Original paper

Obesity and postural stability in women after mastectomy

Otyłość a stabilność posturalna kobiet po mastektomii

Magdalena M. Kabała[1], Jacek Wilczyński[2]

[1]PhD student, Institute of Physiotherapy, Faculty of Medicine and Health Science, Jan Kochanowski University, Kielce, Poland
Head of the Institute: Prof. Marianna Janion MD, PhD
[2]Department Posturology, Hearing, and Balance Rehabilitation, Faculty of Medicine and Health Sciences, Jan Kochanowski University in Kielce, Poland
Head of the Department: Prof. JKU Jacek Wilczyński MD, PhD

Medical Studies/Studia Medyczne 2019; 35 (1): 48–54
DOI: https://doi.org/10.5114/ms.2019.84051

Key words: obesity, postural stability, mastectomy.

Słowa kluczowe: otyłość, stabilność posturalna, mastektomia.

Abstract

Introduction: Obesity may result in increased instability of posture in the case of external disturbances. The consequences of mastectomy may be a disturbance in statics and body balance. Disturbances in postural coordination may be associated with unevenly distributed postural muscle tension or abnormal body mass.
Aim of the research: To assess the impact of body mass index on postural stability of post-mastectomy women based on posturographic examination.
Material and methods: The study involved 40 women after mastectomy belonging to the "Amazonki" (Amazons) Club of the Świętokrzyskie Province at the Świętokrzyskie Oncology Centre in Kielce. The age range of patients was from 52 to 87 years. Patients were divided into three groups according to body mass index (BMI) criteria, i.e. normal body mass, overweight, or obese. To assess equivalent reactions, the Postural Stability Test and the Clinical Test of Sensory Interaction and Balance (CTSIB) were used on the Biodex Balance System platform. The research was carried out at the Posturology Laboratory at Jan Kochanowski University in Kielce.
Results: In the case of the Postural Stability Test in static mode, obese patients demonstrated better postural stability. Comparing the same test in dynamic mode, women after mastectomy with normal BMI maintained body balance better in comparison to obese women. The CTSIB showed lower values regarding all four criteria in obese women compared to women with normal BMI. Upright position of the subjects was characterised by higher sways in the sagittal plane than the frontal one (A/P > M/L).
Conclusions: Impairment of the postural control mechanism may result from both the aging process and comorbidities – among others, obesity and medication.

Streszczenie

Wprowadzenie: Otyłość może prowadzić do zwiększonej niestabilności postawy w sytuacji zaburzeń zewnętrznych. Zaburzenia statyki i równowagi ciała stanowią jedną z licznych konsekwencji radykalnej mastektomii. Nierównomiernie rozłożone napięcie mięśni posturalnych u kobiet po mastektomii lub nadmierna masa ciała może zakłócać koordynację postawy ciała.
Cel pracy: Ocena wpływu wskaźnika masy ciała na stabilność posturalną kobiet po mastektomii na podstawie badania posturograficznego.
Materiał i metody: Badaniami objęto 40 kobiet po mastektomii w wieku od 52 do 87 lat, które należą do Świętokrzyskiego Klubu „Amazonki" przy Świętokrzyskim Centrum Onkologii w Kielcach. Pacjentki podzielono na trzy grupy ze względu na wskaźnik masy ciała (BMI) – z prawidłową masą ciała, z nadwagą i z otyłością. Do oceny reakcji równoważnych zastosowano Test stabilności posturalnej oraz Test integracji sensorycznej i równowagi (CTSiB) na platformie Biodex Balance System. Badania wykonano w Laboratorium Posturologii Instytutu Fizjoterapii Uniwersytetu Jana Kochanowskiego w Kielcach.
Wyniki: W przypadku Testu stabilności posturalnej w trybie statycznym lepszą stabilność posturalną miały pacjentki z otyłością. W tym samym teście w trybie dynamicznym kobiety po mastektomii z prawidłowym BMI stabilniej utrzymywały równowagę ciała w porównaniu z kobietami otyłymi. W teście CTSiB kobiety otyłe miały niższe wartości we wszystkich czterech kryteriach niż kobiety z prawidłowym BMI. Postawę stojącą badanych charakteryzowały większe wychwiania w płaszczyźnie strzałkowej niż czołowej (A/P > M/L).
Wnioski: Upośledzenie mechanizmu kontroli postawy może wynikać z procesu starzenia się, występowania dodatkowych chorób, takich jak otyłość, oraz z przyjmowania leków.

