Aesth Plast Surg (2019) 43:305–312
https://doi.org/10.1007/s00266-018-1264-1

High- and Extra-High-Profile Round Implants in Breast Augmentation: Guidelines to Prevent Rippling and Implant Edge Visibility

Antonio Carlos Abramo[1] · Marcio Scartozzoni[1] · Thiago Walmsley Lucena[1] · Romulo Grechi Sgarbi[1]

Received: 7 August 2018 / Accepted: 22 October 2018 / Published online: 27 November 2018

Abstract

Background Rippling and implant edge visibility after breast augmentation depends on several factors. Among the most relevant are breast soft tissue thickness, particularly the retroareolar mammary parenchyma, and implant profile. They were correlates to prevent these occurrences.

Methods Thirty patients underwent breast augmentation through subfascial dissection involving the pectoralis, serratus, external oblique, and rectus abdominis fascias. The thickness of the retroareolar mammary parenchyma distributed patients into two groups. Group I: patients with thickness equal to or greater than 4.0 cm received high-profile 85% fill round implants. Group II: patients with thickness up to 3.9 cm received extra-high-profile 100% fill round implants. MRI was performed preoperatively and 5 years after augmentation to evaluate breast tissue changes and implant contouring.

Results Seventeen patients with high-profile implants and thirteen patients with extra-high-profile implants had noticeable improvement of the breasts without the occurrence of rippling or implant edge visibility. A natural appearance of the breast, increased mammary cone, balanced upper and lower pole contouring was maintained at 5 years postoperatively. MRI performed 5 years after breast augmentation validated patient clinical outcomes not evidencing implant deformities, or soft tissue thinning, parenchymal atrophy or chest wall deformities.

Conclusions The adequate correlation between retroareolar mammary parenchyma thickness with high-profile 85% fill and extra-high-profile 100% fill textured round implants was of utmost importance in preventing rippling and implant edge visibility. The wide fascial support, width of the implant smaller than the breast diameter, and soft cohesive gel-filled implants were co-adjuvant factors in preventing rippling and implant edge visibility.

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 Rippling · Implant edge visibility · Breast augmentation · High-profile round implant · Extra-high-profile round implant · MRI

✉ Antonio Carlos Abramo
acabramo@abramo.com.br; clinica@abramo.com.br

Marcio Scartozzoni
clinica@abramo.com.br

Thiago Walmsley Lucena
clinica@abramo.com.br

Romulo Grechi Sgarbi
clinica@abramo.com.br

[1] Post-Graduate Course of Plastic Surgery, ACA - Institute of Assistance in Plastic Surgery of São Paulo, Brazilian Society of Plastic Surgery and Brazilian Medical Association, Rua Afonso de Freitas 641, São Paulo, SP 04006-052, Brazil

Introduction

Cutaneous undulations after breast augmentation are commonly reported as wrinkling or rippling. These words are used interchangeably to describe the same deformity; however, they have different meanings. Wrinkling is an implant occurrence caused by low cohesion of the gel or less filling of the shell. Gel cohesiveness is formed by increasing the number of cross-links between its molecules, which results in better retention of the implant shape and

less folds [1]. A comparative prospective study regarding soft and low cohesive silicone gel reported that the greater the cohesiveness, the less tendency of wrinkling [2]. Soft cohesive silicone gel implants are helpful in preventing skin undulations after augmentation. It supports pressure without fracturing and does not cause damage in the surrounding tissues [3]. In turn, rippling is the cutaneous manifestation, visible or palpable, of the implant ripples and edge that are typically most apparent when the patient bends forward. In situations in which the soft tissue coverage for the implant is insufficient, these harmful effects become more apparent [4]. Risk factors for rippling are related to the breast tissue quality and low cohesivity of the implant gel [5]. Adequate coverage over the implant ripples is a mandatory element in preventing rippling or implant edge visibility. The TEPID system addresses the tissue characteristics (T) of the envelope (E), the parenchyma (P) and the implant (I), and the dynamics (D) of implant and filler distribution that affect soft tissues. [6]. Measurement of the breast tissue has been usually done by pinching the breast tissue and a caliper. The difficulty of measuring breast tissue stimulated the development of devices for measuring soft tissue in cosmetic breast surgery [7]. The inframammary incision is the most common approach used in breast augmentation. A comparative study of the long-term cosmetic effects of the scar on the inframammary fold and axilla reported no differences between them [8]. Subfascial dissection provides additional coverage for the implant, minimizing the occurrence of rippling and implant edge visibility [9]. Deformities of the breast tissues and chest wall after breast augmentation have been related to the pressure exerted by high- and extra-high-profile implants. However, the same negative outcomes for high- and extra-high-profile implants are also seen with low- and moderate-profile implants [10]. Magnetic resonance imaging (MRI) examination is widely employed to evaluate the breast tissues and the implant after breast augmentation. It identifies atrophy of breast soft tissue and mammary parenchyma, chest wall deformities, and changes in implant contouring [11].

