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Abstract

Background Studies have demonstrated the importance of anthropometric measurements of the breasts, based on linear measurements for the selection of the volume of breast implants, their positioning, and surgical planning.

Objectives The objective of this study is to evaluate the main changes in anthropometric measurements in breast augmentation.

Methods A prospective, randomized clinical study with 74 female candidates for breast augmentation. All the individuals were split into five groups, according to the implant volume. The implants used were of different textures, from three different brands (LifeSil, Politech, and Silimed). The following measures were taken: distance from the nipple to the inframammary fold (N-IMF), inter-nipple-areolar complex distance (N-N), distance from the Sternal notch to the Nipple (SN-N), areola diameter, and breast projection.

Results The most significant breast anthropometric alteration after mammoplasty was the N-IMF distance; that is, an expansion of the lower pole of the breast, followed by an increase in the areolar diameter. Mostly of measurements showed stability between 3rd and 6th months after the surgery. The projection was the most interesting measure due to presenting two patterns of behavior according to the analysis criteria performed. When comparing the implant projection and the final breast projection, it was observed that the implant profile represented a 27% increase in the final breast projection.

Conclusions This study provides an essential comparative analysis between anthropometric changes in breast augmentations and serves as a predictive tool in the preoperative evaluation of the patient during surgical planning.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Anthropomentric measurements · Breast augmentation · Breast · Implant

Introduction

Since the first use of the silicone breast implant filled with gel in 1964, breast augmentation has become very popular, and in many countries, it is the most common cosmetic procedure [1].

According to data from the 2017 American Society of Plastic Surgery, an augmentation mammoplasty is the main aesthetic surgical procedure in the USA, corresponding to more than 300,000 cases and an increase of 41% in the last 10 years [2].

In a recent survey, the International Society of Aesthetic Surgery (ISAPS) showed that, in 2017, 2,524,115 plastic surgeries were performed in Brazil, for aesthetic purposes [3]. Two main factors contributed to this scenario: the large number of plastic surgeons in Brazil (6200 active members of the Brazilian Society of Plastic Surgery—SBCP) and the availability of several implant brands, including national manufacturers, such as Silimed® and LifeSil®, in addition

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to different international brands, such as Allergan®, Mentor®, Polytech®, Motiva®, Silimed® and LifeSil®, among others. This demand entails a comprehensive analysis of the new parameters concerning the patient and the new implants on the market. On the other hand, many clinical studies have been conducted to understand the effect of silicone implants on breast tissue, as well as approaches to resolve complications or other unexpected occurrences. The selection of implants must consider an appropriate interaction between the surgeon and the patient in the preoperative evaluation, as well as the morphology of the breast and thorax. Advances have been achieved in the development of techniques and design of implants, coverings, and the use of chips for their tracking [4–10].

Some different criteria and methods can be applied to select an ideal implant, in terms of design, shape and volume, incisions, breast contour, the anatomy of the nipple-areolar complex (NAC), among others. A meticulous analysis of the breast's characteristics and the patient's cooperation during surgical planning are the key to achieving a favorable result.

Studies have demonstrated the importance of anthropometric measurements of the breasts based on linear measurements for the selection of the volume of breast implants, their positioning, and surgical planning. Tebbetts developed a preoperative evaluation protocol for primary mammoplasty, determining parameters such as tissue coverage (pinch test), breast base; cutaneous stretching of the NAC; NAC-IMF (inframammary fold) and others. This protocol aims to choose the implant pocket, type of implant and location of the incision [14–15]. Much has been emphasized on anthropometric parameters for evaluation and choice of the most appropriate implant, such as the measurement of the base of the breast, pinch test, distance NAC-IMF. However, the implants present some parameters such as diameter, volume, height, and projection. All of these measures are analyzed to choose the best implant. Hidalgo and Spector [16] have emphasized the importance of the shape of the chest wall, considering the position and projection of the implants. Bayram et cols, [17] has emphasized vertebral and chest wall deformities during the preoperative evaluation. The main problem is the absence of an objective protocol that is recognized for a complete morphological assessment of the breast. This issue involves the proportionality of the breasts and thorax, degree of ptosis of the breasts, asymmetries, among others [18–22].

There are two methods for anthropometric breast assessment: linear and volume measurements. For this second, it is necessary to use equipment and soft wear for 3-D analysis. The 3-D image allows us to assess volume, surface area, shape, size, and contour, providing much more information than conventional photographic analysis [23]. In breast reconstruction, a 3-D image of the contralateral breast has been used to estimate the volume needed for reconstruction after mastectomy [24].

It is evident that an appropriate anthropometric assessment of the patient's breast and chest, planning the type of implant, and the surgical technique adopted are fundamental to the final result. In this scope, many studies seek to create clinical protocols that assist in the suitable method of preoperative evaluation for patients [25–27]. Despite this, it is important to determine which are the main anthropometric alterations that most change in the postoperative period in breast augmentation. Thus, this analysis could bring to patients more information and create a realistic perspective as possible of their result.

Objective

The primary objective of this study is to evaluate the main changes in anthropometric measurements in breast augmentations, as well as, correlate the increase in the projection of the breast with the projection of the implant.

