

## CLINICAL SCIENCE

# Postural control in women with breast hypertrophy

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**OBJECTIVES:** The consequences of breast hypertrophy have been described based on the alteration of body mass distribution, leading to an impact on psychological and physical aspects. The principles of motor control suggest that breast hypertrophy can lead to sensorimotor alterations and the impairment of body balance due to postural misalignment. The aim of this study is to evaluate the postural control of women with breast hypertrophy under different sensory information conditions.

**METHOD:** This cross-sectional study included 14 women with breast hypertrophy and 14 without breast hypertrophy, and the mean ages of the groups were  $39 \pm 15$  years and  $39 \pm 16$  years, respectively. A force platform was used to assess the sensory systems that contribute to postural control: somatosensory, visual and vestibular. Four postural conditions were sequentially tested: eyes open and fixed platform, eyes closed and fixed platform, eyes open and mobile platform, and eyes closed and mobile platform. The data were processed, and variables related to the center of pressure were analyzed for each condition. The Kruskal-Wallis test was used to compare the conditions between the groups for the area of center of pressure displacement and the velocity of center of pressure displacement in the anterior-posterior and medial-lateral directions. The alpha level error was set at 0.05.

**RESULTS:** Women with breast hypertrophy presented an area that was significantly higher for three out of four conditions and a higher velocity of center of pressure displacement in the anterior-posterior direction under two conditions: eyes open and mobile platform and eyes closed and mobile platform.

**CONCLUSIONS:** Women with breast hypertrophy have altered postural control, which was demonstrated by the higher area and velocity of center of pressure displacement.

**KEYWORDS:** Hypertrophy; Breast; Postural Balance.

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## INTRODUCTION

Breast hypertrophy is defined as an increase in glandular tissue exceeding physiological limits in the absence of pregnancy and excluding causes such as accidents, tumors, hemorrhage and inflammatory processes. Beyond the breast enlargement itself, breast hypertrophy can be associated with serious psychological and physical changes (1,2). The most common psychological changes are dissatisfaction with body image, low self-esteem, loss of sexual relations (3,4) and other factors that can considerably inhibit social activities (3), leading to varied degrees of depression (4). With respect to the physical symptoms, the weight disparity between the upper and lower trunk enhances the physiological curvature of the spine (5) and increases the tension in

the cervical extensor muscles, resulting in frequent neck pain (6). Back, shoulder and breast pain (7,8), in addition to protraction of the scapula, ptotic breast, paresthesia of the ulnar nerve, and maceration in the infra-mammary groove due to the excessive weight of the breast and in the shoulder secondary to bra strap pressure are frequent complaints (9,10). The effects on quality of life can be evaluated by reports of limited choice of clothing, discomfort during sleep, embarrassment and difficulty performing physical exercises given the size of the breasts (7,11).

Currently, changes caused by breast hypertrophy have been described based on the alteration of body mass distribution, leading to an impact on psychological and physical aspects. However, we hypothesize that sensorimotor inputs are also impaired due to alterations in postural alignment and that postural and/or motor control are ultimately compromised.

Postural alignment itself does not answer the needs of daily life activities because the relationship between body segments is only a quick picture of the body (12). The body responds constantly with postural adjustments to both internal (physiological) and external (environmental) demands when

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an individual performs a simple task (13). Motor and sensory changes may interfere with other body functions. For example, the shoulder stabilizer muscles of subjects with scapular protraction may be excessively recruited in a standing position, impairing the ability to reach for or catch an object with the hands (14). Changes in alignment and trunk mobility may be related to modifications in rib cage mechanics and possibly interfere with respiratory function (8,15). These principles of motor control suggest that breast hypertrophy can lead to sensorimotor alterations and body balance impairment due to postural misalignment. We conducted this study to evaluate postural control under different sensory information conditions in women with breast hypertrophy.

## MATERIALS AND METHODS

### Participants

A cross-sectional study was conducted with 14 women with breast hypertrophy (BHG) and 14 women without breast hypertrophy for control group (CG) (Table 1).

The Sacchini index was used to classify the participants by breast size as normal or hypertrophic. The Sacchini index uses the average of the distances x (the distance between the lateral border of the sternum and mammary papilla) and y (the distance between the inframammary fold and mammary papilla). In this classification, normal-sized breasts measure between 9 and 11 cm, and hypertrophic breasts are larger than 11 cm (16).

