>0.05$). But there was a difference in Scapular Retraction Test (SRT) (p:0.024). The number of patients who had SD was higher in BCS. There was no relationship between SD and other parameters ($p>0.05$) in both surgeries. There was a moderate negative correlation between pain and SRT/SAT in MRMS (r:-0.564; p:0.01 and r:-0.564; p:0.01, respectively) while there was no correlation between pain and SRT/SAT in BCS ($p>0.05$). **Conclusion:** The present study showed that SD should be seen after mastectomy surgery, especially in BCS. Assessment of the presence of SD and training of scapular muscles was thought necessary before/after mastectomy. Although survival is a critical issue, teaching preventive/corrector exercises may be important for patient's quality of life after surgery.

Keywords: *Pectoralis Minor; Scapular Dyskinesia; Breast Cancer; Modified Radical Mastectomy Surgery; Breast-Conserving Surgery.*

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Introduction

The pectoralis minor muscle (mPM) is located between the sternocostal junction of third, fourth, fifth ribs and coracoid process of the scapula (McClure, Michener, Sennett and Karduna, 2001). mPM has an important role in scapular control, scapulohumeral, scapulothoracic joint kinematics, and overhead activities. Shoulder protraction caused by shortness or tension of mPM (Morais and Cruz, 2016) is also associated with pain and dysfunction (Provencher, Golijanin, Gross, Campbell, Gaston, and Anthony, 2014). Shortness or tension of mPM causes secondary anterior tilt and internal rotation of scapula thus leads to shoulder impingement syndrome (Provencher, 2014).

After mastectomy and protective breast surgery, pain (McNeely, Binkley, Pusic, Campbell, Gabram, and Soballe, 2012), limitation of shoulder joint movements (Ebaugh, Spinelli, Schmitz, 2011), rotator cuff syndrome (Ebaugh, 2011), cervical radiculopathy (Itoi, Kido, Sano, Urayama, and Sato, 1999), postmastectomy pain syndrome (Macdonald, Bruce, Scott, Smith, and Chambers, 2005), deep vein thrombosis (Khorana, 2009), and lymphedema (Dumont, Jussila, Taipale, Lymboussaki, Mustonen, and Pajusola, 1988) are frequently seen. The presence of one or more of these findings leads to a negative impact of shoulder girdle structures and consequently deteriorates both upper extremity functionality and quality of life (Ribeiro, Camargo, Alburquerque-Sendín, Ferrari, Arrais, and Salvini, 2019; Marazzi, Masiello, Marchesano, Boldrini, Luzi, Ferrara, et al. 2019).

There are some variations of application about mPM in Modified Radical Mastectomy Surgery (MRMS). The main purpose of this variations are to facilitate axillary exposure. mPM can be removed, preserved or division tendon during surgery by surgeon (Staradub and Morrow, 2002). However, all pectoral muscules are preserved in Breast Conserving Surgery (BCS) (Czajka and Pfeifer, 2020). After breast cancer surgery, scapular movement (Shamley, Srinaganathan, Oskrochi, Lascurain-Aquirrebeña and Sugden, 2009) and serratus anterior function (Adriaenssens, De Ridder, Lievens, Van Parijs, Vanhoeij, Miedema, et al., 2012) are impaired. During arm elevation, scapular upward rotation in the scapular plane (Ribeiro, et al., 2019), and greater scapular movement deviations (Shamley, et al., 2009) were shown in patients who underwent breast cancer surgery. These scapular abnormal movements that occur during upper extremity movements are defined as scapular dyskinesia (SD) (Kibler, 1998). When the literature was examined, there was no study evaluating the presence of SD after mastectomy by clinical tests or examining the relationship between scapular movement

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and the nature of surgery. This study aimed to evaluate the presence of SD in patients who underwent a mastectomy with MRMS or BCS. It was hypothesized that there could be a difference about SD between MRMS and BCS.

Materials And Methods

Ethics Approval

The Noninvasive Clinical Research Ethics Committee was approved the study protocol. The participants were informed about the scope and procedures of the study. All patients were provided written informed consent before participating the study.

Patient Selection

Female patients who underwent mastectomy were accepted in this study. *Inclusion criteria of the study:* To be in the postoperative third month after mastectomy, between 18-65 years of age, and unilateral MRMS or BCS. *Exclusion criteria of the study:* Patients who had received radiotherapy or chemotherapy after surgery, upper extremity surgery, nerve damage, more than 10 degrees normal joint movement limitation of shoulder, positive result of sentinel lymph node biopsy in BCS, a difference of more than 3 cm between a bilateral wrist or elbow circumference measurements, and body mass index >30 kg/m^2.