Introduction

Posturology is a science that defines all neurophysiological regulation processes of body posture in space, both in the standing static position and during movement. The posture of a human is characterised by vertical orientation of the body in relation to a small support surface [1–4]. Maintaining postural stability is a dynamic process that resists various disturbances. These disturbances may result from the internal and external environment of man. In the case of women after mastectomy, lymph oedema of the upper limb or a prosthesis on the operated side may affect postural stability [5, 6]. There are many factors determining the stability of posture, but anthropometry seems to be one of the most important ones affecting balance control. Excessive body mass may result in increased instability of posture in the event of external disturbances. The growth of adipose tissue, apart from many health complications, may have an impact on motor behaviour, quality of life, and postural control [7]. Obesity increases the risk of breast cancer, especially in postmenopausal women, while maintaining normal body mass after menopause causes its decline [8–10]. The mortality rate for breast cancer is higher among obese women than among lean women [10].

Aim of the research

The aim of the study was to assess the impact of body mass index on postural stability in women after mastectomy, based on posturographic examination.

Material and methods

The study involved 40 women after mastectomy, belonging to the "Amazonki" (Amazons) Club of the Świętokrzyskie Province at the Świętokrzyskie Oncology Centre in Kielce. The age range of patients was from 52 to 87 years (mean: 68.5 years). Radical, left-sided mastectomy was performed in 24 (60%) women, and right-sided in 16 (40%) patients. Of the adjuvant treatment, chemotherapy was performed most frequently (80%), followed by radiotherapy (62.5%) and hormonal therapy (37.5%). In the case of medication used by the studied women, cardiological and urological drugs as well as sedatives prevailed. Serious eye disorders, and those significantly disturbing balance (orthopaedic, neurological, rheumatological) were criteria excluding patients from the study group. More than half of the patients had asymmetrical positioning of the shoulder line (shoulder elevation of the treated area), which is a frequent effect of unilateral mastectomy.

Patients were divided into three groups:

- group 1, body mass index (BMI) < 25 kg/m^2, normal body mass, BMI < 25 kg/m^2, (n = 7, age = 67.4 ±11.1 years, mean BMI = 22.3 ±1.8 kg/m^2),
- group 2, BMI < 25–30 kg/m^2 >, overweight (n = 26, age = 68.1 ±8.6 years, mean BMI = 27.2 ±1.4 kg/m^2),
- group 3, BMI > 30 kg/m^2, obese (n = 7, age = 70.9 ±8.0 years, mean BMI = 33.8 ±2.4 kg/m^2).

Basic somatic features were tested. Body height was measured using an anthropometer with an accuracy of 5 mm, while body mass was assessed using an electronic scale with an accuracy of 0.5 kg. Based on the obtained data, the BMI was calculated.

The Biodex Balance System platform was used to assess postural stability. The Postural Stability Test was performed in static and dynamic mode in a standing position (with both feet on the ground) on a stable and moving surface with open eyes. In addition, the Clinical Test of Sensory Interaction and Balance (CTSIB) was used to differentiate visual, somatosensory, or vestibular disturbances. The Postural Stability Test consisted of three 20-second trials, separated by a 10-second break. During the examination, the patient's sight was focused on the monitor screen where a characteristic dot appeared (centre of pressure – COP), which reflected the centre of body mass. In fact, the COP is the point of application of the resultant force of the ground force reaction. The task of the patients was to coordinate the body so that the centre of gravity of the body was in the centre of the circle visible on the monitor at the intersection of the coordinate axes. The position was determined by entering the foot angle using the centreline on the camera screen (scale 0–45° separately for the right and left foot, e.g. 25° for the left foot and 30° for the right foot) and heel position (scale B-J, 1-21 separately for right and left foot, e.g. F7 left foot and E15 right foot). During the test, the patients had a prosthesis on the side that had undergone mastectomy. The dynamic mode test proceeded in a similar way with the additional use of a mobile platform. For the patients after mastectomy, the test started at level 12 (the most stable) and gradually the device went to level 6, which is a more difficult mode with an unstable platform surface [11]. For statistical assessment, the following stability indices were used: overall, anterior/posterior, medial/lateral.