Round implants with high-profile 85% fill and extra-high-profile 100% fill with soft cohesive silicone gel were correlated with different retroareolar mammary parenchyma thicknesses to study the occurrence of rippling and implant edge visibility after breast augmentation.

Patients and Method

Thirty females with ages ranging from 22 to 37 years old and 0 to 2 pregnancies underwent subfascial breast augmentation for cosmetic purposes. Breast diameter was measured with the caliper settled in the breast circumference at the inframammary fold. The pinch test and a caliper were used to measure the thickness of the breast soft tissue and retroareolar mammary parenchyma. A slight pinching of the areola pushed back and up the retroareolar mammary parenchyma delineating its upper boundary on the upper pole skin. Thickness of the retroareolar mammary parenchyma was established by the distance between its overhang in the upper pole and the pinched areola (Fig. 1). Patients were distributed into two groups in relationship to the thickness of the retroareolar mammary parenchyma. Group I was composed by patients with thicknesses equal to or greater than 4.0 cm and Group II by patients with thicknesses up to 3.9 cm. They were clinically reviewed at months three, six and nine, and annually for 5 years. MRI was performed before and 5 years after breast augmentation, or at the time of the clinical appearance of rippling or visible implant edge. The Pearson product-moment correlation coefficient analyzed the strength of linear correlation between two variables, from -1 to $+1$, where 0 is no linear correlation, $+1$ is total positive linear correlation, and -1 is total negative linear correlation [12]. It measured the strength of the linear correlation between extra-high-profile round implants and retroareolar mammary parenchyma thickness up to 3.9 cm, and between high-profile round implants and retroareolar mammary parenchyma thickness equal to or greater than 4.0 cm, to prevent rippling and implant edge visibility. This correlation was also appraised through a scatter diagram which is a representation of data points of

Fig. 1 The arrows point the thickness of the retroareolar mammary parenchyma measured by the caliper jaws from the pinched areola (long arrow) to the upper boundary of the retroareolar tissue projection in the upper pole (short arrow)

two variables in an X–Y plot. Points closely grouped along an axis indicate a linear positive correlation between the two variables [13]. The closer the points of the two variables, the greater the correlation between them.

Selection of the Implant

Thirty patients received sixty round implants, textured surface, soft silicone gel-filled ranging from 260 to 300 cc, from the same manufacturer (Cristalline™ Paragel™-Eurosilicone™). Selection of the implant profile considered width and projection, and not the volume. Implant width was 1.0 to 1.5 cm smaller than the breast diameter, whereas the projection was selected by the retroareolar mammary parenchyma thickness. As high-profile round implants have less projection and major diameter than extra-high-profile round implants with the same volume, they were indicated for patients with mammary parenchyma thickness equal to or greater than 4.0 cm. In turn, extra-high-profile implants having major projection and less diameter were indicated for patients with mammary parenchyma thickness up to 3.9 cm.

Operative Technique

Breast augmentation was performed through a 5.0 cm long straight incision, 0.5 cm above the inframammary fold, from the breast midline toward its lateral circumference. The pocket diameter for the implant was drawn on the breast skin 1.0 to 1.5 cm less than the breast circumference. Subfascial dissection exposed the muscle fibers from the inframammary fold to the skin marks. Subfascial in-block dissection involved the fascias of the pectoralis and anterior serratus muscles, and may also include the fascias of the oblique external and rectus abdominis muscles (Fig. 2). An optic fiber made easier subfascial dissection and hemostasis, particularly in the upper pole of the breast. The implants were centered in the nipple to fulfill, symmetrically, both poles of the breast. Drains were not used.

