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Factors Affecting Lower-pole Stretch after Breast Augmentation

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Background: Breast augmentation surgical planning based on soft-tissue characteristics including the type of lower-pole pocket direction has been described. Objective outcome measures of the effects of some of these choices on postoperative lower-pole settling, including dual-plane dissection type, have been lacking.
Objective: The aim of this study was to determine whether the type/extent of dual-plane dissection, patient age, or variables in breast implant characteristics affected implant–soft tissue dynamics of the lower pole of the breast enough to cause difference in implant settling during the postoperative period.
Methods: Measurements of nipple-to-inframammary fold distance in primary breast augmentation patients were collected prospectively for 227 female primary breast augmentation patients during postoperative visits over an 8-year period. Changes in this distance during the postoperative period were evaluated for correlation with dual-plane dissection type, patient age, implant fill material, implant size, and implant profile.
Results: Increasing dual-plane dissection type did demonstrate a trend toward greater postoperative lower-pole stretch. Only implant profile affected lower-pole stretch, with statistical significance shown in the ultrahigh-profile group. Age, implant fill material, and size of implant did not show any notable effect.
Conclusions: Ultrahigh-profile implants cause significantly more lower-pole stretch postoperatively, whereas increasing dual-plane dissection type appears to have some effect as well. Age, implant material, and size of implant are of less importance over a 6-month period. *(Plast Reconstr Surg Glob Open 2021;9:e3865; doi: 10.1097/GOX.0000000000003865; Published online 2 November 2021.)*

INTRODUCTION

Breast augmentation remains the most popular cosmetic plastic surgery procedure in the United States,[1] and much has been written about breast implant position options over the last two decades. The benefits of submuscular implant positioning have been described extensively, and are well accepted.[2–9] Muscle coverage at the upper pole of the augmented breast minimizes visible traction or underfill rippling (important in patients with minimal soft-tissue coverage)[7] and decreases capsular contracture rates[2–4,6,9,10] and implant palpability.

In the lower pole of the breast, differences in soft-tissue coverage change the mechanical characteristics and implant soft-tissue dynamics in this area.[9] More compliant tissues, such as those at the lower pole after a subglandular dissection, can allow the implant to stretch out and fill the commonly seen empty lower pole of a breast with glandular ptosis. Therefore, patients presenting with such anatomy have been described as being best treated with subglandular placement. Other factors thought to act on the lower pole of the breast and, therefore, affect the final position of the implant and the final shape of the breast include the amount of existing skin/soft tissue at the lower pole of the breast and the starting distance from the nipple to the inframammary fold (IMF), size of the implant,[2,4] shape and projection of the implant, preoperative compliance of the overlying soft-tissue envelope, tightness of the IMF, mobility of soft tissue at the IMF, surgical dissection (which can change many of the aforementioned factors), and possibly implant texturing.[4,9,11]

In 2001, Tebbetts focused attention on the importance of implant–soft tissue relationships in breast augmentation. He described approaches intended to combine the benefits of upper-pole muscle coverage with the benefits of lower-pole subglandular coverage.

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Three variations of partial submuscular dissections were described. These ranged from a type I dissection in which the costal origins of the muscle and its fascia were simply divided, to the most extreme type III dissection which further elevated the caudal margin of the released muscle up to the superior boarder of the areola, whereas the intermediate type II dissection left the inferior margin at the inferior border of the areola. Thus, the newly described surgical technique could tailor the resulting lower-pole soft-tissue compliance to best account for an individual patient's unique anatomy and the surgical goals to affect that anatomy. He concluded that "dual-plane augmentation mammaplasty adjusts implant and tissue relationships to ensure adequate soft-tissue dynamics to offer increased benefits and fewer tradeoffs compared with a single pocket location in a wide range of breast types."[9] Despite the importance of this concept, no objective data was demonstrated to prove that the techniques achieved their goals.