Material and Methods

A prospective, randomized clinical study was carried out from January 2017 to December 2019, with 75 female patients without comorbidities, aged between 18 and 55 years, candidates for breast augmentation surgery at the plastic surgery department of University of the State of Rio de Janeiro (UERJ).

The 75 patient candidates for primary breast augmentation surgery were randomly assigned to five groups, according to the implant volume, due to it is a less variable measure. All patients were grouped into the following groups: patients who underwent breast augmentation with 250 mL implants (PG-1); patients underwent breast augmentation with 275 to 285 mL implants (PG-2); patients who underwent breast augmentation with 300 mL implants (PG-3); patients underwent breast augmentation with 320 to 330 mL implants (PG-4); and patients who underwent breast augmentation with larger implants than 350 mL (PG-5).

- Prosthesis group 1 (PG-1): implants with a volume of 250 mL—20 implants.
- Prosthesis group 2 (PG-2): implants with a volume of 275–285 mL—38 implants.
- Prosthesis group 3 (PG-3): implants with a volume of 300 mL—26 implants.
- Prosthesis group 4 (PG-4): implants with a volume of 320–330 mL—56 implants.

- Prosthesis group 5 (PG-5): implants with a equal or bigger than volume of 350 mL—8 implants.

In each group, round silicone implants were used via the inframammary route and in the retroglandular plane.

All patients, after accepting to participate in the clinical trial through verbal invitation, signed the free and informed consent form; were referred for clinical, cardiological, laboratory, and image examination. The recruitment of patients was carried out between January 2016 and December 2017. This study was carried out in accordance with the ethical principles of the declaration of Helsinki 2000 and Istanbul 2008. This trial followed the norms of resolution 466/12 and the subsequent ones of National Health Council / Ministry of Health. He was submitted to the ethics and research committee of Pedro Ernesto University Hospital of the State University of Rio de Janeiro-UERJ, being approved on 12/04/2017 (no 2.013.473).

The round breast implants used were of different shell textures (polyurethane, foam and microtextured), from three different brands (Silimed, LifeSil, and Polytech), using the profile with the highest projection of each one. The following measures were taken: distance from the nipple to the inframammary fold (N-IMF); inter-nipple distance (N–N); distance from the sternal notch to the nipple (SN-N); nipple-areolar complex diameter (linear horizontal measure from "3 h." to "9 h."); and breast projection. To analyze the projection of the breast after the implant was inserted, two evaluations were carried out based on the volume and projection of the implants.

All research data were recorded on the protocol sheet (Fig. 1) and clinical evaluations were carried out in the pre- and postoperative period in three time intervals: preoperative, 3rd month, and 6th month. All measurements were performed with the patient in an orthostatic position (s-tanding up), by a single examiner, with use of a flexible ruler without any breast stretch.

In these assessments, the following anthropometric measurements were performed and statistically analyzed, in general, and in each subgroup (PG-1;PG-5):

- distance from the nipple (N) to the inframammary fold (IMF);
- distance between the right and left nipples (N–N);
- distance from the sternal notch to the nipple (SN-N);
- Nipple-areolar complex diameter (NAC); and
- projection of the breasts (drawing a straight line from the anterior axillary line to the most projected point of the breast).