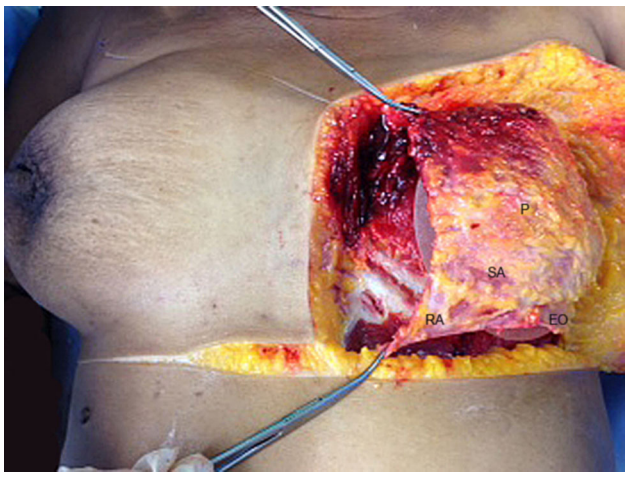

Fig. 2 Cadaver dissection: in-bloc dissection of the pectoralis (P), serratus anterior (SA), external oblique (EO) and rectus abdominis (RA) fascia fully involved the implant

Results

All patients had breast soft tissue thickness over 2.0 cm. Breast modifications which occur after pregnancy did not interfere in the outcomes. Thirty females, regardless of group, received soft cohesive silicone gel-filled round implants with equal size on both breasts. Seventeen patients received high-profile implants (Fig. 3) and thirteen patients received extra-high-profile implants (Fig. 4); all had noticeable improvement of the breasts at 5 years postoperatively. It was characterized by improvement of the mammary cone projection with a natural and balanced contouring for the upper and lower poles. MRI was performed 5 years after breast augmentation, at the same time of the clinical evaluation, validating the results on both groups of patients. Pre- and postoperative MRI showed no significant differences regarding the breast tissues and chest wall, involving thinning of the breast subcutaneous tissue, parenchymal atrophy, or chest wall deformity (Figs. 3e, f and 4e, f). MRI at 5 years postoperatively showed no significant differences in the implant projection with that standardized by the manufacturer. The Pearson product-moment correlation coefficient indicated a significant correlation between implant profile and thickness of retroareolar mammary parenchyma with the non-occurrence of rippling and implant edge visibility. It was 0.954 for Group 1 and 0.987 for Group 2. The scatter diagram of data also exhibited a strong linear positive correlation between the two variables in both groups of patients. Table 1 summarizes patient distribution and outcomes.

Group 1—Seventeen patients with retroareolar mammary parenchyma thickness ranging from 4.0 to 5.2 cm received thirty-four high-profile 85% fill round implants. Four patients with retroareolar mammary parenchyma thickness from 4.0 to 4.6 cm and breast diameter from 11.7 to 12.0 cm received implants with a projection of 4.1 cm, width of 10.7 cm and 260 cc fill. Nine patients with retroareolar mammary parenchyma thickness from 4.3 to 5.0 cm and breast diameter from 11.8 to 12.6 cm received implants with a projection of 4.3 cm, width of 10.9 cm and 280 cc fill. Four patients with retroareolar mammary parenchyma thickness from 4.3 to 5.2 cm and breast diameter from 12.3 to 13.5 cm received implants with a projection of 4.4 cm, width of 11.1 cm and 300 cc fill. All patients had improvement of the breast projection and contour without the occurrence of rippling or implant edge

