Breast Volume Asymmetry Value, Ratio, and Cancer Risk

Ragıp Kayar[1] and Özgül V. Çilengiroğlu[2]

[1]Breast Surgeon, Private Outpatient Breast Clinic, İzmir, Turkey. [2]Faculty of Sciences, Department of Statistics, Dokuz Eylül University, İzmir, Turkey.

ABSTRACT

AIM: The aim of this study was to investigate the criteria for determining the cancer risk of the breast asymmetry by comparing breast volume asymmetry levels between healthy women and women with cancer.

MATERIALS AND METHODS: Two hundred and one women with breast cancer (group 1) were compared with 446 healthy women (group 2) who had no pathologic findings in breast sonography and mammograpy repeated with one-year interval. Data were evaluated retrospectively. Each breast volume was measured twice by Grossman-Roudner Discs. The mean value has been recorded. The amounts of volume difference between two breasts (asymmetry value) and the rates of the volume difference to the breast volume of the smaller side (asymmetry ratio) were compared in both groups.

RESULTS: There was a statistically significant difference between two groups with regard to average age and body mass index ($P < 0.01$). This significance was decreased but not disappeared, when the comparison was made within the 40–69 age group ($P > 0.01$). The rate of cases with asymmetry value over 50 mL was significantly higher in the cancer group ($P = 0.029$). Unfortunately, it disappeared in the 40–69 age group ($P = 0.201$). The breast volume asymmetry ratio over 20% was significantly higher in the cancer group both in all ages and in the 40–69 age group ($P < 0.01$). Odds ratio was 2.18 in the entire (all) series and 2.01 in the 40–69 age group. Moreover, there was no significant difference with regard to the rate of tumor location between the smaller or larger side of breast.

CONCLUSION: Our data show that there is a positive correlation between breast asymmetry ratio over 20% and breast cancer risk. These results need to be confirmed by prospective randomized controlled trials.

KEYWORDS: asymmetry ratio, asymmetry value, breast asymmetry, breast cancer epidemiology, breast volume measurement, breast volumetry

CITATION: Kayar and Çilengiroğlu. Breast Volume Asymmetry Value, Ratio, and Cancer Risk. *Breast Cancer: Basic and Clinical Research* 2015:9 87–92 doi:10.4137/BCBCR.S32789.

TYPE: Original Research

RECEIVED: August 26, 2015. **RESUBMITTED:** November 8, 2015. **ACCEPTED FOR PUBLICATION:** November 10, 2015.

ACADEMIC EDITOR: Goberdhan P. Dimri, Editor in Chief

PEER REVIEW: Three peer reviewers contributed to the peer review report. Reviewers' reports totaled 841 words, excluding any confidential comments to the academic editor.

FUNDING: Authors disclose no external funding sources.

COMPETING INTERESTS: Authors disclose no potential conflicts of interest.

CORRESPONDENCE: ragip_kayar@yahoo.com

Paper subject to independent expert blind peer review. All editorial decisions made by independent academic editor. Upon submission manuscript was subject to anti-plagiarism scanning. Prior to publication all authors have given signed confirmation of agreement to article publication and compliance with all applicable ethical and legal requirements, including the accuracy of author and contributor information, disclosure of competing interests and funding sources, compliance with ethical requirements relating to human and animal study participants, and compliance with any copyright requirements of third parties. This journal is a member of the Committee on Publication Ethics (COPE). Provenance: the authors were invited to submit this paper.

Published by Libertas Academica. Learn more about this journal.

Introduction

It has been established that intrauterine environment may cause a developmental instability (DI) due to various factors such as mutation, radiation, and physiologic stress. DI can change genetic and/or phenotypic characteristics of any individual. It may result in an asymmetry in double organs such as hands, ears, and especially breasts. Since sexually selected traits, such as breasts, are more revealing of genetic or environmental stresses, the relationship between breast asymmetry and cancer risk has been a challenging subject in breast cancer epidemiology.[1,2]

Anthropometric characteristics of breast were seldom investigated for cancer risk,[3] only the relation between breast size and cancer has been searched.[4,5]

It has been shown that breast asymmetry is more frequent in large breasts compared with small breasts and is higher in women without children than in women with at least one child.[3]

The breast volume, as one of the main anthropometric criteria of breast, has usually been considered in preoperative surgical planning and to evaluate cosmetic outcome after breast surgery.[5] Unfortunately, the relationship between breast volume asymmetry and cancer has been inadequately investigated.[6–8]

There are three types of breast asymmetries: shape, position, and size (volume). Shape asymmetry is seen in tubular breast and Poland syndrome. Position asymmetry is very frequent in scoliosis. Volume asymmetry is seen in disorders of breast development such as macromastia and hypoplasia.

