ISSN: 2651-4451 • e-ISSN: 2651-446X

Turkish Journal of Physiotherapy and Rehabilitation

2022 33(3)203-209

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Received: 17.11.2021 (Geliş Tarihi)
Accepted: 01.03.2022 (Kabul Tarihi)

IS THERE A DIFFERENCE IN BALANCE FUNCTIONS BETWEEN BREAST CANCER SURVIVOR WOMEN AND HEALTHY WOMEN?

ORIGINAL ARTICLE

ABSTRACT

Purpose: Breast cancer survivors have various physical problems and balance disorders after mastectomy surgery (BCS). The study aimed to compare the balance functions in BCS women who had a mastectomy with healthy women.

Methods: Sixty-six individuals, BCS women who had a mastectomy (BCS group, n=33) and healthy women (control group, n=33), were included in the study. In this study, subjective balance problems and falling characteristics, static balance (Tandem Romberg Test - TRT) and dynamic balance (Y Balance Test- (YBT) and computer-based dynamic balance platform - Technobody-PK 200 WL) functions of the study and control groups were compared.

Results: The individuals in the BCS group (48.48%) experienced more balance problems than the control group (6.06%), but there was no difference between the two groups in terms of falling characteristics. Static balance (TRT) eyes-closed results were lower in the BCS group than the control group (t=-2.21, p=0.03), but there was no difference between the groups in TRT eyes-open results. There was no difference in any sub-parameter in dynamic balance measurements between the groups.

Conclusion: Subjective balance problems and static balance functions are affected more in BCS than in healthy individuals. It is recommended that balance functions should be evaluated and followed up with appropriate treatment methods in BCS women who had a mastectomy.

Keywords: Breast Cancer, Falling, Mastectomy, Postural Balance

MASTEKTOMİ YAPILMIŞ MEME KANSERLİ KADINLAR İLE SAĞLIKLI KADINLAR ARASINDA DENGE FONKSİYONLARI AÇISINDAN FARK VAR MIDIR?

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Meme kanseri sağkalanlarında mastektomi cerrahisi sonrasında çeşitli fiziksel problemler ve denge kayıpları meydana gelmektedir. Çalışmanın amacı mastektomi yapılmış meme kanserli kadınlar ile sağlıklı kadınların denge fonksiyonlarının karşılaştırılmasıdır.

Yöntem: Çalışmaya 66 birey, mastektomi yapılmış meme kanserli kadın (BCS grubu, n=33) ve sağlıklı kadın (kontrol grubu, n=33) dâhil edildi. Çalışma ve kontrol gruplarının subjektif denge problemleri ve düşme özellikleri, statik denge (Tandem Romberg Testi - TRT) ve dinamik denge (Y Denge Testi- YDT ve bilgisayar destekli dinamik denge platformu -Technobody-PK 200 WL) fonksiyonları açısından karşılaştırıldı.

Sonuçlar: BCS grubunda yer alan bireylerin (%48,48) kontrol grubundan (%6,06) daha fazla denge kaybı yaşadıkları fakat düşme özellikleri açısından iki grup arasında fark olmadığı görüldü. Statik denge (TRT) gözler kapalı ölçüm sonuçlarının BCS grubunda kontrol grubuna göre daha düşük düzeyde olduğu (t= -2,21, p=0,03) fakat gözler açık ölçüm sonuçları açısından iki grup arasında fark olmadığı tespit edildi. Dinamik denge ölçüm sonuçları incelendiğinde YDT ve Technobody ölçümlerinde iki grup arasında hiçbir alt parametrede fark olmadığı bulundu.

Tartışma: Meme kanseri sağkalanlarında subjektif denge problemi ve statik denge fonksiyonları sağlıklı kişilere göre daha fazla etkilenebilmektedir. Bu nedenle bu hasta grubunda denge fonksiyonlarının değerlendirilmesi ve uygun tedavi yöntemleri ile takip edilmesi tavsiye edilmektedir.