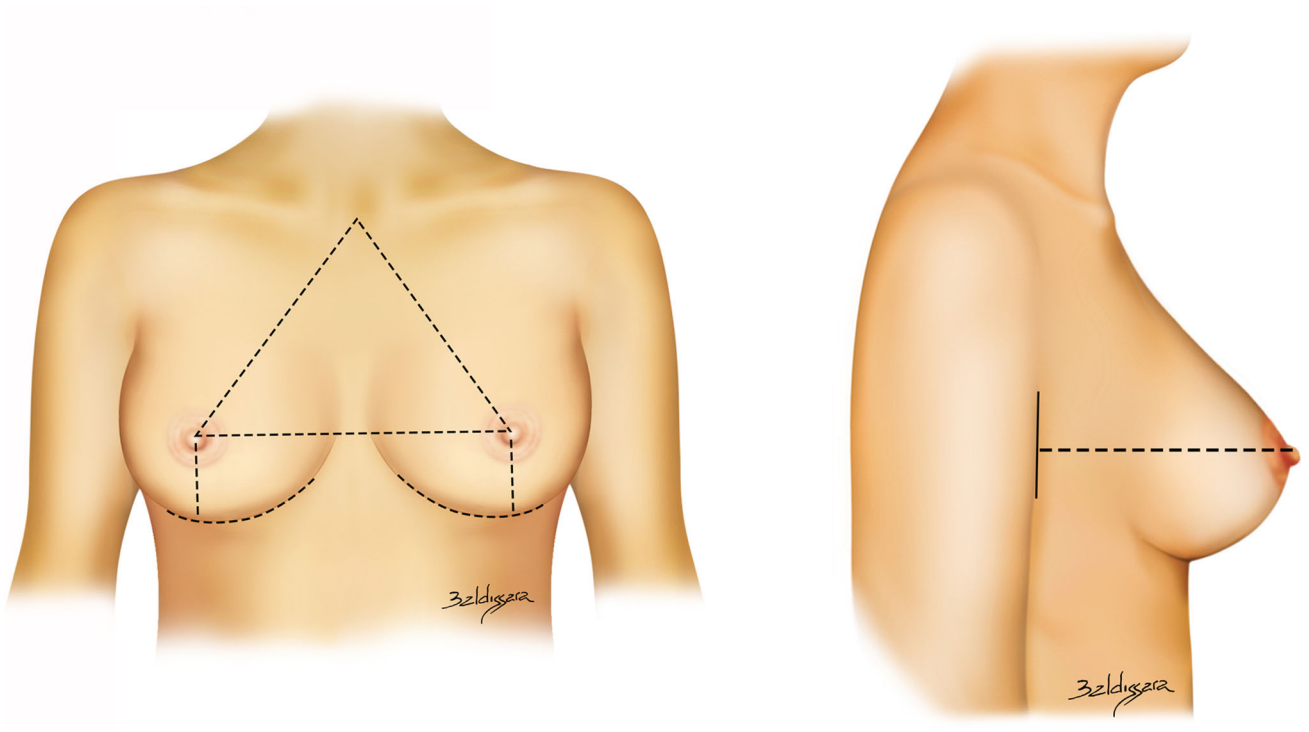

Fig. 1 Breast Landmark Mesasurments: All the anthropometric measurements of patients enrolled in this study were taken in preoperative, 3rd, and 6th postoperative months. The data were taken of the distance from the nipple to the inframammary fold (N-IMF); inter nipple distance (N–N); distance from the sternal notch to the Nipple (SN-N); a NAC diameter; and breast projection. The measure was done by a flexible ruler

Inclusion criteria were defined as: female gender; age between 18 and 55 years; primary breast surgery and retroglandular location of the round implants. As non-inclusion criteria: associated comorbidities; previous chest surgery; association with another procedure at the same surgical time; patient's refusal to participate in the study; clinical, laboratory and radiological changes that make surgery impossible; psychological instability or inadequate expectation of the surgical outcome; positive B-HCG test; failure to attend the consultation for clinical evaluation; patients with a pinch test smaller than 2 cm, who underwent surgery using the retromuscular plane; and patients who underwent surgery via periareolar or transaxillary access.

Exclusion criteria were: patients who did not attend the postoperative evaluation and patients with a BMI variation above 10%.

All the patients were submitted to breast imaging in the preoperative period with ultrasound (for patients under 30 years old) or mammography (for patients over 30 years old).

All patients underwent breast augmentation in the hospital under sedation and local anesthesia with a solution containing 40 mL of 0.4% lidocaine, 20 mL of 0.75% ropivacaine, 140 mL of SF 0.9% and 1 mL of adrenaline (1: 200,000 IU). All the patients received cefazolin 2 g, intravenously, in anesthetic induction, 1 g 8/8 h in the first 24 h and a week of cephalexin orally (500 mg four times a day), administered in the postoperative period.

During surgery, an incision in the inframammary fold of 4 to 5 cm was performed followed by dissection of the implant pocket in the retroglandular space with electrocautery, and it may be necessary to complete it with a digital maneuver.

As this is a clinical study with another arm, the implants and the pocket were not irrigated with a solution containing antibiotics or any other type of substance before the implant insertion. The gloves were changed during the surgery, and glove powder was removed with saline solution. The wound was closed in layers with 3–0 mononylon sutures to close the implant pocket and monocryl 4–0 for subdermal and intradermal sutures. After the surgery is finished, a bandage is applied.

In the postoperative period, patients used a moderate compression bra, continuously for one month, in addition to recommendations to avoid any effort and local trauma. The follow-up on this series was 6 months.

The statistical analysis was addressed to determine parametrically and no parametric to the normal profile of the data. We used the non-parametric test of Wilcoxon to compare two dependent paired samples the gap distance before and after the breast measurement in the same patient. The GraphPad Prism 5 software (USA) was used to analyze the data. The results were expressed as mean ± standard deviation (SD). Values of $p < 0.05$ were considered statistically significant.

Results

One hundred and forty-eight breasts were analyzed, in 74 female patients, aged 18 to 55 years (mean = 26.5 years). The volume of the round implants ranged from 250 to 380 mL (mean 322 mL).

Results were found, in the general analysis of all patients, in relation to the right N-IMF distance (in the pre- and postoperative periods of 3 and 6 months: mean of 5.895 cm (SD: 1.0), 8.25 cm (SD: 0.98) and 8.615 cm (SD: 0.96), respectively; in relation to the left N-IMF distance, an average of 5.978 cm (SD: 1.0) preoperatively, an average of 8.304 cm (SD: 0.96) in the 3-month postoperative period and an average of 8.669 cm (SD: 0.93) in the 6-month postoperative period (Fig. 2); in relation to the N–N distance, an average of 19.23 cm (SD: 1.82) in the preoperative, an average of 19.30 cm (SD: 1.56) in the postoperative period of 3 months and an average of 20.11 cm (SD: 1.4) in the postoperative period of 6 months (Fig. 3); in relation to the distance right SN-N, an average of 19.11 cm (SD: 1.48) in the preoperative period, an average of 19.26 cm (SD: 1.0) in the 3-month postoperative period and an average of 19.86 cm (SD: 1,13) in the 6-month postoperative period; in relation to the left SN-N distance an average of 19.12 cm (SD: 1.38) in the preoperative period, an average of 19.26 cm (SD: 1.2) in the 3-month postoperative period and an average of 19.87 cm