The minute volumes of breast asymmetry are quite frequent in healthy women than it is assumed according to our clinic observation; however, their prevalence in normal population has not been reported yet. Most of these are subclinic. Therefore, to define a pathologic cutoff value in asymmetry, it is very important to distinguish the cases having higher risk of cancer among the cases with breast volume asymmetry. Unfortunately, there has been no study yet to define the pathologic criteria of volume asymmetry.

In our study, we compared both breast volumes in healthy women and women with cancer to define criteria showing increased risk of breast cancer.

Materials and Methods

Among women treated or followed-up in our outpatient clinic during 1995–2001, 201 women with breast cancer (group 1) and 446 healthy women (group 2) were compared with regard to volume differences between their both breasts. The data were evaluated by retrospective analysis. Because the study comprised a retrospective analysis of anonymized data collected in the course of clinical care, the study was exempt under the federal regulations of Turkey from the requirement for ethics committee approval.

The women were accepted as healthy if their initial and one-year later findings of physical, sonographical, and mammographical examinations were within normal limits. Inclusion criteria are having the records of age, weight, and height, and accepting voluntarily to be measured breast volume. General criteria of exclusion are pregnancy, lactation, and having previous breast surgery.

Exclusion criteria only for the cancer group are having bilateral, terminal stage, or inflammatory breast cancer. Male breast cancers were also excluded.

Breast volume measurement. Breast volume measurement (BVM) has been performed as a part of physical examination by Grossman-Roudner Disc (GRD) method.[9] The measurements in cancer cases were made before surgical management. Informed consent was collected from each woman verbally. GRD method is a simple comfortable means of BVM with no cost and it takes only one or two minutes. Each measurement was made twice. The mean value was recorded. Minimum measurable volume interval is 25 mL in the scale of GRD discs.

Asymmetry criteria of breast volume. In our study, we used two criteria to measure the degree of asymmetry:

(1) The asymmetry value (quantity): It is the plain difference between both breast volumes. For example, if the volumes of breasts are 400 and 450 mL, the asymmetry value is (450–400) = 50 mL.
(2) The asymmetry ratio: It is the rate of asymmetry value to the volume of small side of breasts. For example, if the breast volumes are 400 and 450 mL, the asymmetry ratio is 12.5% (50/400 = 1/8 = 0.125).

The formula for calculating asymmetry ratio is:

$$\text{Asymmetry ratio (\%)} = \frac{\text{Asymmetry value}}{\text{Breast volume of small side}}$$

Side of breast cancer. In women with asymmetric breast, the side of tumor location was evaluated. Along the evaluation, the minimal differences (even below 25 mL) between the sides were accepted as asymmetry.

Statistical analysis. In our study, we used a retrospective study design. Descriptive statistics of the data in the statistical analysis of risk factors for all ages and 40–69 age group (mean ± standard deviation, frequency, and percentages) are calculated. In addition, "*t*"-test for a mean of two independent samples of these risk factors with continuous variable and the chi-square test for discrete variable with frequency values were analyzed. Volume differences between the two breasts (asymmetry value) and the level of asymmetry (asymmetry ratio) measured by chi-square test were given in relation to cancer. This margin of error of 5% and 1% were used for testing. In addition, odds ratio (OR) was used to measure the association between asymmetry and cancer.

Findings

In our study, the data of 201 women with breast cancer (31.1%) and 446 control group (68.9%), which consists of healthy women, were studied retrospectively. The risk factors of age, body mass index (BMI), right breast volume (RBV), and left breast volume (LBV) are the continuous variables in the study. However, BMI and breast volumes are then handled as discrete variables. Descriptive statistics of risk factors for the cancer group and the control group are given in Table 1. According to these statistics, the mean and standard deviation of age in the cancer group and the control group are 50.42 ± 11.43 and 40.95 ± 11.79, respectively. The mean and standard deviation in these two groups were found for BMI 28.57 ± 5.10 and 25.61 ± 5.16, respectively. The mean of the RBV and LBV in the cancer group (609.68 and 600.47 mL) was more than the control group (443.88 and 442.58 mL). Later on, when these variables are discrete, the large breast volume values (BMI > 30, RBV and LBV > 400) were found to be in the cancer group (35.8%, 76.6%, and 77.1%). In addition, two independent *t*-tests for means of continuous variables of the risk factors and the chi-square test for frequencies of discrete variables in the $\alpha = 0.01$ error level were found to be statistically significant in both groups (all *P*-values <0.01).