1. The Overall Stability Index (OSI) reflects the variability of the platform's position from the horizontal plane expressed in degrees over the time of all movements performed in the test. Its high value indicates a large number of movements performed during the test.
2. The Anterior/Posterior Stability Index (A/P) reflects the variation of the platform position for sagittal plane movements expressed in degrees.
3. The Medial/Lateral Stability Index (M/L) reflects the variation in the position of the platform for movements in the frontal plane expressed in degrees [11].

The CTSIB quantification consisted of four 20-second trials. The test was carried out in conditions of sensory conflicts in a standing position via the method of registering sways, based on displacements of foot's centre of pressure measurements. The first trial included the following conditions: eyes open, hard surface; second – eyes closed, hard surface; third – eyes open, foam surface; and the fourth – eyes closed, foam surface. After each trial, there was a 5-second break. The subjects were instructed to adopt a standing position on both legs with their arms hanging freely alongside the trunk, with eyes directed towards the monitor [11].

All parameters registered by the posturographic platform were collected in a completely non-invasive manner, and the device was safe for the research

Table 1. Descriptive statistics of analysed scales of the Postural Stability Test in static mode depending on BMI classification

Analysed scales	BMI [kg/m²]	Descriptive statistics of the analysed scales							
		Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	ANOVA
General Stability Index	< 25	1.49	1.07	0.40	0.65	1.70	1.75	3.50	*F* = 1.269 *p* = 0.267
	< 25–30 >	1.06	0.99	0.30	0.50	0.75	1.15	4.80	
	> 30	0.91	0.56	0.40	0.40	0.70	1.50	1.50	
Stability Index A/P	< 25	0.91	0.71	0.30	0.35	0.90	1.10	2.30	*F* = 0.172 *p* = 0.681
	< 25–30 >	0.82	0.92	0.20	0.33	0.40	0.88	4.50	
	> 30	0.73	0.51	0.30	0.30	0.40	1.20	1.40	
Stability Index M/L	< 25	0.96	0.73	0.20	0.40	0.90	1.25	2.30	*F* = 6.613 *p* = 0.014
	< 25–30 >	0.42	0.35	0.10	0.20	0.30	0.50	1.40	
	> 30	0.37	0.28	0.10	0.15	0.40	0.45	0.90	
Zone A (%)	< 25	95.29	10.37	72.00	97.5	100.00	100.00	100.00	*F* = 0.679 *p* = 0.415
	< 25–30 >	96.73	9.30	55.00	99.00	100.00	100.00	100.00	
	> 30	99.14	2.27	94.00	100.00	100.00	100.00	100.00	
Zone B (%)	< 25	4.14	9.67	0.00	0.00	0.00	1.5	26.00	*F* = 0.536 *p* = 0.469
	< 25–30 >	3.04	8.99	0.00	0.00	0.00	1.00	44.00	
	> 30	0.86	2.27	0.00	0.00	0.00	0.00	6.00	
Zone C (%)	< 25	0.57	0.96	0.00	0.00	0.00	1.00	2.00	*F* = 0.684 *p* = 0.110
	< 25–30 >	0.19	0.93	0.00	0.00	0.00	0.00	3.00	
	> 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Zone D (%)	< 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	F = 0.000 *p* = 1.000
	< 25–30 >	0.39	0.20	0.00	0.00	0.00	0.00	1.00	
	> 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Quadrant 1 (°)	< 25	12.71	8.98	1.00	7.50	14.00	15.50	28.00	*F* = 1.217 *p* = 0.277
	< 25–30 >	20.50	17.83	0.00	9.00	13.00	31.00	60.00	
	> 30	23.71	27.23	0.00	4.50	15.00	35.50	71.00	
Quadrant 2 (°)	< 25	8.86	5.81	3.00	4.50	7.00	12.00	19.00	*F* = 0.415 *p* = 0.523
	< 25–30 >	10.04	10.29	0.00	3.00	5.00	16.75	34.00	
	> 30	5.71	6.24	0.00	0.00	4.00	11.00	14.00	
Quadrant 3 (°)	< 25	43.43	24.53	10.00	27.00	45.00	59.00	77.00	*F* = 2.811 *p* = 0.102
	< 25–30 >	23.19	20.42	2.00	7.25	13.50	35.25	81.00	
	> 30	24.00	23.64	0.00	10.00	22.00	28.00	70.00	
Quadrant 4 (°)	< 25	35.00	19.05	8.00	22.50	30.00	53.00	56.00	*F* = 0.848 *p* = 0.363
	< 25–30 >	46.27	24.50	7.00	28.75	44.50	60.75	92.00	
	> 30	46.57	23.37	9.00	35.00	48.00	61.5	76.00	