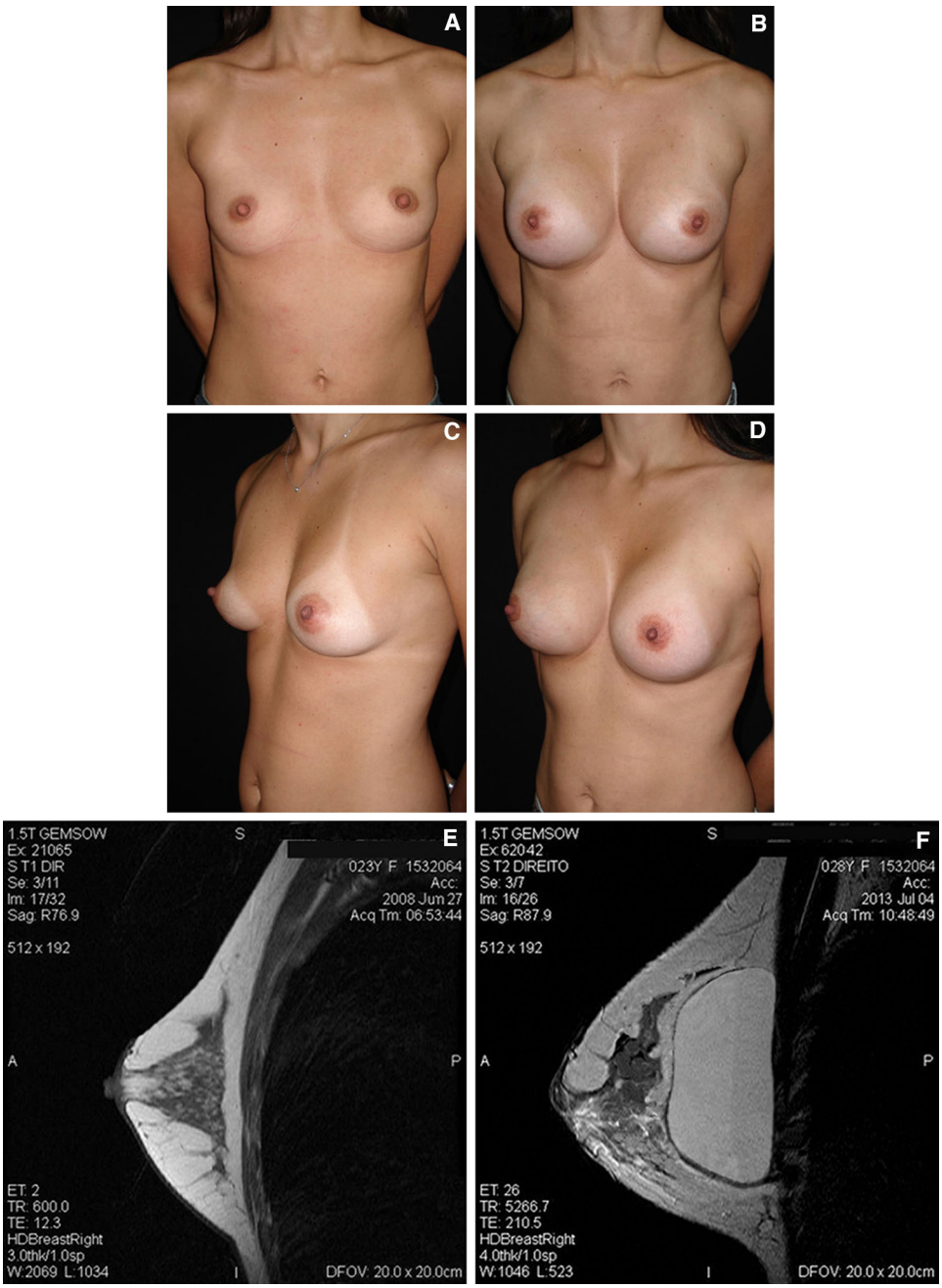

Fig. 3 **a**, **c** A 28-year-old female before breast augmentation. **b**, **d** Well-defined contour and projection for the breasts provided by 280 cc High-Profile 85% fill round implant. **e** Preoperative MRI. **f** MRI at 5 years postoperative showed no breast and implant deformities

visibility (Fig. 5a–d). The scatter diagram for Group 1 showed an increase in the two variables which were very closely grouped, indicating a very strong linear positive correlation between high-profile 85% fill round implants and retroareolar mammary parenchyma thickness equal to or greater than 4.0 cm to prevent rippling and implant edge visibility (Fig. 6).

Group 2—Thirteen patients with retroareolar mammary parenchyma thickness ranging from 2.2 to 3.9 cm received twenty-six extra-high-profile 100% fill round implants. Four patients with retroareolar mammary parenchyma thickness from 2.8 to 3.9 cm and breast diameter from 11.4 to 11.9 cm received implants with a projection of 4.5 cm, width of 10.4 cm and 260 cc fill. Seven patients with retroareolar mammary parenchyma thickness from 2.3 to 3.7 cm and breast diameter from 11.5 to 12.4 cm received implants with a projection of 4.7 cm, width of 10.6 cm and 280 cc fill. Two patients with retroareolar mammary parenchyma thickness from 2.3 to 3.8 cm and breast diameter from 13.0 to 13.5 cm received implants with a projection of 4.9 cm, width of 10.8 cm and 300 cc fill. All patients had improvement of the breast projection and contour without the occurrence of rippling or implant edge visibility (Fig. 7a–d). The scatter diagram for Group 2 showed