Women in the BH group (BHG) were recruited from the Department of Plastic Surgery and the Department of Gynecology of the Clinics Hospital, School of Medicine, University of São Paulo. The CG contained women from the local community. The exclusion criteria for both groups included rheumatic, neurological, respiratory and vestibular conditions due to possible balance alterations. None of the participants were engaged in regular physical activity. The Ethics Committee of the Clinics Hospital in São Paulo, Brazil, approved (0102/10) the study, and all of the participants signed the informed consent form.

### Procedure

**Evaluation of postural control.** The participants were requested to stand still, barefoot, on the platform PRO Balance Master (NeuroCom® Inc., Oregon, USA) with their arms alongside the body and the feet placed according to the standard indicated on the support base, remaining as relaxed and stable as possible and breathing normally.

Data were collected in three trials of 20 seconds each under four postural conditions: i) eyes open and fixed platform (EO/FP, integrity of the somatosensory, visual and vestibular information); ii) eyes closed and fixed platform (EC/FP, absence of visual information and integrity of the somatosensory and vestibular information); iii) eyes open and mobile platform (EO/MP, disturbance of somatosensory information and integrity of the visual and vestibular information); and iv) eyes closed and mobile platform (EC/MP, disturbance of somatosensory information, absence of visual and vestibular information integrity).

The postural conditions were always tested in the above described sequence, with a progressive demand of control to avoid the effect of adaptation of the postural response, which is frequent when a task with a lower demand follows

another with a greater demand (17). In EO/FP, all of the sensory afferents are available, and it is thus the least challenging task, whereas in EC/MP, only one of three sensory inputs remains completely available, so the central nervous system has to reweight sensory integration to control posture, making it the most challenging of the test conditions.

### Data Processing

Data were processed using Matlab 6.5 software (The Mathworks, USA). Variables related to center of pressure (CoP) displacement, including the area and velocity in the anterior-posterior (MVy) and medial-lateral (MVx) directions, were analyzed for each condition.

## STATISTICAL ANALYSIS

Statistical analyses were conducted using Minitab 15.1 software (Minitab, State College, PA, USA). Student's t test was used to compare the demographic data. The mean values of the three trials for area, MVy and MVx for each condition were compared between groups using the Kruskal-Wallis test. A *Pearson* product-moment correlation coefficient was applied to verify the association between variables and age when a difference was found between groups. The alpha level error was set at 0.05 for all analyses.

## RESULTS

Table 1 presents the subjects' age and BMI and a comparison of the values between groups. Note that there were no differences between groups, although four women in the CG and two in the BHG were considered obese.

An analysis of postural control showed that the area is significantly higher in women with breast hypertrophy under EO/FP, EO/MP and EC/MP conditions. Furthermore, the MVy in the EO/MP and EC/MP conditions was also higher in the BHG. A significant *Pearson's* correlation between age and these variables/conditions was only found for area in the BHG in the EO/FP condition. Therefore, the median age was used as a reference to divide the subjects into two age subgroups: (1) lower and equal to the median age and (2) higher than the median age. An analysis of variance with two factors (group and age) showed an effect in the group factor ( $p=0.009$ ), but age did not differ ( $p=0.274$ ), and no interaction was identified between group and age ( $p=0.420$ ). The median values and the ranges for area, MVy and MVx for each condition in each group and the p-values for the inter-group comparisons are shown in Table 2.

**Table 1 - Subject characteristics (age and BMI) with a p-value comparison between BH (n = 14) and CG (n = 14).**

Variable	Group	Mean (standard deviation)	Median (range)
Age	CG	39 ± 15	32 (24-73)
	BH	39 ± 16	31 (24-71)
p-value		0.84	
BMI	CG	27.29 ± 3.22	27.49 (20.00-31.22)
	BH	27.24 ± 3.21	26.73 (21.41-32.46)
p-value		0.66	

BH = breast hypertrophy, CG = control group, BMI = body mass index.

**Table 2** - The median values and range of area, MVy and MVx for each condition between groups.

Condition	Group	Area	MVy	MVx
		Median (range)	Median (range)	Median (range)
EO/FP	BH	0.4 (0.1-1.7)	0.9 (0.7-1.2)	0.8 (0.7-1.1)
	CG	0.2 (0.0-0.7)	0.9 (0.7-1.9)	0.7 (0.6-1.3)
<i>p</i> -value		0.004	0.927	0.462
EC/FP	BH	0.9 (0.2-3.6)	1.1 (0.9-2.2)	0.8 (0.8-1.3)
	CG	0.3 (0.1-0.9)	1.0 (0.8-1.9)	0.8 (0.6-1.3)
<i>p</i> -value		0.073	0.215	0.383
EO/MP	BH	3.9 (0.9-14.8)	2.0 (1.3-4.5)	1.1 (1.0-2.1)
	CG	1.4 (0.8-3.8)	1.6 (1.4-1.9)	1.0 (0.8-1.3)
<i>p</i> -value		0.003	0.004	0.168
EC/MP	BH	10.2 (4.3-40.4)	4.7 (2.5-8.3)	1.6 (1.1-4.2)
	CG	4.7 (2.5-8.8)	3.3 (1.9-6.3)	1.6 (1.0-1.9)
<i>p</i> -value		0.001	0.015	0.183