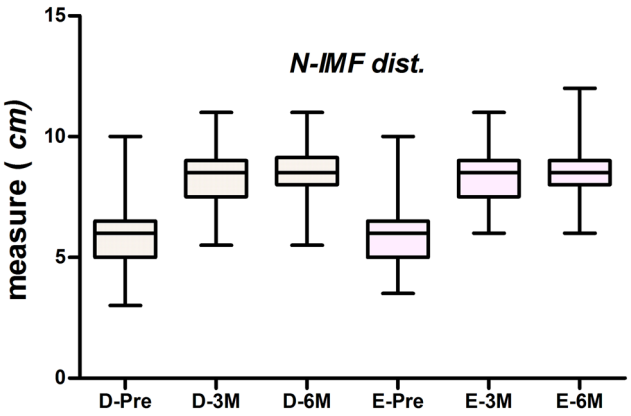

Fig. 2 Nipple–IMF measurements: All the measures were taken in the preoperative time, 3rd and 6th months. The right N-IMF distance, presented a mean of 5.895 cm (SD: 1.0), 8.25 cm (SD: 0.98) and 8.615 cm (SD: 0.96), respectively. The left N-IMF distance, an average of 5.978 cm (SD:1.0), 8.304 cm (SD: 0.96); 8.669 cm (SD: 0.93), respectively. The interval between 3rd and 6th months, there was stability of measures. Both the distance measurements showed a *p*-value < 0.05

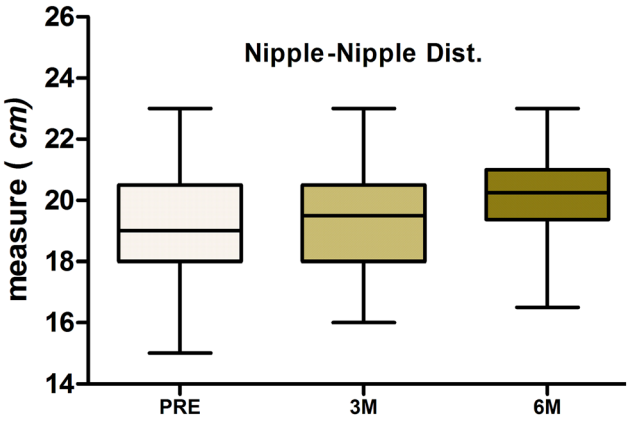

Fig. 3 Nipple–Nipple (N–N) Measurements: All the measures were taken in the preoperative time, 3rd and 6th months. The N–N distance, presented a mean of 19.23 cm (SD: 1.82), 19.30 cm (SD: 1.56) and 20.11 cm (SD: 1.4), respectively. The distance measurements showed a p value < 0.05

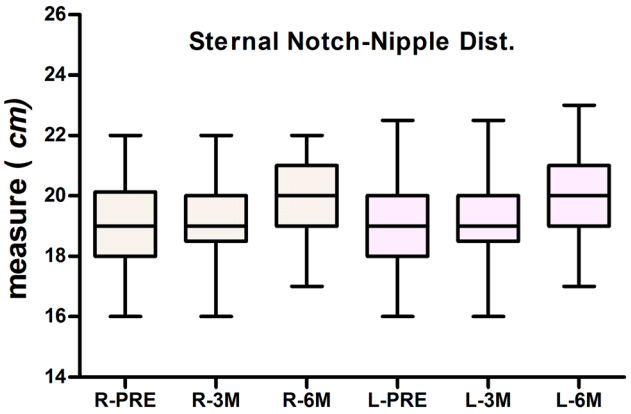

Fig. 4 Sternal Nocth–Nipple (SN-N) Measurements: All The measures were taken in the preoperative time, 3rd and 6th months. The right SN-N distance, presented a mean of 19.11 cm (SD: 1.48), 19.26 cm (SD: 1.0) and 19.86 cm (SD: 1,13), respectively. The left SN-N distance, an average of 19.12 cm (SD: 1.38), 19.26 cm (SD: 1.2); 19.87 cm (SD:1.18), respectively. In the interval between preoperative time and 3rd month, there was not a relevant increase of the both distances. However, there was a significant increase in the distances between preoperative time and 6th month interval. P value < 0.05

(SD: 1.18) in the 6-month postoperative period (Fig. 4); in relation to the diameter of the right NAC, an average of 3.138 cm (SD: 0.78) in the preoperative period, an average of 4.014 cm (SD: 0.75) in the postoperative period of 3 months and an average of 4.020 cm (SD: 0.77) in the postoperative period of 6 months; in relation to the diameter of the left NAC, an average of 3.146 cm (SD: 0.77) in the preoperative period, an average of 4.007 cm (SD: 0.81) in the postoperative period of 3 months and an average of 4.041 cm (SD: 0.78) in the 6-month postoperative period (Fig. 5); in relation to the measurement of the right breast projection, an average of 10.67 cm (SD: 1.39)