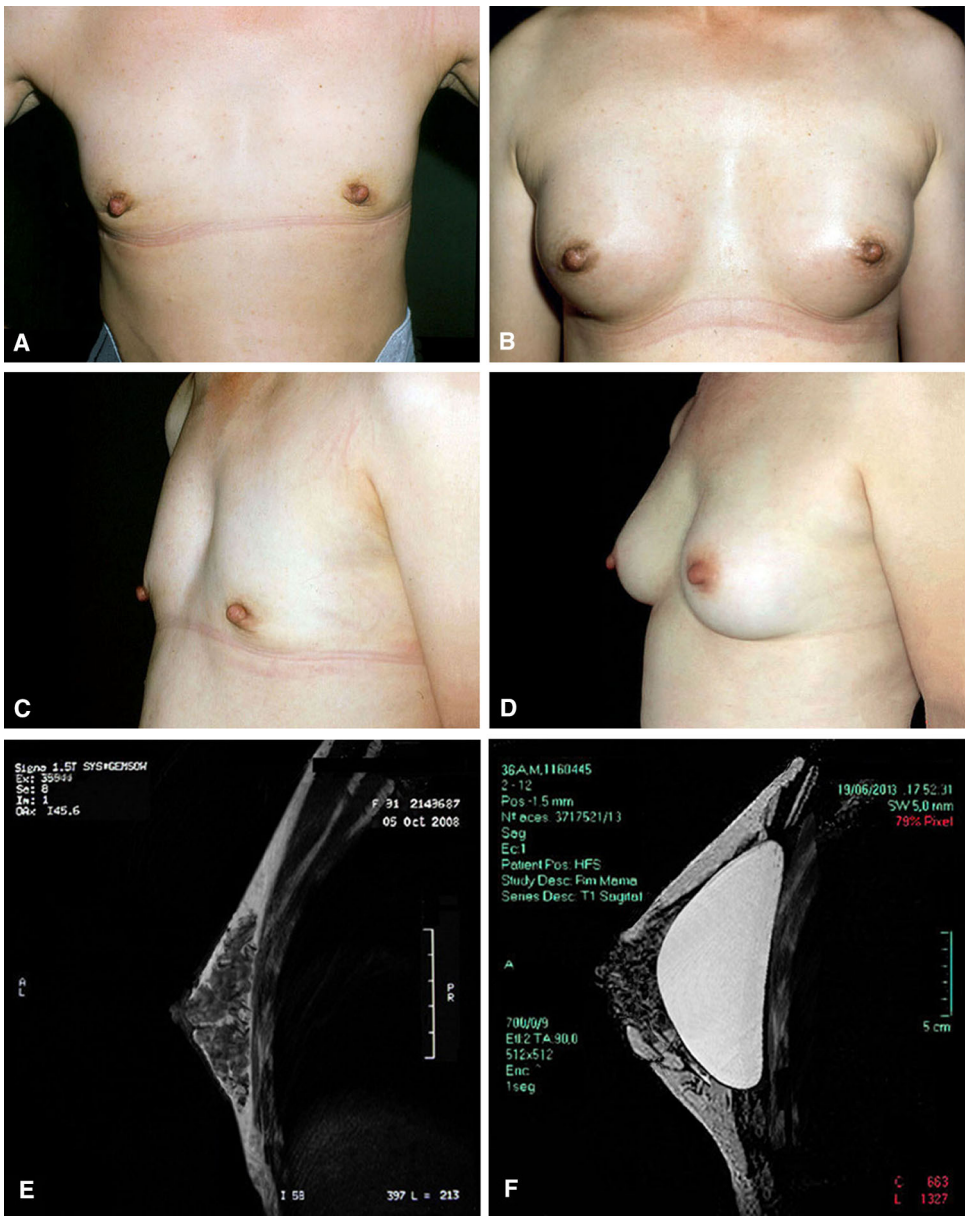

Fig. 4 **a**, **c** A 29-year-old female without breast definition. **b**, **d** Noticeable improvement of the breasts achieved with 280 cc Extra-High-Profile 100% fill round implant. **e** Preoperative MRI. **f** MRI at 5 years postoperative exhibited no breast and implant deformities

an increase in the two variables which are proximally grouped around a straight line, indicating a strong positive linear correlation between extra-high-profile 100% fill round implants and retroareolar mammary parenchyma thickness up to 3.9 cm to prevent rippling and implant edge visibility (Fig. 8).