Sample size: For calculating sample size, a similar study was taken a reference after mastectomy (Crosbie, Kilbreath, Dylke, Refshauge, Nicholson, Beith, et al. 2010). Subjects were calculated to be in each group with a 5% Type 1 and 80% Type 2 error limits for evaluating SD. The effect width was taken as 0.815. As a result, the number of people in each group to be included was determined as a 20. Analyses were performed with the G*Power 3.1.9.2 software.

Evaluation

After demographic information (age, height, weight, operation side, health history, and type of surgery) were recorded, the patients were divided into two groups according to the type of surgery: MRMS and BCS. All evaluations were performed by the same physiotherapist respectively.

Pain assessment: Pain was evaluated with the Visual Analogue Scale (VAS) that was consists of a 10 centimeter (cm) line. Meaning of 0 cm was ‘no pain’ and the meaning of 10

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cm was ‘pain as intolerable’. The patient was wanted to put a mark that defines her pain intensity on the VAS. The scale was scored by measuring the distance from the 0 cm to the patient’s mark (Shimoji and Aida, 2020).

Assessment of scapular position and function: SD was evaluated using lateral scapular slide test (LSST), scapular retraction test (SRT) and scapular assistive test (SAT). SAT and SRT are defined as corrective maneuvers. These tests give information about the role of SD in the present clinical picture by evaluating whether the patient causes a change in the existing symptoms (Kibler, Sciascia and Dome, 2006).

LSST was evaluated in three different positions. (a) Arms were in a neutral position and near the body during standing position, (b) Arms resting on hips with thumbs posterior, and (c) Arms were evaluated bilaterally at 900 abduction and maximum internal position. The distances between the lower angle of the scapula and the spinous process of the thoracic vertebrae were measured with a tape measure in all three positions and recorded in cm. The test was considered positive when a difference between bilateral measurements was greater than 1.5 cm (Kibler, 1998).

The SRT was used to evaluate contributions to rotator cuff strength and labral symptoms. Before the test, supraspinatus muscle strength was evaluated by manual muscle test, and the labral injury was evaluated by the dynamic labral shear test. After the scapula was placed in the retraction position, the scapula was stabilized and all tests were repeated again. The test was considered positive when there was a relative increase in supraspinatus muscle strength or relief of symptoms (Kibler, Sciascia and Dome, 2006).

The SAT was used to evaluate scapular contributions to impingement and rotator cuff strength. During active shoulder elevation, gentle pressure was applied to assist scapular upward rotation. The test was accepted as positive when relief painful arch findings or increase range of movement (Kibler, 1998).

Assessment of upper extremity function and disability: "Disability of the Arm, Shoulder, and Hand (DASH)" questionnaire was used to determine the functional status, disability and participation level of the upper extremity after breast cancer surgery. All questions were scored between 1 and 5 points (1: no difficulty; 5: maximum difficulty) according to the Likert system, and the patient's function and symptom score were determined. The maximum score of the questionnaire is 100 points which indicates a severe disability (Hudak, Amadio and Bombardier, 1996). The Turkish version of the DASH questionnaire was used (Düger, Yakut, Öksüz, Yörükan, Bilgütay and Ayhan, 2006).

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Statistical Analysis

Statistical analyses were performed with the IBM-SPSS for Windows version 20 software (IBM Corp., Armonk, New York, United States). Descriptive statistics were given as mean and standard deviation for numerical data. The normal distribution of the obtained numerical variable was determined with visually (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk Tests, Variation Coefficient Analysis). The difference between the demographic information (age, weight, height, BMI) and pain severity between the groups was evaluated by the Mann Whitney U test, and the Wilcoxon test was used to evaluate differences between upper extremity function-disability levels. The correlation coefficients and their significance were calculated using the Pearson or Spearman test between upper extremity function-disability levels, pain severity, LSST, SRT, and SAT in groups. LSST, SRT and SAT were compared with Pearson chi-square test between groups. A correlation coefficient range between 0.30 and 0.39 reflects the poor agreement, between 0.40 and 0.59 reflect the moderate agreement, between 0.60 and 0.69 reflect the good agreement, between 0.70 and 0.75 reflect very good and those >0.75 indicates high agreement.