Anahtar kelimeler: Meme Kanseri, Düşme, Mastektomi, Postüral Denge

INTRODUCTION

Breast cancer is a type of cancer that starts in the breast tissue which is formed by canals and lobules (1). In recent studies, the most common cancer type in women is stated as breast cancer (2) mastectomy surgery and adjuvant treatments (radiotherapy, chemotherapy, and hormone replacement therapy) are among the treatments after breast cancer (3). Although mastectomy surgery is the most preferred method, it is known that mastectomy surgery may cause many changes in a woman's body (4) . Various problems occur in body structure and functions, causing activity and participation limitations in breast cancer survivors (BCS) after mastectomy (5). The most prominent problems are limited shoulder mobility, lymphedema, arm, and shoulder pain, defined as Arm Shoulder Problems (ASP), muscle strength loss, loss of balance, and fatigue (6). Especially the women with breast cancer face postural instability more than healthy women (7), and the postural changes occur due to the exclusion of breast tissue during the surgery, such as decreasing muscular strength, pain, and limitation in the spine, which impairs the static balance (8,9). It has been stated that chemotherapy treatment after the mastectomy surgery has central neurotoxic effects (10), which may also cause balance problems. In the meta-analysis study by Hsieh et al., it was found that the functional reach scores, center of pressure (COP) velocity, gait speed, and Timed Up and Go Test (TUG) average times were lower than their respective normative values, indicating potential balance and gait impairments in BCS (11). Based on the mastectomy surgery and adjuvant treatments, possible balance problems might increase the fall risk and fear of falling as well as causing limitations in activities of daily living and restrictions in quality life. The aim of the study was to compare the balance functions in BCS women who had a mastectomy with healthy women.

METHODS

Study Design and Patient Population

Thirty-three BCS women who had mastectomy were included in the BCS group, and 33 age-matched healthy women with similar characteristics were included in the control group. The BCS was contacted via telephone, and 33 of 35 of them accepted to participate in the study.

This study was designed as a prospective study that compared two groups of women: breast cancer survivors and age-matched healthy women. The recruitment strategies, including flyers, word-of-mouth, and emails, were used to reach both breast cancer survivors and healthy women. Written informed consent was obtained from all of the volunteer participants. All participants were evaluated in the clinical units of Eastern Mediterranean University, Department of Health Sciences, Healthy Living Center in the years 2017-2018. Ethical approval was obtained from the Eastern Mediterranean University Ethics Board for Scientific Research and Publication (date: 18/07/2016, decision no: 2016/30(a)-07).

The study included women with BCS who had mastectomy treatment and healthy women with similar characteristics who had not previously received any form of surgical procedure between the ages of 35 and 70. However, the excluded women are the patients who had chemotherapy and/or radiotherapy treatment, or who had immediate or delayed breast reconstruction after mastectomy, which might affect the physical features, and who are on post-operative 0-6 months period following mastectomy surgery.

Outcome Measurements

The purpose of the study was explained to the participants, and written informed consent was obtained from the participants before enrollment. The socio-demographic information of the individuals, the subjective balance problem, and falling characteristics were recorded. The participants were asked how many times they had a loss of balance in the last 6 months to evaluate the subjective balance problems. To evaluate falling characteristics, the individuals were asked if they had a history of falling, if they had fallen, the frequency of falling, and whether they had fractured during falling in the last 6 months. The Tandem Romberg Test (TRT) was used for evaluating the static balance, and the Y Balance Test (YBT) and computer-based dynamic balance platform (Technobody-PK 200 WL) was used for the evaluation of dynamic balance.

Tandem Romberg Test (TRT)

Tandem Romberg Test (TRT) is a variation of the original Romberg test. TRT was used in the clinical evaluation of balance problems caused by sensory and motor disorders. The participants were positioned in a tandem position, arms crossed across the chest, and were asked to maintain this position. If any change occurred, the time was stopped and recorded. The TRT was applied both in eyes-open and eyes-closed positions. Each test was repeated three times, and the chronometer registered the total time in seconds (s) needed to perform the test (12).

Y Balance Test (YBT)

Y Balance Test (YBT) is used to evaluate the dynamic balance. The YBT is a reliable and valid tool for quantitative balance assessment. Three test trials in each direction were applied, and the mean value of the 3 test trials was calculated for the data analysis. The specific testing order was anterior, posteromedial, and posterolateral. The subject maintained a single-leg stance with hands on the pelvis while pushing a rectangular reach-indicator block with the contralateral leg as far as possible along with the 3 directions. For average value calculation, a formula was used as; [(Sum of the 3 reach directions /3 times the limb length) X 100] (13).

Computer-based Dynamic Balance Platform (Technobody-PK 200 WL)

A computer-based dynamic balance platform (Technobody-PK 200 WL) was used for measuring the dynamic balance. The Technobody-PK 200 WL device was found to be compatible with Y Balance Test, Berg Balance Scale, and TUG test, and it was stated that the Technobody-PK 200 WL is a reliable method for following the progression and for objectively measuring the dynamic balance performances of the individuals (14). The "Equilibrium Assessment" and the "Sleight Assessment" tests in the Technobody-PK 200 WL device were used to evaluate dynamic balance. The anterior/ posterior and medial/lateral sleight assessment and balance assessment, reached target number, perimeter, and average pace were recorded. The procedure was described prior to the performance, and participants were instructed to follow the instructions and maintain their balance during testing. Each measurement was repeated three times, and the best score was recorded.