Discussion

Careful evaluation of the breast tissue thickness, knowledge of the implant, and adequate surgical technique are indispensable requirements in planning breast augmentation [14]. Thickness of the breast tissues, particularly the retroareolar mammary parenchyma, apart from increased breast projection, were of utmost importance to regularize the implant contour in preventing rippling and implant edge visibility. The limit of 4.0 cm for the retroareolar mammary parenchyma thickness had the purpose to correct the implant undulations. High-profile 85% fill round implants have at least a small amount of wrinkling. The retroareolar mammary parenchyma from 4.0 cm, apart from increasing the breast projection, regularized the undulations of the implant. The pressure over the apex of the high-profile implant spread the gel toward its circumference, making regular its contour. Continuous centrifugal pressure over the implant minimized the long-term risk of rippling and implant edge visibility, as evidenced in the MRI 5 years after augmentation. Differently, extra-high-profile 100% fill round implants have almost no

Table 1 Patient distribution and outcomes

	Age	Pregnancy	Breast				Implant					
			Diameter (cm)		Retroareolar tissue (cm)		Projection (cm)		Width (cm)		Volume (cc)	
			Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
1	28	1	13.2	13.5	2.7	2.3	4.9*	4.9*	10.8*	10.8*	300*	300*
2	24	0	11.9	11.6	2.9	3.7	4.5*	4.5*	10.4*	10.4*	260*	260*
3	31	2	12.3	12.9	4.8	5.2	4.4	4.4	11.1	11.1	300	300
4	35	1	11.5	11.9	3.4	3.0	4.5*	4.5*	10.4	10.4	260*	260*
5	28	1	12	12.1	4.6	5.0	4.3	4.3	10.9	10.9	280	280
6	22	0	11.8	11.5	3.3	3.7	4.7*	4.7*	10.6*	10.6*	280*	280*
7	23	0	12.6	12.1	5.0	4.8	4.3	4.3	10.9	10.9	280	280
8	25	0	12	12.4	4.4	4.8	4.3	4.3	10.9	10.9	280	280
9	32	1	12.2	11.8	2.7	3.0	4.7*	4.7*	10.6*	10.6*	280*	280*
10	29	0	13	12.9	4.7	4.5	4.4	4.4	11.1	11.1	300	300
11	31	0	12.1	12	4.5	5.0	4.3	4.3	10.9	10.9	280	280
12	35	2	13	13.5	3.8	3.7	4.7*	4.7*	10.8*	10.8*	300*	300*
13	29	1	12.4	12	2.9	2.2	4.7*	4.7*	10.6*	10.6*	280*	280*
14	27	1	11.7	11.9	4.3	4.0	4.1	4.1	10.7	10.7	260	260
15	33	1	12.2	12.3	4.5	4.5	4.3	4.3	10.9	10.9	280	280
16	27	2	11.9	11.8	4.0	4.6	4.1	4.1	10.7	10.7	260	260
17	32	1	11.7	12	3.5	3.5	4.7*	4.7*	10.6*	10.6*	280*	280*
18	36	2	12.3	12.9	4.8	5.0	4.4	4.4	11.1	11.1	300	300
19	30	2	13.5	13.1	4.8	4.3	4.4	4.4	11.1	11.1	300	300
20	26	0	11.5	11.6	3.3	2.8	4.5*	4.5*	10.4*	10.4*	260*	260*
21	25	0	12.5	12.1	5.0	5.0	4.3	4.3	10.9	10.9	280	280
22	32	1	11.7	12	4.4	4.0	4.1	4.1	10.7	10.7	260	260
23	24	0	11.9	11.7	2.9	3.4	4.7*	4.7*	10.6*	10.6*	280*	280*
24	23	0	11.9	12.3	4.3	4.8	4.3	4.3	10.9	10.9	280	280
25	23	0	11.9	11.8	4.0	4.5	4.1	4.1	10.7	10.7	260	260
26	22	0	12.2	11.9	2.3	2.5	4.7*	4.7*	10.6*	10.6*	280*	280*
27	37	2	11.9	11.8	3.1	3.6	4.7*	4.7*	10.6*	10.6*	280*	280*
28	28	1	12.4	11.9	5.0	4.4	4.3	4.3	10.9	10.9	280	280
29	29	0	11.8	12.1	5.0	4.5	4.3	4.3	10.9	10.9	280	280
30	31	0	11.4	11.8	3.3	3.9	4.5*	4.5*	10.4*	10.4*	260*	260*