BMI – body mass index, Stability Index A/P – Anterior/Posterior Stability Index, Stability Index M/L – Medial/Lateral Stability Index.

group. The study was carried out in May 2016 at the Posturology Laboratory of the Institute of Physiotherapy, Faculty of Medicine and Health Sciences, Jan Kochanowski University in Kielce.

Statistical analysis

The obtained parameters were saved to one database and processed statistically. For the assessment of variables the arithmetic mean, standard deviation (SD), and median were used. The ANOVA test was used to determine the correlation between body mass indices and postural stability indices. The results were recorded on an Excel spread sheet. Statistical significance was assumed at the level of $p < 0.05$.

Results

The study conducted among women post mastectomy did not show any significant differences in postural stability between individuals with normal body mass, those overweight, or those obese. Analysis of anthropometric variables showed a statistically significant difference only between body mass indices and the Medial-Lateral Stability Index (M/L) (°) in the Postural Stability Test during static mode ($F = 6.613$, $p = 0.014$). Other variables regarding postural stability, which did not differ significantly in static mode, were: Overall Stability Index (°) ($F = 1.269$, $p = 0.267$), (%) time in zone C ($F = 0.684$, $p = 0.110$), (%) time in quadrant I ($F = 1.217$, $p = 0.277$), and (%) time in quadrant III ($F = 2.811$, $p = 0.102$) (Table 1). For the Postural Stability Test in dynamic mode, the results were as follows: Overall Stability Index (°) ($F = 1.280$, $p = 0.265$), Medial-Lateral Stability Index (M/L) (°) ($F = 3.294$, $p = 0.078$), (%) time in zone A ($F = 2.917$, $p = 0.096$), (%) time in zone B ($F = 2.699$, $p = 0.109$), (%) time in zone C ($F = 2.301$, $p = 0.138$), (%) time in zone D ($F = 2.896$, $p = 0.097$), (%) time in quadrant I ($F = 1.124$, $p = 0.296$), and (%) time in quadrant III ($F = 3.226$, $p = 0.081$) (Table 2).

All postural stability parameters were within the normal range. In addition, larger sways in the sagittal plane were observed compared to the frontal one. The ANOVA test did not show statistically significant results between the conditions of the Clinical Test of Sensory Interaction and Balance (CTSIB). The test results were as follows: eyes open, hard surface ($F = 0.960$, $p = 0.333$); eyes closed, hard surface ($F = 0.357$, $p = 0.554$); eyes open, foam surface ($F = 0.004$, $p = 0.950$); and eyes closed, foam surface ($F = 0.526$, $p = 0.473$) (Table 3).

Discussion

Biomechanical changes in postural control and physical activity in women after mastectomy associated with obesity are still not fully understood. In patients after radical surgery, a tendency was observed indicating increased body sways in the sagittal plane compared to the frontal one [12, 13]. Therefore, patients may be more susceptible to loss of balance during anterior-posterior destabilisation of posture, and at the same time, be more resistant to destabilisation in the event of lateral forces. In the case of the Postural Stability Test in static mode, obese patients had better postural stability. Comparing the same test in dynamic mode, women after mastectomy with normal BMI maintained body balance in comparison to obese women. Research by Colné *et al*. also showed worse results in dynamic posturography of the obese group compared to static tests [14]. In addition, Neri *et al.* stated that obesity can indirectly influence the balance and postural stability of the body [15]. Bearing in mind that higher values of BMI are equivalent to lower muscle mass, it can be presumed that obese women with possible lymphatic oedema, under dynamic conditions, and in the event of loss of stabilisation of posture will have a difficult return to balance. Studies show that the risk of falls increases with the weakening of lower limb and back muscle strength, as well as the deterioration of mobility. Excessive body mass is often found in people with low levels of physical activity, which may result in an increase concerning postural instability in external disorders [16]. Other studies indicate that intense and frequent physical activity is associated with better functioning in everyday life and a reduction in the feeling of fatigue and depressive symptoms among patients with breast cancer [17, 18].