Statistical Analysis

The sample size was calculated by using the G*Power Version 3.1. program. The Statistical Package for Social Sciences (SPSS) 21.0 was used for the data analysis. The difference between the two independent means (two groups) was used to calculate the sample size. In the power analysis, $\alpha=0.05$, $\beta=0.95$ and with $d=0.81$ the number of individuals for each group was determined as 33. The Kolmogorov-Smirnov test, QQ plot, and skewness-kurtosis were performed before the statistical analysis to test for the normal distribution of the data. Using the Kolmogorov-Smirnov test for normality, the data set was found to be normally distributed. Therefore, the Independent T test was used for the comparison of age, anthropometric measures, static balance, and Tandem Romberg Test (TRT) eyes-open and eyes-closed, dynamic balance tests Technobody-PK 200 WL "Sleight Assessment" and "Equilibrium Assessment" and Y Balance Test (YBT) healthy women and BCS women with similar characteristics. Chi-Square test was used to compare the results of subjective balance problems and falling characteristics.

RESULTS

The distribution of the participants based on their socio-demographic was presented in Table 1. There was no significant difference between the study and control groups in body mass index (BMI), height, body weight, and age ($p>0.05$). The subjective balance problems and falling characteristics of the participants were presented in Table 2. It was found that 48.48% of the BCS group and 6.06% of the control group reported a subjective loss of balance in the last 6 months. There was a significant difference in subjective loss of balance between the control and the BCS group, and the BCS group reported higher rates of loss of balance than the control group ($p=0.00$).

In terms of falling characteristics, 21.21% of the BCS group reported a history of falling in the last 6

Table 1. Socio-Demographic Characteristics of the Participants

	BCS Group (n=33)		Control Group (n=33)		t	P
Variables		s		S		
Age	54.24	8.59	55.06	8.18	-0.40	0.693
Weight (kg)	70.33	11.99	66.03	10.09	1.58	0.120
Height (cm)	160.97	5.77	161.67	5.60	-0.50	0.620
BMI (kg/m2)	27.40	5.53	25.25	4.52	1.73	0.089
	n	%				
Period of Mastectomy (years)						
<5 years	7	27.27				
5-10 years	13	39.39	-			
10 < years	11	33.33				

BMI: Body Mass Index, t test, p<0.05

months. The falling frequency results showed that 42.90% of the participants reported ≤2 falling, and 51.70% reported 3≤ falling in the last 6 months in the BCS group. The fall-related fracture results showed that 6.06% of the BCS group individuals had a fracture history due to falling in the last 6 months. The control group did not report a history of falling and falling-related fractures in the last 6 months. There was no statistically significant difference between the groups in the falling characteristics (p>0.05) (Table 2).

There was a significant difference between the TRT eyes-closed test results between the two groups. The TRT eyes-closed results of the control group were better than the BCS group (p=0.03). However, no difference was found between the TRT eyes-open results (p<0.05). There was no statistically significant difference in terms of any parameter between the YBT balance scores and Technobody-PK 200 WL measure results (p>0.05) (Table 3).

DISCUSSION

BCS may experience various physical problems like muscle weakness, postural disorders, arm/shoulder problems (ASPs), balance problems, and functional limitations after mastectomy. This study aimed to compare the difference in balance functions between BCS women who had a mastectomy and healthy women. The BCS group reported higher rates of loss of balance than the control group, but there was no difference between the groups in terms of falling characteristics such as a history of falling, falling frequency, and falling-related frac-

Table 2. Subjective Balance Problems and Falling Characteristics of the Participants

Variables	BCS Group (n=33)		Control Group (n=33)		Total		x^2	P
	N	%	n	%	N	%		
Loss of Balance								
No	17	51.52	31	93.94	48	72.73	14.9	0.002*
Yes	16	48.48	2	6.06	18	27.27		
History of Falling								
No	26	78.79	33	100.00	59	89.39	7.83	0.011
Yes	7	21.21	0	0.00	7	10.61		
Falling Frequency								
≤ 2	3	42.9	0	0.00	3	42.9	-	-
3 ≤	4	57.1	0	0.00	4	57.1		
Fall-related Fracture								
No	31	93.94	33	100.00	64	96.97	2.06	0.238
Yes	2	6.06	0	0.00	2	3.03		