Results

A total of 40 female patients who underwent surgery for unilateral breast cancer were included in the study. The demographic characteristics, upper extremity function-disability levels, pain severity, and differences between the groups were given in **Table 1**. The distribution of all numerical data except upper extremity function-disability levels (DASH score) were normal. There were no significant differences in age, body weight, body mass index, DASH scores and pain severity between the BCS and MRMS groups (p>0.05).

Table 1: Demografic caracteristics, DASH scores and pain severity between the groups.

	Group	Mean ±SD	Min-Max	p
Age (years**)**	BCS	48 ±7,83	35-64	0,269*
	MRMS	45 ±10,32	23-60	
Body Mass Index (kg/m^2**)**	BCS	24,29 ±2,99	19-31	0,523*
	MRMS	24,93 ±3,35	19-31	
DASH Scores	BCS	24,09 ±16,24	2,50-60,80	0,695**
	MRMS	21,78 ±15,15	0,00-50,83	
Pain Severity (cm**)**	BCS	2,69 ±1,70	0,4-5,8	0,463*
	MRMS	2,28 ±1,75	0,0-6,8	

BCS: Breast Conserving Surgery; MRMS: Modified Radical Mastectomy Surgery; DASH: Disability of the Arm, Shoulder, and Hand; SD: Standart Deviation; *Mann-Whitnney U Test; ** Wilcoxon Test, p<0,05.

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Scapular position and function test results of individuals who have undergone different types of mastectomy surgery are given in **Table 2**. There was no difference in the results of LSST and SAT which were used to detect SD between groups (p>0.05). When scapula retraction test results were examined, there was a difference between the groups (p:0.024). BCS patients had more SD than MRMS patients.

Table 2: Scapular Position and Function test results between Groups.

Type of Test	Surgery	Result of Test	n (%)	p
LSST	BCS	Positive	7 (35)	1,000
		Negative	13 (65)	
	MRMS	Positive	7 (35)	
		Negative	13 (65)	
SRT	BCS	Positive	11 (55)	**0,024**
		Negative	9 (45)	
	MRMS	Positive	4 (20)	
		Negative	16 (80)	
SAT	BCS	Positive	8 (40)	0,173
		Negative	12 (60)	
	MRMS	Positive	4 (20)	
		Negative	16 (80)	
LSST/SRT/SAT	BCS	At Least One Test Positive	11 (55)	0,527
	MRMS	At Least One Test Positive	8 (40)	

BCS: Breast Conserving Surgery; MRMS: Modified Radical Mastectomy Surgery; LSST: Lateral Scapular Slide Test; SRT: Scapular Retraction Test; SAT: Scapular Assistive Test; Mann-Whitney U Test; p<0,05.

In the MRMS group, no correlation was found between DASH scores and pain severity, LSST, SRT, SAT and between pain severity and LSST (p>0.05). There was a moderate negative correlation between pain severity and SRT, SAT (r:-0.564; p:0.01 and r:-0.564; p:0.01, respectively). There was a very good positive correlation between SRT and SAT (r:1.0; p:0.001) (**Table 3**).

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Table 3: Correlation Analyses between DASH, Pain Severity, LSST, SRT, and SAT in MRMS group.

	Pain Severity (cm)	**LSST**	**SRT**	**SAT**
DASH	0,057 0,812**	-0,337 0,147*	-0,239 0,311*	-0,239 0,311*
Pain Severity (cm)		-0,182 0,443*	-0,564 0,010*	-0,564 0,010*
LSST			0,419 0,066*	0,419 0,066*
SRT				1,0 0,001*

DASH: Disability of the Arm, Shoulder, and Hand; LSST: Lateral Scapular Slide Test; SRT: Scapular Retraction Test; SAT: Scapular Assistive Test; ***:** Spearman Correlation Analysis; **: Pearson Correlation Analysis; p<0,05.

In the BCS group, no correlation was found between DASH and pain severity, LSST, SRT, SAT, and between pain severity and LSST, SRT, SAT (p>0.05). Good positive correlation between LSST and SRT, SAT (respectively, r:0.666; p:0.001 and r:0.685; p:0.001), and a very good positive correlation between SRT and SAT were found (r:0.739; p:0.001) (**Table 4**).

Table 4: Correlation Analyses between DASH, Pain Severity, LSST, SRT, and SAT in BCS group.