Current scientific studies show that the instability of posture is most often associated with an increase in lateral sways of the body [16]. The author's research indicates that the observed decrease in the dynamics of sways in the frontal plane may mean that obese women with an external prosthesis may have more stable posture. Excessive mass combined with greater distribution of fat, especially in the hips and thighs, necessitates increased foot support. Such a body build can effectively limit lateral body movements and minimise the risk of falls. According to the World Health Organisation (WHO), the distribution of adipose tissue in terms of obesity can be divided into two types, with different metabolic and health consequences. The first type is android, in which fat is mainly located in the upper body, especially in the stomach and chest, while the second type is gynoidal, where fat accumulates on the thighs and buttocks [19]. In the case of women after mastectomy, the android-type prevails. Lymph oedema in the upper limb and prosthesis on the operated side may affect postural stability. Several hypotheses explaining the influence of body mass on controlling balance in obese people have been proposed. In obese individuals, body geometry is modified by the increased mass of body segments [20, 21]. Studies have reported that those who are obese have much higher trunk weight and increased abdominal fat correlated with a higher

Table 2. Descriptive statistics of analysed scales of the Postural Stability Test in dynamic mode depending on BMI classification

Analysed scales	BMI [kg/m²]	Descriptive statistics of the analysed scales							
		Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	Anova
General Stability Index	< 25	1.80	0.52	1.00	1.60	1.80	2.00	2.60	F = 1.280 p = 0.265
	< 25–30 >	1.68	0.68	0.80	1.30	1.50	1.85	4.30	
	> 30	2.30	1.43	0.80	1.55	2.00	2.50	5.20	
Stability Index A/P	< 25	1.46	0.53	0.80	1.15	1.30	1.70	2.40	F = 0.440 p = 0.511
	< 25–30 >	1.29	0.70	0.50	0.90	1.20	1.30	4.10	
	> 30	1.74	1.31	0.40	0.90	1.40	2.15	4.30	
Stability Index M/L	< 25	0.79	0.34	0.40	0.45	0.90	1.05	1.20	F = 3.294 p = 0.078
	< 25–30 >	0.81	0.32	0.40	0.60	0.70	0.98	1.40	
	> 30	1.16	0.61	0.50	0.65	1.30	1.40	2.20	
Zone A (%)	< 25	98.71	1.50	96.00	98.00	99.00	100.00	100.00	F = 2.917 p = 0.096
	< 25–30 >	98.70	3.50	84.00	100.00	100.00	100.00	100.00	
	> 30	93.29	12.84	65.00	94.00	100.00	100.00	100.00	
Zone B (%)	< 25	1.14	1.46	0.00	0.00	1.00	1.50	4.00	F = 2.699 p = 0.109
	< 25–30 >	0.69	1.87	0.00	0.00	0.00	0.00	9.00	
	> 30	4.57	8.79	0.00	0.00	0.00	4.00	24.00	
Zone C (%)	< 25	0.14	0.38	0.00	0.00	0.00	0.00	1.00	F = 2.301 p = 0.138
	< 25–30 >	0.46	1.45	0.00	0.00	0.00	0.00	7.00	
	> 30	1.43	2.57	0.00	0.00	0.00	1.50	7.00	
Zone D (%)	< 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	F = 2.896 p = 0.097
	< 25–30 >	0.15	0.61	0.00	0.00	0.00	0.00	3.00	
	> 30	0.71	1.50	0.00	0.00	0.00	0.50	4.00	
Quadrant 1 (°)	< 25	15.57	32.40	0.00	0.00	1.00	10.00	88.00	F = 1.124 p = 0.296
	< 25–30 >	22.31	20.86	0.00	9.75	15.50	30.00	79.00	
	> 30	30.43	37.12	3.00	8.50	13.00	41.00	98.00	
Quadrant 2 (°)	< 25	9.86	16.72	0.00	1.50	3.00	8.00	47.00	F = 0.202 p = 0.656
	< 25–30 >	28.96	30.06	0.00	5.50	18.50	48.75	100.00	
	> 30	16.14	13.40	2.00	8.50	10.00	21.00	42.00	
Quadrant 3 (°)	< 25	48.57	29.12	0.00	33.50	58.00	63.50	88.00	F = 3.226 p = 0.081
	< 25–30 >	24.31	22.23	0.00	6.50	23.00	37.25	76.00	
	> 30	25.71	24.27	0.00	11.00	21.00	34.50	68.00	
Quadrant 4 (°)	< 25	26.00	18.14	3.00	11.00	34.00	34.50	54.00	F = 0.021 p = 0.887
	< 25–30 >	24.42	23.30	0.00	3.25	19.50	40.25	87.00	
	> 30	27.71	22.34	0.00	12.00	23.00	44.50	58.00	