Chi Square Test, p<0.05

Table 3. Tandem Romberg Test (TRT), Y Balance Test (YBT), and Computer-Based Dynamic Balance Test (Technobody) Results

Variables	BCS Group (n=33) ±s (%95 GA)	Control Group (n=33) ±s (%95 GA)	T	p
TRT (eyes-open) (s)	67.23 ± 48.47 (50.05 - 84.42)	77.50 ± 50.48 (59.60 - 95.40)	-0.84	0.409
TRT (eyes-closed) (s)	14.86 ± 10.01 (11.31 - 18.41)	24.68 ± 23.47 (16.35 - 33.00)	-2.21	0.030*
YBT right anterior (cm)	67.38 ± 14.57 (62.22 -72.55)	67.16 ± 11.27 (63.17 -71.16)	0.07	0.945
YBT right posterolateral (cm)	55.42 ± 22.98 (47.27 - 63.57)	61.87 ± 19.61 (54.92 - 68.82)	1.23	0.229
YBT right posteromedial (cm)	69.56 ± 16.93 (63.56 - 75.57)	75.79 ± 16.22 (70.04 - 81.54)	1.52	0.132
YBT left anterior (cm)	68.01 ± 15.46 (62.53 - 73.49)	67.64 ± 13.64 (62.81 - 72.48)	0.10	0.928
YBT left posterolateral (cm)	54.99 ± 22.84 (46.89 - 63.09)	62.56 ± 21.48 (54.95 - 70.18)	1.39	0.170
YBT left posteromedial (cm)	69.68 ± 19.04 (62.93 - 76.44)	74.61 ± 13.39 (69.86 - 79.35)	1.22	0.229
TECHNOBODY Sleight Assessment A/P	0.66 ± 3.84 (-0.7 - 2.02)	-1.12 ± 4.09 (-2.57 - 0.33)	1.83	0.072
TECHNOBODY Sleight Assessment M/ L	-0.15 ± 3.03 (-1.23 - 0.92)	-0.2 ± 3.61 (-1.48 - 1.08)	0.06	0.954
TECHNOBODY Sleight Assessment Reached target number	4.36 ± 1.64 (3.78 - 4.94)	5.01 ± 2.35 (4.17 - 5.84)	1.29	0.201
TECHNOBODY Equilibrium Assessment A/P	-0.13 ± 3.55 (-1.38 - 1.13)	-0.28 ± 3.14 (-1.39 - 0.84)	0.18	0.867
TECHNOBODY Equilibrium Assessment M/L	-0.2 ± 2.6 (-1.12 - 0.72)	-0.55 ± 3.22 (-1.69 - 0.59)	0.49	0.627
TECHNOBODY Equilibrium Assessment Perimeter Error	101.74 ± 63.59 (79.19 - 124.29)	101.85 ± 42.84 (86.66 - 117.04)	0.01	0.993
TECHNOBODY Equilibrium Assessment Average Speed	8.98 ± 3.13 (7.87 - 10.09)	10.17 ± 4.11 (8.71 - 11.63)	1.32	0.192

TRT: Tandem Romberg Test, YBT: Y Balance Test, cm: Centimeter s: Second, A: Anterior, P: Posterior, M: Medial, L: Lateral, t test, $p<0.05$

tures. Static balance (TRT) eyes-closed results were lower in the BCS group than the control group, but there was no difference between the two groups in TRT eyes-open results. There was no difference between the groups in sub-parameter dynamic balance measurements, computer-based dynamic balance platform, and the YBT.

Balance is defined as the process of maintaining the body's center of gravity (COG) within the base of support. It requires constant adjustment, which is provided by muscle activity and joint positioning. Maintenance of postural balance requires detecting body movements, integrating sensory information in the central nervous system, and appropriate motor response. The balance comprises static and dynamic balance (15). Static and dynamic balance are different from each other in terms of biomechanics; While static balance is achieved by controlling the projection of the COG on the ground, dynamic balance does not require COG control but requires the COG to fall on the support surface. In this sense, dynamic balance is more difficult to gain than static balance. In dynamic balance, three sensorial systems (i.e., visual, vestibular, and proprioceptive) are required to keep the COG on the base of support (16,17).