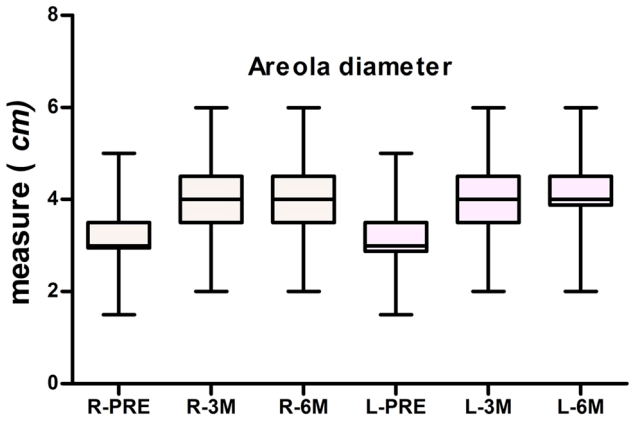

Fig. 5 Nipple-Areolar Complex Measurements: All the measures were taken in the preoperative time, 3rd and 6th months. The right NAC distance, presented a mean of 3.138 cm (SD: 0.78), 4.014 cm (SD: 0.75) and 4.020 cm (SD: 0.77), respectively. The left NAC distance, an average of 3.146 cm (SD: 0.77), 4.007 cm (SD: 0.81); 4.041 cm (SD: 0.78), respectively. In the interval between 3rd and 6th, there was stability of measures. Both the distance measurements showed a p value < 0.05

preoperatively, an average of 12.11 cm (SD: 1.2) in the postoperative period of 3 months and an average of 12, 11 cm (SD: 1.23) in the 6-month postoperative period; in relation to the measure of the left breast projection, an average of 10.47 cm (SD: 1.5) in the preoperative period, an average of 11.93 cm (SD: 1.3) in the postoperative period of 3 months and an average of 11.93 cm (SD: 1.27) in the 6-month postoperative period (Fig. 6).

Analyzing the general impact of the projection of the implants (average projection of all implants was 5.31 cm) in the breasts after breast augmentation, a gain of 1.44 cm

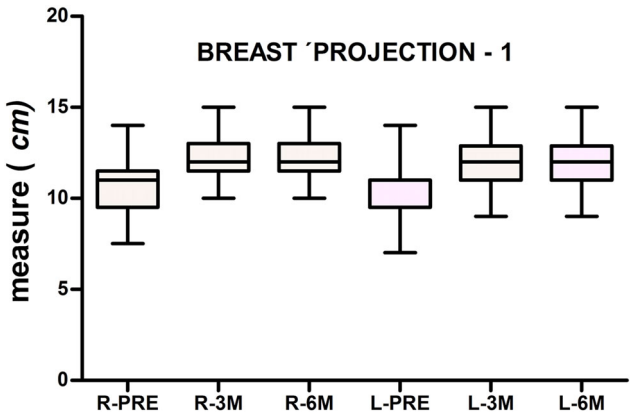

Fig. 6 Breast Projetion Measurements. All the measures were taken in the preoperative time, 3rd and 6th months. The right breast projection distance, presented a mean of 10.67 cm (SD: 1.39), 12.11 cm (SD: 1.2) and 12, 11 cm (SD: 1.23), respectively. The left breast projection distance, an average of 10.47 cm (SD: 1.5), 11.93 cm (SD: 1.3); 11.93 cm (SD: 1.27), respectively. In the interval between 3rd and 6th, there was stability of measures. Both the distance measurements showed a p value < 0.05