To investigate the ability of the different types of dual-plane dissections to adjust the lower-pole compliance to clinically significant and predictable degrees, the current author prospectively collected data related to lower-pole postoperative changes for all primary breast augmentations over an 8-year period to assess the effect of dual-plane dissection type on postoperative lower-pole stretch.

MATERIALS AND METHODS

Between 2008 and 2015, preoperative and postoperative breast measurements were recorded for all the senior author's primary breast augmentation patients. All implants used in this study were Mentor (Mentor Worldwide LLC, Irvine, Calif.) smooth round implants. No secondary/reoperative patients, reconstruction patients, or augment-mastopexy patients were included in the study. For every breast surgery patient, preoperative measurements include nipple:sternal notch distances, nipple:IMF (N:IMF) distances, nipple:nipple distances, and basewidths. For purposes of this study, only N:IMF distances were considered postoperatively as the dependent variable to be measured and were tracked for up to 1 year postoperatively.

Independent measurements of each augmented breast (side) were recorded and characterized separately, as many patients had different dissection types between the two sides. Information about each patient's dissection type (dual-plane I, II, or III) was recorded. Additionally, patient age, type of implants (saline versus silicone), size of implants, style of implants (moderate, moderate-plus, high, or ultrahigh profile), and tightness of the IMF (loose, medium, or tight) were recorded.

At the completion of the study, N:IMF distances at 2 weeks, 6 weeks, 6 months, and 1 year for each patient were compared to that patient's preoperative N:IMF distance. A ratio of these distances and a percent increase over time were then calculated. If any patient required reoperation, no foregoing data was collected for that patient. If a patient was not available for follow-up at a required precise postoperative time (eg, 6 wks) but was instead seen earlier or later, data for that missed visit were not included in the study. Many patients moved or were otherwise not available for late postoperative visits, so data points for many late results were not available.

RESULTS

Two hundred twenty-seven female patients, and 454 breasts, were included in the study. There were 117 saline patients (234 breasts) and 110 silicone patients (220 breasts). At the completion of the data collection period, postoperative measurements were available for 229 breasts at 2 weeks, 243 breasts at 6 weeks, 187 breasts at 6 months, and 44 breasts at 1 year. This attrition rate is shown in Figure 1.

The types of dissections performed consisted of 212 dual-plane type I, 88 dual-plane type II, and 154 dual-plane type III. The average age of the women in the study was 31.9 years (SD = 9.0), with a median of 30 and a mode of 24 years. The study group consisted of 234 saline implants and 220 silicone implants. The average implant size was 392.9 cm^3 (SD = 98.9 cm^3), with a median of 375 cm^3 and a mode of 375 cm^3. Eighteen implants placed were moderate profile, 211 were moderate-plus profile, 208 were high profile, and 14 were ultrahigh profile.

Overall Result

When all breasts were evaluated together, independent of any of the recorded variables, the average N:IMF distance was found to increase by 15.4% (SD = 0.2%) at 2 weeks postoperative, 25.2% (SD = 2.1%) at 6 weeks postoperative, 39.5% (SD = 3.5%) at 6 months, 39.9% (SD = 8.6%) at 1 year, and 42.9% (SD = 6.8%) at 2 years, as shown in Figure 2. As noted in Table 1, SDs of these measurements increased throughout the study period because the number of patients/breasts at follow-up appointments decreased.

These values were then compared between groups based on the aforementioned independent variables of dual-plane dissection type, age groups, material, implant size, and implant style/projection.

Dissection Type

Dual-plane dissection type was first considered and is demonstrated in Figure 3. All groups showed approximately

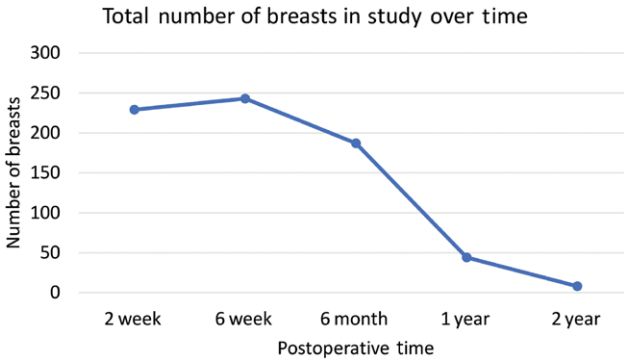

Fig. 1. Change in number of breasts, n, included at each time point of analysis.