Table 1. Descriptive statistics of the risk factors in all series.

RISK FACTORS	CANCER ($n_1 = 201$)	CONTROL ($n_2 = 446$)	*P*-VALUE
Age	($f_{1a} = 200$) 50.42 ± 11.43 (min–max: 23–79)	($f_{2a} = 445$) 40.95 ± 11.79 (min–max: 18–77)	<0.01
BMI	($f_{1b} = 191$) 28.57 ± 5.10	($f_{2b} = 413$) 25.61 ± 5.16	<0.01
RBV	($f_{1c} = 201$) 609.68 ± 345.93	($f_{2c} = 446$) 443.88 ± 204.16	<0.01
LBV	($f_{1d} = 201$) 600.47 ± 332.49	($f_{2d} = 446$) 442.58 ± 193.48	<0.01
BMI < 30 – ≥ 30	$f_{1e1} = 119$ (59.2%) – $f_{1e2} = 72$ (35.8%)	$f_{2e1} = 333$ (74.7%) – $f_{2e2} = 80$ (17.9%)	<0.01
RBV < 400 – ≥ 400	$f_{1f1} = 47$ (23.4%) – $f_{1f2} = 154$ (76.6%)	$f_{2f1} = 189$ (42.4%) – $f_{2f2} = 257$ (57.6%)	<0.01
LBV < 400 – ≥ 400	$f_{1g1} = 46$ (22.9%) – $f_{1g2} = 155$ (77.1%)	$f_{2g1} = 184$ (41.3%) – $f_{2g2} = 262$ (58.7%)	<0.01

Table 2. Descriptive statistics of the risk factors in the 40–69 age group.

RISK FACTORS	CANCER ($n_1 = 151$)	CONTROL ($n_2 = 225$)	*P*-VALUE
Age	($f_{1a} = 151$) 51.42 ± 7.32	($f_{2a} = 225$) 49.88 ± 6.93	0.040 < 0.05
BMI	($f_{1b} = 144$) 29.23 ± 5.24	($f_{2b} = 207$) 27.89 ± 4.84	0.014 < 0.05
RBV	($f_{1c} = 151$) 637.95 ± 366.63	($f_{2c} = 225$) 501.51 ± 232.11	<0.01
LBV	($f_{1d} = 151$) 621.39 ± 346.39	($f_{2d} = 225$) 495.76 ± 212.30	<0.01
BMI < 30 – ≥ 30	$f_{1e1} = 84$ (58.3%) – $f_{1e2} = 60$ (41.7%)	$f_{2e1} = 144$ (69.6%) – $f_{2e2} = 63$ (30.4%)	0.030 < 0.05

The 40–69 age range was believed to be more accurate with the idea that originated from the age of all the differences between the two groups, because the number of cases in the 40–69 age group is greater. Considering the fact that 376 women in this age range of these differences disappeared at $\alpha = 0.01$ error level was statistically significant (*P*-values = 0.040, 0.014, 0.030 > 0.01). The only statistically significant difference between the RBV and LBV in these two groups was found at the level of 99% confidence interval (CI; *P*-values <0.01). In this case, the 40–69 age group should be compared with breast asymmetry volume and breast asymmetry ratio (Table 2).

Volume difference between the two breasts was found to be 131 (131/201 = 65.17%) in women in the cancer group, while it was found to be 294 (294/446 = 65.92%) in the control group. The chi-square test was performed between asymmetry and cancer risk in all the age groups. According to the chi-square test, there was no statistically significant relationship between these two factors with 99% CI ($P = 0.853 > 0.01$). Likewise, this difference could not be detected in the 40–69 age group ($P = 0.488 > 0.01$). These statistical tests and results represent breast asymmetry volume difference of 25 mL. The relationship of asymmetry and cancer has been studied in the breast volume difference of 50 mL. Here, the relationship of asymmetry and cancer in the 40–69 age group as a source of frequencies could not be determined (Table 3).

The breast asymmetry ratio may be a better approach instead of using breast asymmetry value because of the variability of the breast asymmetry volume in women. For example, the breast volume difference of 50 mL is very significant in a small breast (50 mL in the breast of 250 mL means 20% difference), but this difference of 50 mL is not significant in a large breast (50 mL in the breast of 1,000 mL means 5% difference).