Table 1 Data of the anthropometric breast measurements

	Preop	Postop 3 M	Postop 6 M	↑%	*P* value
General measures (implant Proj. = 5.31 cm)					
N-IMF Right	5.895	8.25	8.61	46.17	0.0001
N-IMF Left	5.978	8.304	8.669	45	0.0001
N–N	19.23	19.30	20.11	4.5	0.0001
SN.-N right	19.11	19.26	19.86	3.9	0.0001
SN.-N Left	19.12	19.26	19.87	3.9	0.0001
NAC Right	3.13	4.01	4.02	28.43	0.0001
NAC Left	3.14	4.00	4.04	28.66	0.0001
Breast Proj. Right	10.67	12.11	12.11	13.49/27.11*	0.0001
Breast Proj. Left	10.47	11.93	11.93	13,94/27.49*	0.0001
G1: 250 ml implant (imp. Proj. = 5.12 cm)					
N-IMF Right	5.60	7.90	8.45	50.89	0.0001
N-IMF Left	5.67	7.85	8.45	49.02	0.0001
N–N	18.94	19.11	19.78	4.43	0,10**
SN.-N right	17.70	18.95	19.05	7.62	0.0007
SN.-N Left	17.85	19.10	19.15	7.28	0.0002
NAC Right	2.75	3.75	3.75	36.36	0.0010
NAC Left	2.82	3.8	3.85	36.52	0.0009
Breast Proj. Right	10.21	11.50	11.50	12.63/25.19*	0.0001
Breast Proj. Left	10.04	11.33	11.33	12.84/25.19*	0.0001
G2: 275–285 ml implant (imp. Proj = 5.4 cm)					
N-IMF Right	6.154	8.385	8.692	41.30	0.0001
N-IMF Left	6.192	8.423	8.692	40.38	0.0001
N–N	19.38	19.38	20.00	3.19	0,0001
SN.-N right	19.92	19.95	20.08	0.80	0.0009
SN.-N Left	19.85	19.88	20.10	1.25	0.0018
NAC Right	3.16	3.85	3.87	22.46	0.0001
NAC Left	3.25	3.90	3.925	20.61	0.0001
Breast Proj. Right	10.21	11.50	11.50	12.63/23.88*	0.0001
Breast Proj. Left	10.04	11.33	11.33	12.84/23.88*	0.0001
G3: 300 ml implant (imp. Proj. = 5.6 cm)					
N-IMF Right	5.895	8.25	8.61	46.17	0.0001
N-IMF Left	5.978	8.304	8.669	45	0.0001
N–N	19.23	19.30	20.11	4.57	0,016
SN.-N right	19.11	19.26	19.86	3.92	0.055**
SN.-N Left	19.85	19.85	20.08	1.15	0.375**
NAC Right	3.19	3.80	3.80	19.12	0.0001
NAC Left	3.11	3.80	3.80	22.18	0.0001
Breast Proj. Right	10.92	12.11	12.11	10.89/21.25*	0.0001
Breast Proj. Left	10.71	12.08	12.08	12.79/24.46*	0.0007
G4:320–330 ml implant (imp. Proj = 5.57 cm)					
N-IMF Right	5.88	8.44	8.77	49.14	0.0001
N-IMF Left	6.00	8.53	8.88	48	0,0001
N–N	19.52	19.63	20.43	4.66	0,0001
SN.-N right	19.46	19.52	20.19	3.75	0.0008
SN.-N Left	19.42	19.46	20.19	3.96	0.0002
NAC Right	3.14	4.24	4.24	35	0.0001
NAC Left	3.11	4.17	4.22	35.69	0.0001

Table 1 continued

	Preop	Postop 3 M	Postop 6 M	↑%	*P* value
Breast Proj. Right	10.98	12.45	12.45	13.38/ 26.39*	0.0001
Breast Proj. Left	10.73	12.18	12.18	13.51/ 26,03*	0.0001
G5: ≥ 350 ml implant (Proj. = 5.6 cm)					
N-IMF Right	6.12	8.37	8.87	44.93	0,003
N-IMF Left	6.12 s	8.37	8.87	44.93	0,003
N–N	18.50	18.88	19.88	7.45	0,048
SN.-N right	18.50	18.88	19.75	6.75	0.0796**
SN.-N Left	18.50	18.88	19.75	6.75	0.0796**
NAC Right	3.75	4.62	4.62	23.2	0.006
NAC Left	3.75	4.62	4.62	23.2	0.006
Breast Proj. Right	10.25	12.25	12.25	19.51/35.71*	0.00013
Breast Proj. Left	10.25	12,25	12.25	19.51/35.71*	0.00013

*These data represent the increase percentage of final projection of breast, considering the implant projection representation to the breast post-augmentation.**p value > 0.05. (*N* Nipple, *IMF* inframammary fold, *SN* sternal notch, *NAC* nipple-areolar complex)

is observed in the right breast, which represented an increase of 27.11%, and 1.46 cm in the left breast, which represented an increase of 27.49% (Table 1).

In the 3-month analysis, the N-IMF, areola (NAC) and breast projection measures showed statistical significance ($p < 0.05$); in the 6-month analysis, all measures showed statistical significance ($p < 0.05$). On the other hand, the N-IMF measure between 3 and 6 months showed no variation, when we analyzed the implants shell with polyurethanes in relation to the other ones used in this study, which showed an increase in this measure (Fig. 7).

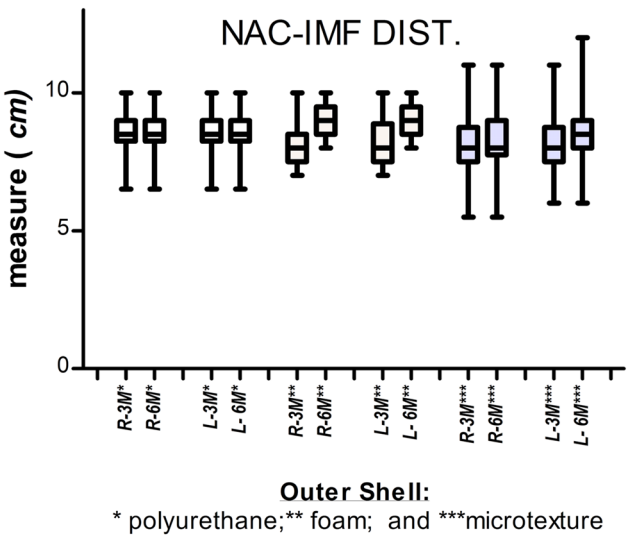

Fig. 7 Nipple–IMF X Implant Shell. This graph shows the behavior of the lower breast segment, according to the implant shell in the interval between 3rd- and 6th-month analysis. when we analyzed the implants shell with polyurethanes in relation to the other ones used in this study, the N-IMF showed no variation in this subgroup ($p = 0.8239$)

The results of the five studied subgroups are shown in Table 1 (Fig. 8).