BMI – body mass index, Stability Index A/P – Anterior/Posterior Stability Index, Stability Index M/L – Medial/Lateral Stability Index.

BMI [20, 21]. In addition, the research by Cieślińska-Świder *et al.* regarding the influence of the type of obesity on swaying posture showed that women with abdominal obesity show lower stability in a standing position than women with fat located on the thighs and buttocks [7]. Corbeil *et al.* studied the influence of body mass and fat distribution on postural stability subjected to external disturbances. The authors concluded that obese people with abnormal amounts of abdominal fat may be more likely to fall than people with normal body mass [22]. Additionally, Al-Momani *et al.* found a significant impact of disability regard-

Table 3. Descriptive statistics of the analysed scales of the Sensory Interaction and Balance Test, depending on BMI classification

Analysed scales	BMI [kg/m²]	Descriptive statistics of the analysed scales							
		Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum	ANOVA
Eyes open firm surface	< 25	0.82	0.34	0.44	0.62	0.71	1.00	1.33	F = 0.960 p = 0.333
	< 25–30 >	0.77	0.39	0.35	0.51	0.66	0.86	1.82	
	> 30	0.62	0.27	0.36	0.43	0.58	0.70	1.15	
Eyes closed firm surface	< 25	1.27	0.37	0.77	1.08	1.28	1.40	1.90	F = 0.357 p = 0.554
	< 25–30 >	1.16	0.46	0.55	0.83	1.05	1.38	2.40	
	> 30	1.13	0.36	0.64	0.87	1.13	0.44	1.55	
Eyes open foam surface	< 25	1.34	0.35	0.89	1.05	1.40	1.62	1.74	F = 0.004 p = 0.950
	< 25–30 >	1.39	0.73	0.55	0.9	1.15	1.75	3.93	
	> 30	1.32	0.43	0.88	0.97	1.21	1.61	1.99	
Eyes closed foam surface	< 25	3.94	0.75	2.68	3.6	3.95	4.43	4.88	F = 0.526 p = 0.473
	< 25–30 >	3.28	0.86	1.73	2.84	3.23	3.71	5.71	
	> 30	3.55	1.61	1.51	2.15	4.00	4.73	5.60	

ing the upper limb, stroke, heart disease, arthritis, joint diseases, diabetes, and hypertension, as well as mental disorders and cognitive impairment in walking and balance deficits among older people [23]. In obese women, deficits in the recovery of balance may result from different functional conditions of postural stability [24]. The cause may be slower response due to increased inertia of body segments, increased stiffness of joints, and reduced mobility due to excessive fat tissue, muscle weakness, or lack of coordinated movements [16, 25]. In turn, the results of research by Skalska *et al.* showed that postural abnormalities may increase with age [26]. In addition, pharmacotherapy can also affect postural stability, especially in older individuals. In the author's study, the majority of post-mastectomy patients received cardiac-related drugs, among others, antihypertensive or antiarrhythmic medication, which may interfere with maintaining stable posture in dynamic conditions, and even lead to the risk of falls. Antidiabetic and central nervous system drugs such as benzodiazepines and phenothiazines as well as antidepressants may interfere with cognitive function, resulting in prolonged response time or impairment of consciousness [27]. According to Biskup *et al.*, routine medication for women after mastectomy can cause an increased risk of falls [28]. Naessen *et al.* studied the effect of endogenous oestradiol and hormonal therapy on balance responses in elderly women using a balance platform. The study showed that patients had low levels of oestradiol in the serum associated with a greater disturbance of postural stability, while hormonal therapy, compared to placebos, improved the postural stability of women with low serum oestradiol levels [29].