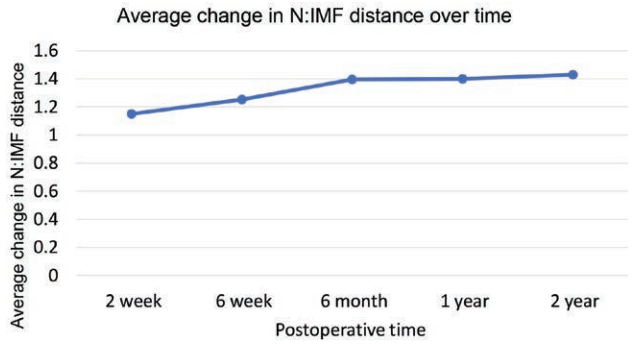

Fig. 2. Average change in N:IMF distance over time for all patients.

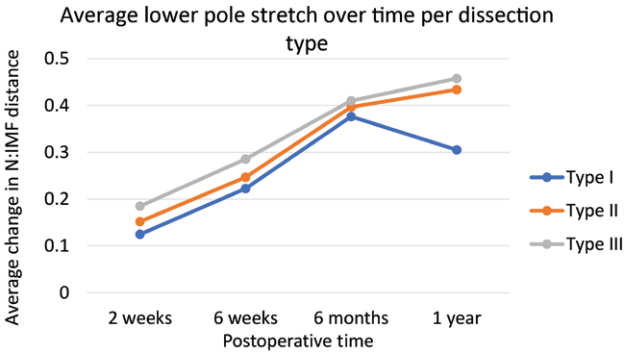

Fig. 3. Average change in N:IMF distance over time as a function of dissection type.

10% lower-pole stretch between each sequential visit up to 6 months, and then all groups demonstrated approximately 15% stretch between 6 weeks and 6 months (Table 2). Of central importance to this study, there was a greater lower-pole stretch for the type III group than the type II group, and for the type II group compared to the type I group at every point in time. In other words, compliance of the lower pole was in the order of type I < II < III. This change was not significant at 6 months.

Patient Age

Patient age ranged from 18 to 70, with an average of 32 years (SD = 9) (Fig. 4). Patients were grouped into three age ranges for comparison: younger than 30, 30–39, and older than 39 years. Lower-pole stretch was calculated over time for each group (Table 3). The comparison of these groups, as further presented in Figure 5, demonstrated no particular correlation between age and lower-pole stretch.

Implant Material

Results of lower-pole stretch with saline versus silicone were very similar and showed no particular trend (Table 4; Fig. 6). It should be noted, though, that implant sizes differed in these groups. For the silicone group, the mean, median, and mode sizes were 359, 375, and 375 cm^3, respectively. For the saline group, the mean, median, and mode sizes were 425, 400, and 400 cm^3, respectively (Table 5).

Implant Size

The average implant size of the study group was 393 cm^3 (median 375, mode 375, range 200–800 cm^3). Implant sizes were grouped into three ranges: less than 350, 350–450, and more than 450 cm^3. At each time point, the moderate size implant group (350–450 cm^3) showed the greatest increase in N:IMF distance, as shown in Figure 7. This suggests that no positive correlation exists between implant size and lower-pole stretch. Note, however, that SDs are large for all of these measurement averages (Table 6).