Discussion

The world scenario of breast augmentation presents great diversity in its practices and trends in different countries. It is extremely important to assess these differences and standardize more appropriate protocols, thus increasing the level of safety of the surgery and the quality of the results. The present study sought to analyze the anthropometric factor in relation to breast augmentation surgery, through a careful analysis of which anthropometric components suffered major and minimal interference after the breast implant surgery, as well as the behavior of these measures in an interval of 6 months.

Through the studies of *Tebbets, Hidalgo, Specto and Bayram* [14–17] among others, clinical protocols for preoperative evaluation were established. All of these protocols seek to guide the best choice of implant, pocket, projection and others. On the other hand, there are few studies that analyze the main anatomical changes after breast augmentation.

We sought to establish a breast anthropometry protocol in women undergoing breast augmentation, analyzing only linear measurements, since, for an adequate and accurate measurement of breast volume, the use of specific equipment and software would be necessary, which would burden the study. In a previous study, it was found that most

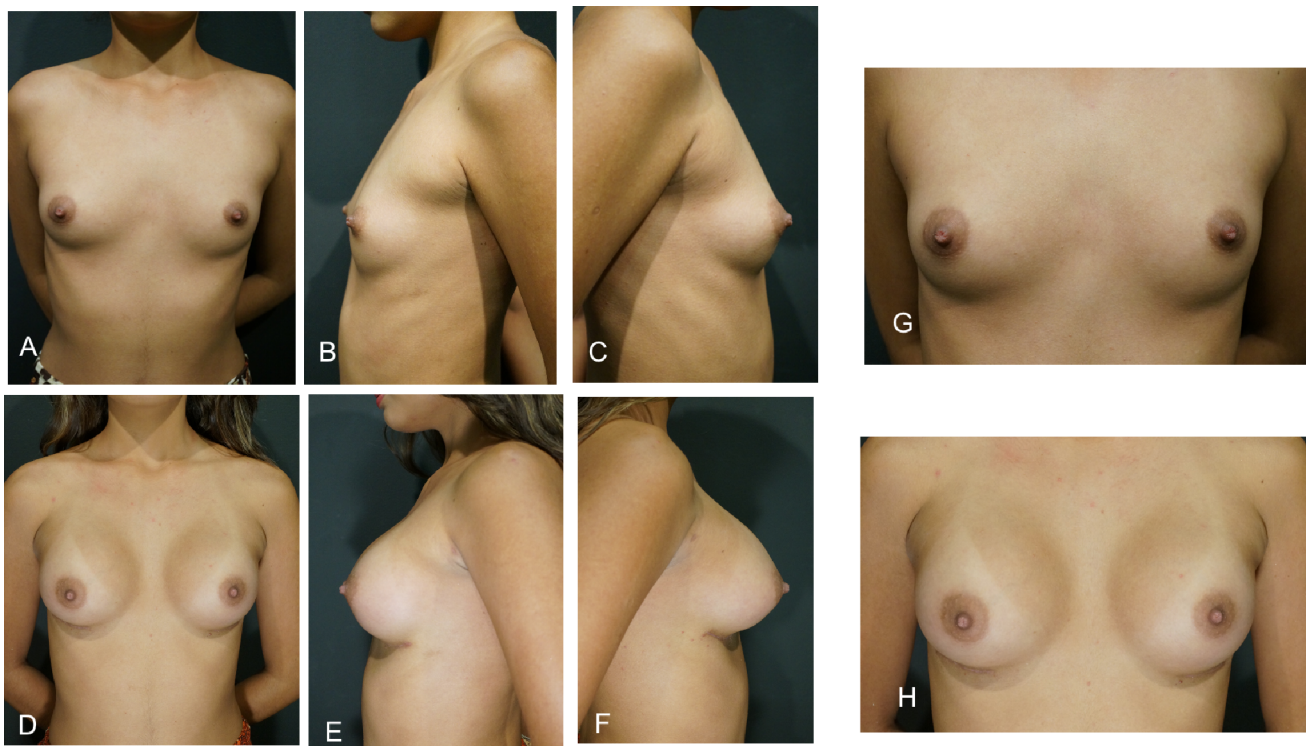

Fig. 8 Pre- and postoperative aspects of breast augmentation: Patient submitted to round 325 ml implant in retro glandular plane, inframammary incision (6th postoperative month). Pre- (**a**–**c**, **g**) and postoperative (**e**–**f**, **h**) aspects in frontal and lateral views. The figures **d**–**f** and H show the increase in the volume and projection. Observe the expansion of four breast segments (uppers and lowers) with increase in the N-IMF distance and NAC diameter

Brazilian surgeons do not use 3-D imaging equipment for surgical planning [28].