In order to assess the influence of obesity on postural stability and pelvic inclination, Son examined 12 obese persons and 12 people with normal body mass using a tensometric platform. The test results showed that in the case of hard and foam surfaces of the platform during the test with closed eyes, the centre of gravity speed and total tilt distance were significantly higher in the obese group than in the group characterised by normal body mass. However, in the case of hard and foam platform surfaces, for the examination with open eyes, the centre of gravity speed and the total tilt distance did not differ significantly in both groups [30]. Rachwał *et al.* [31], to assess the importance of visual control in maintaining static balance, examined 150 people by means of a tensometric platform, including 75 amazons and 75 women with similar anthropometric parameters. The study consisted of two trials: with eyes open and closed. The results of the test showed that the equivalent reactions of amazons were dependent on the organ of sight, while the postural stability of patients after mastectomy was better in comparison to the control group. This difference could be related to the women's applied rehabilitation programme after oncological treatment in order to maintain stable posture [31].

Despite the proven effect of increased body fat as a significant factor in the aetiology of malignant breast tumours, the effect of distribution of this tissue is not fully understood and requires further research. Maintaining normal body mass after menopause causes a decrease in the risk of breast cancer [9]. Maintaining proper proportions of body composition should be one of the basic preventive behaviours among women, especially over the age of 50 years [10].

Conclusions

Impairment of the postural control mechanism may result from both the aging process and comorbidities – among others, obesity and medication. Women after mastectomy with obesity had better results in static posturography as opposed to dynamic posturography. Standing posture of the subjects was characterised by larger sways in the sagittal plane than in the frontal plane.

Conflict of interest

The authors declare no conflict of interest.