Implant: high-profile 85% fill soft cohesive gel textured round implant

*Extra-high-profile 100% fill soft cohesive gel textured round implant

undulations, not requiring pressure to adjust their surface. It is adequate to compensate the low projection of breasts with retroareolar mammary parenchyma thickness up to 3.9 cm. Non-occurrence of rippling and implant edge visibility happened by adequate association of the implant profile, a 3-dimensional relationship between projection and diameter, with the retroareolar mammary parenchyma thickness. It was corroborated by the *r* values of 0.954 for high-profile and 0.987 for extra-high-profile round implants of the Pearson correlation coefficient and by the strong linear positive correlation of the scatter diagram for high- and extra-high-profile round implants and retroareolar mammary parenchyma thicknesses. The scatter diagram was very useful because it is applicable when one variable is easy to measure, such as the implant profile, and the other is not, such as the retroareolar mammary parenchyma thickness [15]. Additional coverage of the implant by the subcutaneous tissue thickness over 2.0 cm and subfascial dissection avoided implant edge visibility apart from preventing rippling. Subfascial dissection added a new layer of soft tissue between the implant and skin [16]. Cohesivity of the silicone gel-filled implant preserves its structural integrity even when pressed by the mammary parenchyma [17]. The soft cohesive gel of high- and extra-

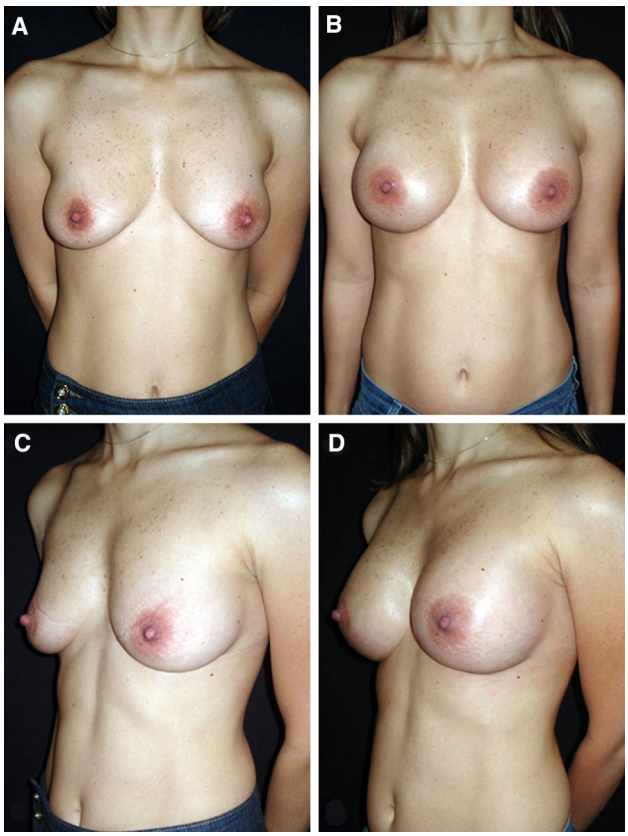

Fig. 5 **a**, **c** A 30-year-old female of Group 1 with retroareolar thickness of 4.8 cm in the right breast and 4.3 cm in the left breast. **b**, **d** A 300 cc high-profile 85% fill round implant increased the breast projection with a balanced upper and lower pole

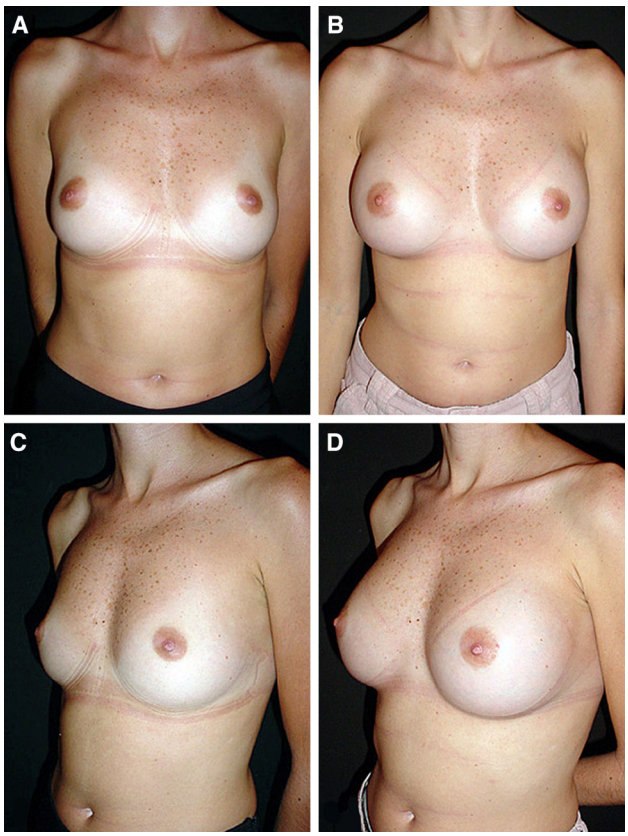

Fig. 7 **a**, **c** A 28-year-old female of Group 2 with retroareolar thickness of 2.7 cm in the right breast and 2.3 cm in the left breast. **b**, **d** A 300 cc extra-high-profile 100% fill round implant increased the mammary cone with a natural contour for the upper and lower poles