Area = area of center of pressure displacement, MVy = velocity in anterior posterior direction, MVx = velocity in the medial lateral direction, BH = breast hypertrophy, CG = control group, EO/FP = eyes open and fixed platform, EC/FP = eyes closed and fixed platform, EO/MP = eyes open and mobile platform, EC/MP = eyes closed and mobile platform.

## DISCUSSION

This study was conducted to evaluate the effect of the sensory integration in postural control in women with breast hypertrophy and our results contribute with three important findings. First, the results provide evidence that postural control is altered in BH because body sway is higher in this group. Second, postural control is altered, with a higher CoP velocity in the anterior-posterior direction. Finally, sensorial manipulation changes postural control in women with BH.

### Postural control is altered in women with breast hypertrophy with a higher CoP area

Women with breast hypertrophy present a higher CoP displacement area, which is independent of the sensory input. In this study, body balance, which was measured by CoP displacement, was correlated with muscle activity. Both very large and very small amounts of muscle activity lead to postural instability (18). When standing upright, the human body is often compared to an inverted pendulum system rotating around the ankle joint (19), which determines the area of CoP displacement. Similar to obese individuals (18), we suggest that the increased tissue concentration present in the thoracic area in women with breast hypertrophy tends to dislocate the center of mass close to the anterior boundaries of the base of support. As a result, the ground reaction force is amplified to induce higher torque at the ankle level and to increase muscle activity and postural adjustments, which justifies the increase in CoP displacement.

### Postural control is altered with a higher CoP velocity in the anterior-posterior direction

Our results showed that women with breast hypertrophy present a higher velocity of CoP displacement in the anterior-posterior direction under conditions in which somatosensory input is disturbed. While medial-lateral sway reflects the ability to distribute body weight between

the two lower limbs, anterior-posterior sway reflects variations in the activities of the ankle flexor muscles, which control CoP displacement in the sagittal plane (19).

Analogous to obese individuals (18), the increased body mass in the thoracic area of women with breast hypertrophy brings the center of mass forward, requiring higher torque in both ankle flexion and extension to promote recurrent postural adjustments for the extra anterior body mass.

### Sensorial manipulation changes postural control

Spatial orientation in postural control is based on the interpretation of convergent information from the somatosensory, visual and vestibular systems. When one of the sensorial inputs is disturbed, the central nervous system has to reweight the integration from the remaining inputs to promote postural control. According to Horak (20), healthy individuals rely most on somatosensory information when standing on a firm support with opened eyes. Our study proved that women with breast hypertrophy presented altered postural control when somatosensory inputs were disturbed with or without visual information.

A limitation of the present study was the age range of the sample (young adults to elderly subjects). Although both groups had a similar age range, older people could possibly present changes in postural control due to breast weight and sensorimotor changes arising from the aging process. To control this limitation a correlation with age was verified and a second analysis on subgroups of age showed differences between groups; age and the interaction between age and group did not have significant effects.

The present study provides new insight into the physical changes in women with breast hypertrophy. Although aesthetics can be an issue, breast hypertrophy is associated with alterations in postural control and may have functional consequences. Therefore, breast hypertrophy should be considered for assistance by health care services.

Women with breast hypertrophy presented altered postural control with a greater area of center of pressure displacement under three out of four sensorial information conditions. Only a marginal difference was observed for the condition in which visual information was absent and somatosensory information was available. Women with breast hypertrophy also showed a higher velocity of center of pressure displacement in the sagittal plane of the body when somatosensory information was disturbed, with or without visual integrity.

## AUTHOR CONTRIBUTIONS

Barbosa AF was responsible for the data acquisition and analysis. Raggi GC was responsible for the manuscript preparation. Sá CS was responsible for data acquisition. Costa MP was responsible for the patient selection and data acquisition. Lima Junior JE was responsible for the patient selection and data acquisition. Tanaka C was responsible for the data analysis and manuscript preparation.

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