	Pain Severity (cm)	**LSST**	**SRT**	**SAT**
DASH	0,128 0,590**	-0,409 0,073*	-0,331 0,153*	0,006 -0,593*
Pain Severity (cm)		-0,335 0,124*	-0,374 0,103*	-0,337 0,146*
LSST			0,664 0,001*	0,685 0,001*
SRT				0,739 0,001*

DASH: Disability of the Arm, Shoulder, and Hand; LSST: Lateral Scapular Slide Test; SRT: Scapular Retraction Test; SAT: Scapular Assistive Test; ***:** Spearman Correlation Analysis; **: Pearson Correlation Analysis; p<0,05.

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Discussion

This study aimed to evaluate the presence of SD in patients who underwent a mastectomy with MRMS or BCS. The primary finding of this study, there was a difference in SRT results between the groups. In the BSC group (11 patients (55%)), the number of patients who had a positive SRT was higher than in the MRMS group (4 patients (20%)). At least one of the three SD tests was positive in 19 (47.5%) of the 40 patients who included in the study. The number of patients who had positive at least one of the three SD tests was 11 (55%) in the BCS group and 8 (40%) in the MRMS group. No difference was found between the two surgical methods in terms of pain severity and upper extremity function-disability levels.

SD may develop as a result of shoulder injuries or may occur in response to a painful condition of the shoulder (Kibler and Sciascia, 2010). SD may occur due to muscle imbalance, nerve damage, labrum rupture, and rotator cuff damage and may disrupt the scapula-humeral rhythm (Kibler, 1998). The increase in mPM and latissimus dorsi muscle activations may cause protraction in the shoulder girdle and disrupt scapulohumeral rhythm. To compensate for this disorder, it is known that activation of rotator cuff muscles with biceps muscle increase (Illyés and Kiss, 2006). This increased activation may cause instability and SD (Kibler and Sciascia, 2010). In this study, the main reason why the SRT result was significantly higher in the BCS group may be a result of scapular protraction caused by pectoralis minor muscle shortness. During surgery in the MRCS group, scapular protraction and rotator cuff muscle activation may have reduced by application of mPM, resulting in reduced shoulder symptoms (pain, joint restriction, etc.).

In the literature, we could not find a publication examining the presence of SD after mastectomy. We think that complications that are common after mastectomies such as shoulder pain (McNeely, et al., 2012), decreasing shoulder movements, and rotator cuff syndrome (Ebaugh, et al., 2011) may cause SD. Since preoperative mPM shortness, scapular dyskinesia and shoulder protraction were not known, it could not be compared with postoperative results. Especially in the BCS group, positive SRT results seen more frequently in the third postoperative month compared to the MRCS group may cause more predisposing factors related to shoulder problems and affect the functional level in the long period. Although positive SAT or SRT results do not indicate the diagnosing of specific shoulder pathology, they show the necessity of early scapular rehabilitation exercises to prevent the

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occurrence of symptoms that may occur as a result of SD and improve scapular control (Kibler and Sciascia, 2010).

Shoulder pain is one of the most common problems after breast surgery (McNeely, et al., 2012). The pain severity of the patients included in the study had mild or moderate according to the Serlin et al classification (Serlin, Mendoza, Nakamura, Edwards and Cleeland, 1995), and no difference was found in pain severity between the two surgical methods. It is known that chronic pain is more common in patients who have undergone BCS compared to patients who have undergone modified radical surgery, and there is a negative relationship between age and duration of pain; the pain severity increases with the presence of surgical complications (Tasmuth, Smitten, Hietanen, Kataja and Kalso, 1995). The patients who participated in this study were in the middle age range and the lack of surgical complications such as nerve damage, severe NEH restriction and edema may cause low pain severity and no difference between the two surgical methods.

In the MRMS group, there was a good positive correlation between pain severity and SRT, SAT results, and it was found that pain severities were higher in patients with positive test results. This relationship may be due to the presence of rotator cuff muscle pathology or/and possible pathology in the labrum, or high pain severity adversely affecting scapular movement. This relationship may be due to possible pathology of the rotator cuff muscle or/and the labrum, or high pain severity adversely affecting scapular movement. SAT results were positive in all patients who had positive SRT test in all patients who had MRMS. Also, SAT results were positive in all patients who had positive SRT in all patients who had MRMS. This result indicates that pain-free active movement can be achieved by correcting the pain-triggering position. There was no relationship between pain severity and tests of SD in the BCS group. SAT results were positive in 8 of 11 patients who were SRT positive in the BCS group. It is emphasized that SD should be included in routine shoulder examination before and after surgery in all surgeries that affect shoulder movements (Roche, Funk, Sciascia and Kibler, 2015). After variations of application about mPM to facilitate axillary exposure in MRMS, a shortness/tension/stiffness of Mpm might be decresed and scapular protraction may be prevented, so SD may not be seen. If there are a shortness/tension/stiffness before mastectomy in BCS, pain/inhibition/edema may be continuous or increase after mastectomy and as a result, they might be caused SD.