There was no association of cancer with asymmetry in all series when asymmetry ratio is greater than 5% and 10% ($P = 0.991$ vs $P = 0.102 > 0.01$). However, this relation was found to be statistically significant in the level of 95% CI when the asymmetry ratio is greater than 15% ($P = 0.019 < 0.05$). The asymmetry ratio is greater than 20%, which means much more prominent significance. The number of cases with breast asymmetry ratio (>20%) and symmetry is 123 and 524 women in the whole series, respectively (Table 4).

The percentage of persons with cancer in the asymmetrical group is 45.5%. According to the chi-square test, there was a correlation between the asymmetry factor with cancer in breast asymmetry ratio of more than 20% in the level of 99% CI ($P = 0.000 < 0.01$). The OR represents the odds that an outcome will occur in a given particular exposure, compared with the odds of the outcome occurring in the absence of that exposure. The OR value of 2.18 (OR = [56 × 379]/[37 × 145]),

Table 3. The relationship between breast asymmetry volume and cancer in all ages and in the 40–69 age group.

THE DIFFERENCE OF BOTH BREAST VOLUME (mL)	ASYMMETRY AND SYMMETRY	CANCER $n_1 = 201$ (%)	CONTROL $n_2 = 446$ (%)	TOTAL (100%)	CHI-SQUARE *P*-VALUE
>25 mL (all ages)	Asymmetry	131 (30.8)	294 (69.2)	425	0.853
	Symmetry	70 (31.5)	152 (68.5)	222	
	Total	201 (31.1)	446 (68.9)	647	
>25 mL (40–69 age range)	Asymmetry	101 (40.9)	146 (59.1)	247	0.488
	Symmetry	48 (37.2)	81 (62.8)	129	
	Total	149 (39.6)	227 (60.4)	376	
>50 mL (all ages)	Asymmetry	95 (35.8)	170 (64.2)	265	0.029
	Symmetry	106 (27.7)	276 (72.3)	382	
	Total	201 (31.1)	446 (68.9)	647	
>50 mL (40–69 age range)	Asymmetry	71 (43.3)	93 (56.7)	164	0.201
	Symmetry	78 (36.8)	134 (63.2)	212	
	Total	149 (39.6)	227 (60.4)	376	

Table 4. The relationship between breast asymmetry ratio and cancer in all ages.

BREAST ASYMMETRY RATIO	ASYMMETRY AND SYMMETRY	CANCER $n_1 = 201$ (%)	CONTROL $n_2 = 446$ (%)	TOTAL	CHI-SQUARE *P*-VALUE	ODDS RATIO
>5%	Asymmetry	127 (31.1)	182 (68.9)	409	0.991	–
	Symmetry	74 (31.1)	164 (68.9)	238	–	–
>10%	Asymmetry	94 (34.6)	178 (65.4)	272	0.102	–
	Symmetry	107 (28.5)	268 (71.5)	375	–	–
>15%	Asymmetry	65 (38.2)	105 (61.8)	170	0.019	1.55
	Symmetry	136 (28.5)	341 (71.5)	477	–	–
>20%	Asymmetry	56 (45.5)	67 (54.5)	123	0.000	2.18
	Symmetry	145 (27.7)	379 (72.3)	524	–	–
	Total	201 (31.1)	446 (68.9)	647	–	–

and CI for this relationship is also 1.46–3.27. These values were significant and can be interpreted (the CI does not contain 1). In both symmetric and asymmetric groups, the chance of having cancer is greater than ~2.18 times in all ages (Table 4).

When the asymmetry ratio between the two breasts was considered in the 40–69 age group, an association of cancer with asymmetry was not found in cases where the rate is greater than 5% and 10% ($P = 0.909$ and $P = 0.349 > 0.05$). These results were similar to the results in all series. The association between asymmetry and cancer was found to be statistically significant in the 95% CI when the breast asymmetry ratio was greater than 15% ($P = 0.029 < 0.05$). However, an association between asymmetry and cancer was found to be statistically significant in the 99% CI according to the chi-square test when the breast asymmetry ratio was greater than 20% ($P = 0.000 < 0.01$). This significant difference was obtained in the 40–69 age group and in all series. In that level of breast asymmetry ratio, while the number of asymmetric breasts was 77, the number of symmetric breasts was 299 (Table 5). At the same time, the percentage of cancer in the asymmetric group (53.2%) was greater than the symmetric group (36.2%). The OR value of 2.01 (OR = [41 × 191]/[36 × 108]) and CI for this relationship is also 1.24–334. These values were significant and can be interpreted. The chance of cancer compared with the asymmetry of the symmetry was found about more than 2.01 times (Table 5).