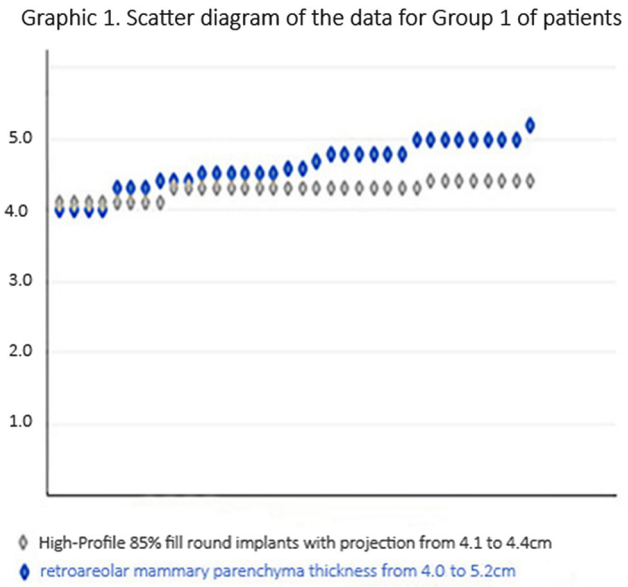

Fig. 6 The scatter diagram for Group 1 of patients exhibits the two variables very closely grouped, indicating a very strong positive linear correlation of the data

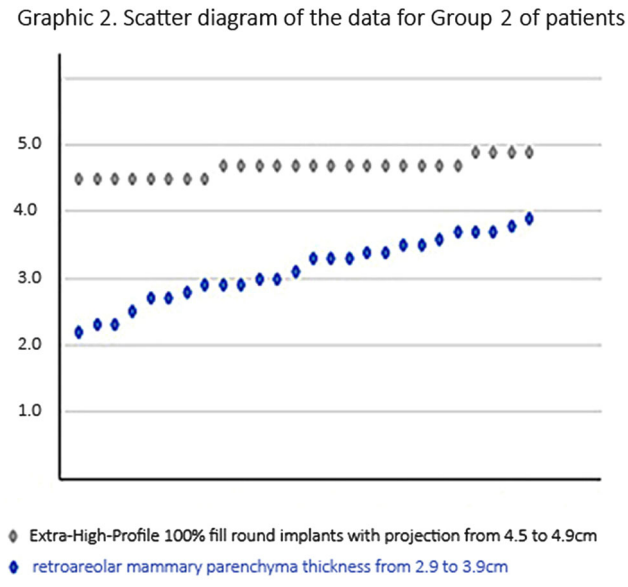

Fig. 8 Scatter diagram for Group 2 of patients shows the two variables proximally grouped around a straight line, indicating a strong positive linear correlation of the data

high-profile round implants was strong enough to support the pressure of the retroareolar mammary parenchyma without rupture, preserving the implant shape, as well as not exerting enough pressure to lead to atrophy of the breast soft tissue and parenchyma, or chest wall deformity. The long-term permanence of high- and extra-high-profile round implants has been reported as a cause of parenchymal atrophy, breast tissue thinning, and chest wall atrophy [18]. They are less intense with silicone gel-filled than saline implants due to the cohesive form-stability of the silicone gel. In this series of patients and according to Largent et al. [19], long-term permanence of high- and extra-high-profile round implants showed minimal risk of rippling, implant edge visibility, breast tissue and parenchymal atrophy, or chest wall deformity.

Conclusion

Adequate association between retroareolar mammary parenchyma thickness and high- and extra-high-profile round implants was a mandatory factor in preventing rippling and implant edge visibility. Subfascial dissection, subcutaneous tissue more than 2.0 cm thick, implant width smaller than the breast diameter, and soft cohesivity of the implant gel were helpful co-adjuvant factors in preventing rippling and implant edge visibility.

Acknowledgements "To the cadavers of selfless dedication".

Compliance with Ethical Standards

Conflict of interest No financial support or benefits have been received by the author or any co-author to accomplish this manuscript.

Ethical Approval All procedures performed in this study involving humans participants were in accordance with the ethical standards of the ACA - Institute of Assistance in Plastic Surgery of São Paulo research committee and with the 1964 Helsinki Declaration and Medical Research Involving Human Subjects and its latter amendments or comparable ethical standards.

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