Various mechanisms might affect the balance of BCS after mastectomy. When the chemotherapy medications cross the blood-brain barrier, the central nervous system functions are affected (10). The chemotherapy may also cause peripheral neuropathy. Peripheral neuropathies in cancer patients are often due to neurotoxic chemotherapeutic agents, the so-called chemotherapy-induced peripheral neuropathy (CIPN); less frequently, they occur as paraneoplastic immune-mediated or neoplastic neuropathies. CIPN is a common clinical problem; approximately 30–40% of patients receiving neurotoxic chemotherapy will suffer from this condition (18). The vestibular organs of the inner ear play an important role in the complex and dynamic human balance system. A number of studies reported significant evidence of vestibular toxicities associated with chemotherapy (7,18). Notably, a drug-induced vestibular loss may affect both sides symmetrically and gradually, resulting in insidious disequilibrium, postural imbalance, and oscillopsia (19). Additionally, there can be a reduction in motor functions due to musculoskeletal problems (e.g., reduced muscle strength) which eventually affects postural control (20,21). Therefore, all these problems mentioned above may eventually lead to balance problems.

Except for all these factors above, another mechanism that negatively affects the balance is "chemo-brain". Chemo-brain is a common term to describe thinking and memory problems during and after cancer treatment. The chemo-brain causes a decrease in cognitive abilities, speed of information processing or reaction time, and organizational skills. The balance can also be negatively affected depending on the effects of cancer treatment on cognitive functions (10). In a study by Silverman et al., it has been stated that the chemotherapy caused prominent changes in basal ganglion activity, cerebellum activity, and frontal cortex activity, which could affect the balance (22).

It was indicated that one-sided mastectomy surgery to treat breast cancer can have deleterious effects on posture and the musculoskeletal system, such as alterations in spine alignment and increased thoracic kyphosis. Accordingly, the balance is negatively affected (23). In a study by Wampler et al., it has been claimed that chemotherapy affects both dynamic and static balance in BCS more than in a healthy population (7). On the other hand, in the study by Tysinger, when compared to the healthy women, the static balance of the BCS was found to be more affected, whereas dynamic balance was not affected (24). In an other previous study, it has been stated that when the visual input is removed (eyes-closed), the static balance is negatively affected in BCS who had a mastectomy (25). Similarly, the current study shows that static balance was lower in the BCS group than the control group in the eyes-closed position, whereas no difference was found between the groups in the eyes-open position. Although the dynamic balance might be gained more difficult than the static balance, it is assumed that the static balance (eyes-closed) in BCS is more affected due to the influenced internal mechanisms (such as visual, vestibular, and cutaneal proprioceptive information) than the muscular strength and postural changes. Therefore, the static balance is negatively affected in BCS, especially when the visual input is removed (eyes-closed). The synchronicity among visual, somatosensory, auditory, and motor systems is attenuated in eyes-closed conditions (26). The COG moves slowly with small sways during static positions due to small external forces acting upon the body, which requires sensory re-weighting. Since dynamic balance tests are mostly applied with the eyes-open conditions, they might not create a challenge in the sensory system; therefore, sensory re-weighing is not required. Accordingly, it can be suggested that different conditions (eyes-open vs. eyes-closed) influence static balance but not dynamic balance.

As many clinicians might omit to evaluate the balance functions in BCS who had a mastectomy, it should be borne in mind that the balance functions, especially eyes-closed static balance, of the BCS who had a mastectomy are more affected than the healthy individuals. In addition, for evaluation and rehabilitation purposes, clinicians should consider the inclusion of balance functions for BCS who had a mastectomy.

In this study, proprioception in the lower extremities was not included in the outcome measures, and this is one of the main limitations of this research. Balance testing in an eyes-closed position aims to eliminate the visual stimulus and encourage the participants to challenge vestibular and proprioceptive senses. It can be interpreted that the difference in eyes-closed static balance results between the BCS who had a mastectomy and healthy women may be due to the decrease in the sense of proprioception, but this interpretation is not possible in this study. We recommend that future research on this topic include an assessment of proprioception.

Although the BCS group reported more balance problems than the control group, there were no differences in falling characteristics. The control group scored better on static balance eyes-closed, and there was no difference in static balance eyes-opened or any of the dynamic balance sub-parameters between the groups. Our findings suggest that balance functions should not be disregarded in BCS who have had a mastectomy.

Sources of Support: The authors declared that this study received no sources of support.

Conflict of Interest: The authors declare that there is no conflict of interest.

Author Contributions: Ferdiye Zabit: writing and performing surgeries, data analysis and performing surgeries, Gözde İyigün: writing and performing surgeries, review of the article, and intellectual concept of the article.

Explanations: None.

Acknowledgement: None

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