In our results, the most significant breast anthropometric alteration after mammoplasty was the N-IMF distance; that is, an expansion of the lower pole of the breast, followed by an increase in the areolar diameter. This first region showed a significant change between the 3rd and 6th month. Probably, this expansion of the lower pole can be attributed to the "*tipping*" or "*lifting*" movement with superior rotation of the NAC, frequently seen in reduction mammoplasty [29–31] or by the phenomenon known as "*bottoming out*" as the increase in the distance between the nipple and the inframammary fold, due to the caudal migration of the implant, generating distortion in the lower pole of the breast. [32] In addition to this expansion of the lower pole, there was an increase in the other poles (lateral, upper and medial), which due to the difficulty of measurement, were not measured in this study. However, when we analyze the behavior of the N-IMF distance, between the implants of different coverings used in this study, we observe the maintenance of this measure in the sub-group of implants coated with polyurethane; which can be attributed to more stability due to greater adherence to breast tissues. (Fig. 7) On the other hand, the smallest changes occurred in the distance between the sternal notch to the nipple (SN-N) and in the distance between the nipples, probably due to the discreet movement of ascension and lateralization (increased distance between N–N) of the NAC due to the increase in the breast content by the retroglandular implant [33].

Among the topographic changes of the breast, the projection was the most interesting measure, due to presenting two patterns of behavior according to the analysis criteria performed. When assumed a general measure of the breast projection as reference, was analyzed according to the percentage increase before and after the surgery. In this context, the results revealed that the average increase in the projection of the breasts studied, in the postoperative period, was 13.49% and 13.94% (breast right/left, respectively).

A second analysis of the breast projection was adopted, considering the impact or role of implant projection on final breast projection post-augmentation. A check was performed between the projection of the implant and the final projection of the breast. Despite the fact that the average projection of the implants was 5.1 cm, this translated in a gain of 1.44 cm and 1.46 cm in an overall projection of the right and left breast, respectively, which represented an increase of 27% of the implant projection (5.1 cm). (Table 1).

Although many surgeons have claimed in the last decade, that implant projection has been an important variable in breast augmentation, our data demonstrated that it could be considered as a predictive tool in approaching the patients during surgical planning in the preoperative evaluation, providing to them a realistic expectation of the breast projection gain according to the projection of the implant used. On the other hand, the final gain in the breast projection, in addition to the use of the implant, we must consider the degree of skin elasticity and sagging, as well as the degree of parenchyma atrophy over the years in the postoperative period. Studies have shown that there is a significant reduction in the breast parenchyma after breast augmentation, which can contribute to a reduction in breast volume and projection [34, 35].

Considering the five subgroups studied (GP1-GP5), observed that there was a rise to the nipples (N–N), N-IMF distances, and breast projection with the increase in the implant size, proportionality. Conversely, NAC diameter and SN-N distance showed a greater increase in breasts with lesser volume of the implant (eg: GP1: 250 ml vol.implant—NAC diameter showing an increase of 36%). We can attribute to this behavior the fact that a smaller breast size, presents a smaller surface to accommodate the implant stress under the breast tissue, what can promote a major expansion of areola (Table 1). Forte et al., in a cadaveric study, demonstrated the increase in the NAC-IMF, SN-NAC distances and areolar diameter related with bigger implant sizes, proportionally. In that study, all the cadavers were measured in lying down position [36].

As limitations of the study, 3-D volumetric measurements were not used, the non-verification of measurements after 1 year of postoperative to assess the long-term behavior of the breast and the reduced number of patients.

We suggest that other studies be carried out in order to correlate the degree of sagging skin and the gain in the projection of the breasts, as well as the comparison of these anthropometric changes between retroglandular and retromuscular implants.

It is known that BMI significantly affects morphometric results. In our study, patients were monitored for BMI over 6 months, with no significant change that indicated the exclusion of the individual from the study.

Conclusion

The augmentation mammoplasty performed with round breast implants, of extra high profile, via inframammary and in the retroglandular plane, showed us that, over 6 months of postoperative, an increase in the distance from the nipple-areolar complex to the inframammary fold, an increase in the distance from the sternal notch to the nipple, an increase in the diameter of the NAC and an increase in the projection of the breast, proportionality with the increase of the implant size.

**The implant projection contributed with an increase of the 27% in final increase in the breast projection. In addition, it was evidenced that the anthropometric measurements after breast augmentation undergo little changes in the period between 3 and 6 months, remaining practically stabilized, except for the lower breast pole.

This study provides an essential comparative analysis between anatomical changes in breast augmentations and serves as a predictive tool in the preoperative evaluation of the patient during surgical planning.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical Approval This study was carried out in accordance with the ethical principles of the declaration of Helsinki 2000 and Istanbul 2008. This trial followed the norms of resolution 466/12 and the subsequent ones of National Health Council/Ministry of Health. He was submitted to the ethics and research committee of Pedro Ernesto University Hospital of the State University of Rio de Janeiro-UERJ, being approved on 12/04/2017 (no 2.013.473).

Informed Consent All participants provide informed consent.

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