References

1. Błaszczyk J. The use of sway vector for the assessment of postural instability. Gait Posture 2016; 44: 1-6.
2. Ku PX, AbuOsman NA, Yusof A, WanAbas WAB. Biomechanical evaluation of the relationship between postural control and body mass index. J Biomech 2012; 45: 1638-1642.
3. Wilczyński J, Półrola P. Body posture and postural stability of people practicing qigong. Medical Studies 2015; 31: 115-121.
4. Wilczyński J. Posturologia – nauka o postawie ciała człowieka. Medical Studies 2011; 23: 7-9.
5. Wilczyński J, Kabała M, Paprocki M, Rychter P, Wilczyński I. Evaluation of postural stability of people with Parkinson's disease with Biodex Balance System device. J Educ Health Sport 2016; 6: 365-376.
6. Błaszczyk J, Beck M, Sadowska D. Assessment of postural stability in young healthy subjects based on directional features of posturographic data: vision and gender effects. Acta Neurobiol Exp 2014, 74: 433-442.
7. Cieślińska-Świder J, Furmanek M, Błaszczyk J. The influence of adipose tissue location on postural control. J Biomech 2017; 60: 162-169.
8. Ahn J, Schatzkin A, Lacey JV Jr, Albanes D, Ballard-Barbash R, Adams KF, Kipnis V, Mouw T, Hollenbeck AR, Leitzmann MF. Adiposity, adult weight change, and postmenopausal breast cancer risc. Arch Intern Med 2007; 167: 2091-2102.
9. Eliassen AH, Colditz GA, Rosner B, Willet WC, Hancinson SE. Adult weight change and risk of postmenopausal breast cancer. JAMA 2006; 296: 193-201.
10. Socha M, Bolanowski M, Jonak W, Górska-Kłęk L, Chwałczyńska A, Stanisławska M. Total fatness and fatty tissue distribution in women after mastectomy. Endokrynol Otył Zab Przem Mat 2008; 4: 7-12.
11. Schlein C. System Balansowy SD. Instrukcja obsługi. Gliwice 2013.
12. Kabała M, Wilczyński J. Evaluation of equivalent reactions in women after mastectomy using biodex balance system. J Educ Health Sport 2017; 7: 565-578.
13. Wilczyński J, Pedrycz A, Mucha D, Ambroży T, Mucha D. Body posture, postural stability, and metabolic age in patients with Parkinson's disease. Biomed Res Int 2017; 2017: 3975417.
14. Colné P, Frelut M, Pérès G, Thoumie P. Postural control in obese adolescents assessed by limits of stability and gait initiation. Gait Posture 2008; 28: 164-169.
15. Neri SGR, Gadelha AB, de David AC, Ferreira AP, Safons MP, Tiedemann A, Lima RM. The association between body adiposity measures, postural balance, fear of falling, and fall risk in older community-dwelling women. J Geriatr Phys Ther 2017; doi: 10.1519/JPT.0000000000000165.
16. Ostrowska B, Mraz M. Body mass index and postural stability in older women with osteoporosis. Gerontol Współcz 2014, 2: 141-145.
17. Phillips SM, McAuley E. Associations between self-reported post-diagnosis physical activity changes, body weight changes, and psychosocial well-being in breast cancer survivors. Supp Care Cancer 2015; 23: 159-167.
18. Alfano CM, Smith AW, Irwin ML. Physical activity, long-term symptoms, and physical health-related quality of life among breast cancer survivors: a prospective analysis. J Cancer Surviv 2007; 1: 116-128.
19. WHO Waist Circumference and Wais-hip Ratio. Report of a WHO Expert consultation, Geneva, 12, 2008.
20. Fabris de Souza SA, Faintuch J, Valezi AC. Postural changes in morbidly obese patients. Obes Surg 2005; 15: 1013-1016.
21. Rodacki AL, Fowler NE, Provensi CL. Body mass as a factor in stature change. Clin Biomech 2005; 20: 799-805.
22. Corbeil P, Simoneau M, Rancourt D, Tremblay A, Teasdale N. Increased risk for falling associated with obesity: mathematical modeling of postural control. IEEE Trans Neural Syst Rehabil Eng 2001; 9: 126-136.
23. Al-Momani M, Al-Momani F, Alghadir AH, Alharethy S, Gabr SA. Czynniki związane z deficytem chodu i równowagi u osób starszych. Clin Interv Aging 2016; 11: 1043-9.
24. Błaszczyk J, Cieślińska-Świder J, Plewa M, Zahorska-Markiewicz B, Markiewicz A. Effects of exercise body weight on postural control. J Biomech 2009; 42: 1295-1300.
25. Dutil M, Handrigan GA, Corbeil P, Cantin V, Simoneau M, Teasdale N, Hue O. The impact of obesity on balance control in community-dwelling older women. Age (Dordr) 2013; 35: 883-890.
26. Skalska A, Ocetkiewicz T, Żak M, Grodzicki T. Influence of age on the parameters of postural control measured with balance platform. New Medicine 2004; 7: 12-16.
27. Borzym A. Upadki osób w podeszłym wieku – przyczyny, konsekwencje i zapobieganie. Psychogeriatr Pol 2009; 6: 81-88.
28. Biskup M, Góźdź S, Macek P, Opuchlik A, Skowronek T, Polit Ł, Żak M. Ryzyko upadku u starszych kobiet po radykalnym leczeniu raka piersi. Medical Studies 2017; 33: 110-116.
29. Naessen T, Lindmark B, Larsenet H. Hormone therapy and postural balance in elderly women. Menopause 2007; 14: 1020-1024.
30. Son SM. Influence of obesity on postural stability in young adults. Osong Public Health Res Perspect 2016; 7: 378-381.
31. Rachwał M, Drzał-Grabiec J, Walicka-Cupryś K, Truszczyńska A. Control of static balance among women after mastectomy. Vision impast on the quality of the equilibrium response. Post Rehabil 2013; 3: 13-20.

Address for correspondence:

Magdalena M. Kabała
PhD student
Institute of Physiotherapy
Faculty of Medicine and Health Science
Jan Kochanowski University
ul. IX Wieków Kielc 19, Kielce, Poland
Phone: +48 507 579 225
E-mail: magdalena.kabala@onet.eu