When the tumor side and asymmetry correlation were evaluated, the volumes of two sides were equal in 35.2% of cases. Tumors were located 32.7% in smaller breast and 32.1% in larger breast (Table 6).

Discussion

Asymmetry in bilateral morphological characters such as fingers and breasts often shows an organism's inability to cope with stressors in the environment.[10] The occurrence of some anomalies and diseases in individuals exposed to developmental instability has been resulted in conducting novel studies aiming to show the correlation between asymmetry and cancer.[1,2]

In this way, Sandson et al investigated computed tomographic scans of 79 patients with breast cancer and 97 controls to assess the cerebral hemisphere asymmetry. Women with breast cancer had cerebral asymmetry significantly more often than the controls ($P<0.0001$) for both frontal and occipital width.[11]

The first study showing a positive correlation between breast asymmetry and cancer was reported by Scutt et al.

Table 5. The relationship between breast asymmetry ratio and cancer in the 40–69 age group.

BREAST ASYMMETRY RATIO	ASYMMETRY AND SYMMETRY	CANCER $n_1 = 149$ (%)	CONTROL $n_2 = 227$ (%)	TOTAL	CHI-SQUARE *P*-VALUE	ODDS RATIO
>5%	Asymmetry	93 (39.4)	143 (60.6)	236	0.909	–
	Symmetry	56 (40.0)	84 (60.0)	140	–	–
>10%	Asymmetry	67 (42.4)	91 (57.6)	158	0.349	–
	Symmetry	82 (37.6)	136 (62.4)	218	–	–
>15%	Asymmetry	53 (48.2)	57 (51.8)	110	0.029	1.45
	Symmetry	96 (36.1)	170 (63.9)	266	–	–
>20%	Asymmetry	41 (53.2)	36 (46.8)	77	0.006	2.01
	Symmetry	108 (36.1)	191 (63.9)	299	–	–
	Total	149 (39.2)	227 (60.8)	376	–	–

Table 6. Side of tumor location.

TUMOR SIDE	CANCER (n = 199)	%
Equal breast	70	35.2
Small breast	65	32.7
Large breast	64	32.1
Total	199[a]	100.0

Note: [a]The location is not known in two cases.

The mean volume difference (asymmetry value) between both breasts was 87.4 mL in the cancer group, while it was 59.3 mL in the control group ($P < 0.001$).[6]

Same authors confirmed same correlation with a further study in 2006. They compared the mean asymmetry value in women developing breast cancer with the women staying healthy during the same breast screening period. They found that the mean asymmetry value is 63.2 mL in the cancer group and 53.0 mL in the control group ($P < 0.001$).[7] In both studies, BVM has been calculated by mammographic method according to Katariya's formula.

Third study searching breast asymmetry and cancer was reported by Williams et al. They calculated breast volumes by the mammographic method with three different formulas: Katariya, Hoe, and Fung. In 688 women (369 cancer, 250 benign, 69 healthy), they found that only Hoe formula revealed a complete concordance in favor of a positive correlation between breast volume asymmetry and breast cancer[8] among the subgroups:

$$\begin{matrix}\text{Breast volume}\\ \text{(Hoe formula)}\end{matrix} = \begin{matrix}\text{Breast height in MLO position}\\ \times \text{ Breast half-width in MLO position}\end{matrix}$$

They used fluctuating asymmetry (FA) in their correlations. The formula of FA in their study was

$$\text{FA} = \frac{\text{Asymmetry value}}{2 \times \text{Sum of both breast volumes}}$$

However, 2D:4D ratio (the rate of the length of second to fourth digits), as a marker of DI, has been determined to show whether there is a relationship between asymmetry and breast cancer risk. In total, 573 patients with breast cancer and 9,044 healthy women were compared for their 2D:4D ratio. It was found that there is a significant correlation between digit asymmetry and breast cancer.[12]

In our study, we applied an easy, repeatable, and costless criteria to show the cancer risk of breast volume asymmetry. Therefore, we preferred GRD method instead of mammographic volume measurement, because it does not require radiation and it is without the cost and discomfort of mammography. Our data yielded that the asymmetry ratio of breast volumes is more efficient than plain asymmetry value to define a positive correlation between cancer risk and volume asymmetry of breasts.