Chronic pain adversely affects approximately 50% of mastectomy patients at a mild level in their daily life activities, and approximately 25% of mastectomy patients in moderate

or severe levels (Tasmuth, et al., 1995). Akça et al. emphasized that although BCS patients were better in quality of life and social functions, there was no difference in terms of physically compared to mastectomy patients (Akça, Ata, Nayır, Erdoğdu and Arıcan, 2014). In this study, when the patients were examined in terms of upper limb function and disability, no difference was found, although both surgical modalities adversely affected the daily life at a mild or moderate level. However, it was observed that the upper extremity functional levels of the patients in the MRMS group were better than the patients in the BCS group. This result shows that MRMS patients can use their upper extremities more in their daily lives, and they have less functional disabilities. There was no correlation between DASH scores and pain severity, SD results between the two surgical methods.

There are significant differences in scapular kinematics between the two upper extremities of patients with shoulder pain after breast cancer treatment. In patients with mastectomy, the affected side rhomboid, trapezius and serratus anterior muscle activity decrease, and shoulder pain or/and disability are seen more than the unaffected side (Shamley, Srinaganathan, Weatherall, Oskrochi, Watson, Ostlere, et al., 2007). Shoulder pain, disability, and decreased muscle activity in trapezius/serratus anterior are among the factors causing SD formation (Kibler and Sciascia, 2010). In this study, three months in assessing the development of SD may have been too early for patients with mastectomy. It is thought that more SD may develop especially in the long-term results of surgery where mPM is preserved.

mPM in breast cancer surgeries is very important in determining postoperative physiotherapy and exercise approaches (Marazzi, et al. 2019). This study showed that SD should be considered in the early period of mastectomy. Evaluating mPM shortness before surgery, initiating exercises that improve flexibility and scapular control may be effective in preventing shoulder pain or/and dysfunction after surgery. It is thought that there is a need for studies comparing the shortness of mPM before and after surgery and the effectiveness of flexibility and scapular control exercises.

There are some limitations to this study: (i) SD could not be evaluated with 3D motion analysis systems, (ii) mPM shortness could not be evaluated before and after surgery (iii) preoperative SD, muscular strength, pain, and upper extremity functionality were not evaluated.

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Conclusion

Mastectomy surgery may provoke musculoskeletal problems. Although there was no difference in pain intensity and functional level in upper extremity in patients with MRMS and in patients with BCS, presence of the scapular dyskinesia was found patients with BCS more than patients with MRMS. The present study showed that scapular dyskinesia should be seen in patients after mastectomy surgery, especially in BCS. Assessment of the presence of scapular dyskinesia and training of muscles around the scapula should be added in rehabilitation programs after mastectomy. Although survival is a more critical issue for these patients, it may be important for the patient to teach protective exercises for scapular dyskinesia before surgery. Application of treatment approaches for scapular dyskinesia in pre- and/or postoperative terms will also play an important role in the treatment of pain, edema, and functional disability due to the nature of surgery. Long-term studies are needed to evaluate scapular dyskinesia, three-dimensional motion analysis in the pre-/post-operative term, and to compare outcomes after different rehabilitation techniques.

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Conflict of interest

All authors have no conflicts of interest with respect to the data collected and procedures used within this study. Authors declare that they have no sponsor in the study design, in the collection, analysis and interpretation of data, in writing of the manuscript, and in the decision to submit the manuscript for publication.

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Compliance with Ethical Standards

The authors confirm this study meets the guidelines of the Declaration of Helsinki and after local ethical approval (Acıbadem Mehmet Ali Aydınlar Üniveristesi Tıbbi Araştırmalar Değerlendirme Kurulu (ATADEK); Decision Number: 2018-3/7; Date: 01.03.2018). All subjects who accepted this study provided written informed consent.

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