The main problem is the definition of asymmetry during the investigation of the relationship between breast asymmetry and cancer. When the breast asymmetry ratio is greater than 20%, the relationship between asymmetry and cancer was found to be statistically significant in the 99% CI in all ages and in the 40–69 age group. The ORs for two groups that were all series and the 40–69 age group were obtained as 2.18 and 2.01, respectively (Tables 4 and 5).

It should be considered that the following biases may affect our results. We have not used random samples of women from the study population. Therefore, the significant difference between the cancer group and the control group diminished but not disappeared in the 40–69 age group. Pregnancy and lactation history were not evaluated in our study, although it was shown previously that they have no effect on breast volume.[3] BVM with GRD has been criticized for its rather low accuracy in volumes over 425 mL.[13] We demonstrated before that this disadvantage can be eliminated by adding two larger discs with 500–700 mL and 700–1500 mL capacity.[14] In fact, this point has no vital importance on changing our results, because most of the cases in our series had a plain asymmetric value below 425 mL.

As a result, the relationship between cancer and the breast volume asymmetry is also supported by this study. In addition, a strong association between breast asymmetry ratio over 20% and cancer risk is found, and this ratio shows an approximately twofold increase in breast cancer risk. However, this work should be confirmed by prospective randomized controlled trials.

Acknowledgments

The authors thank Dr. Cemalettin Topuzlu (Professsor in Surgery, Başkent University, Ankara) and Dr. Saim Kendir (Professor in Statistics, Dokuz Eylül University, İzmir) for their invaluable contributions to our study.

Author Contributions

Conceived and designed the experiments: RK. Analyzed the data: ÖVÇ. Wrote the first draft of the manuscript: RK. Contributed to the writing of the manuscript: ÖVÇ. Agree with manuscript results and conclusions: RK. Jointly developed the structure and arguments for the paper: RK, ÖVÇ. Made critical revisions and approved final version: RK, ÖVÇ. All authors reviewed and approved of the final manuscript.

REFERENCES

1. Manning JT. Resolving the role of prenatal sex steroids in the development of digit ratio. *PNAS*. 2011;108:16143–16144.
2. Scutt D, Manning JT. Symmetry and ovulation in women. *Hum Reprod*. 1996;11:2477–2480.
3. Moller AP, Soler M, Tornhill R. Breast asymmetry, sexual selection and human reproductive success. *Ethol Sociobiol*. 1995;16:207–219.
4. Sun SP, Hsu KW, Chen JS. The evaluation of female breast symmetry by calculating related physicsparameters. *J Med Biol Eng*. 2007;27:87–90.
5. Jansen LA, Backstein RM, Brown MH. Breast size and breast cancer: a systematic review. *JPRAS*. 2014;67:1615–1623.

6. Scutt D, Manning JT, Whitehouse GH, Leinster SJ, Massey JP. The relationship between breast asymmetry, breast size and the occurence of breast cancer. *Br J Radiol*. 1997;70:1017–1021.
7. Scutt D, Lancaster GA, Manning JT. Breast asymmetry and predisposition to breast cancer. *Breast Cancer Res*. 2006;8:R14.
8. Williams AC, Hitt A, Voisin S, Tourassi G. Automated assessment of bilateral breast volume asymmetry as a breast cancer biomarker during mammographyc screening. *Proc of SPIE. Medical Imaging 2013: Computer Aided Diagnosis 86701A, (March 18, 2013)*, Florida, USA; 2013.
9. Grossman A, Roudner LA. A simple means for accurate breast volume determination. *Plast Reconstr Surg*. 1980;66:851–852.
10. Benderlioğlu Z. Fluctuating asymmetry and steroid hormones: a review. *Symmetry*. 2010;2:541–553.
11. Sandson TA, Wen PY, Le May M. Reversed cerebral asymmetry in women with breast cancer. *Lancet*. 1992;339(8792):523–524.
12. Muller DC, Baglietto L, Manning JT, et al. Second to fourth digit ratio(2D:4D), breast cancer risk factors:aprospective cohort study. *Br J Cancer*. 2012;107:1631–1636.
13. Hansson E, Manjer J, Ringborg A. Reliability of plastic cups to measure breast volume. *J Plast Surg and Hand Surg*. 2014;48:254–258.
14. Kayar R, Civelek S, Çobanoğlu M, Güngör O, Çatal H. Fivemethods of breast volume measurement. A comparative study of measurements of specimen volumes in 30 mastectomy cases. *Breast Cancer (Auckl)*. 2011;5:43–52.