Implant Style

The impact of implant style/projection was analyzed by separating implants into groups of moderate profile, moderate-plus profile, high profile, and ultrahigh profile (Table 7). At each time point up to 6 months, the lower-pole stretch in the moderate, moderate-plus, and high-profile groups was similar. In contrast, the ultrahigh-profile group showed a relatively large increase in N:IMF compared to the other three groups at every time point up to 6 months (Fig. 8). This difference was statistically significant at 6 months. It should be noted, though, that implant size did differ among these four groups, as shown in Table 8.

DISCUSSION

In primary breast augmentation, appropriate planning is crucial to avoiding complications and reoperation. Although base width, implant material, pocket location, and implant size may represent the most basic considerations, many other variables have been suggested to affect results.[2–6,12–16] Those choices that influence implant–soft tissue relationships can be expected to dictate changes to that result over the ensuing months and years.

Many factors comprise this critical implant–soft tissue relationship. Tightness and strength of the soft-tissue envelope, often characterized by anterior-pull skin stretch[17] represents only one half of this relationship. The size of the implant contributes to the other half of this equation determining the pressure between the implant and the overlying soft tissue.

Table 1. Average Change in N:IMF Distance over Time for All Patients

	2 wks	6 wks	6 mo	1 yr	2 yrs
Total, N	229	243	187	44	8
Average change (%)	115	125.20	139.50	139.90	142.90
SD (%)	0.20	2.10	3.50	8.60	6.80

Table 2. Average Change in N:IMF Distance over Time as a Function of Dissection Type

		2 wks	6 wks	6 mo	1 yr
Type I	n	92	58	37	6
	Average change (%)	112.48	122.27	137.65	130.54
	SD (%)	11	15	18	12
Type II	n	44	24	8	2
	Average change (%)	115.21	124.68	139.69	143.40
	SD (%)	10	11	13	10
Type III	n	95	66	39	6
	Average change (%)	118.50	128.55	141.02	145.78
	SD (%)	8	13	20	26

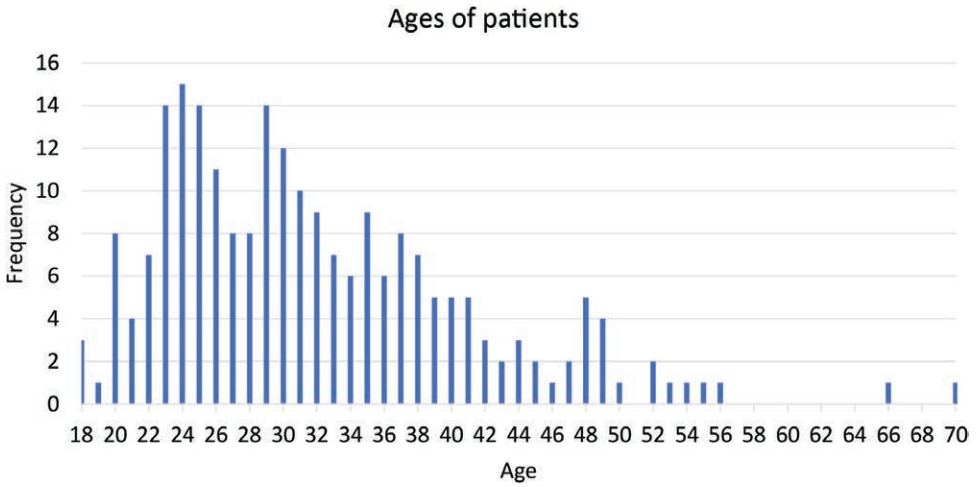

Fig. 4. Distribution of ages of patients included in study.

Table 3. Average Changes in N:IMF Distance in Patients over Time as a Function of Age

	2 wks	6 wks	6 mo	1 yr	2 yrs
n > 40 yrs old	38	40	42	10	2
Total avg > 40 (%)	113.4	124.9	135.1	136.8	137.5
Total SD > 40 (%)	8.3	10.2	15.7	20.0	0.0
n 30–39 yrs old	98	108	70	11	0
Total avg 30–39 (%)	113.5	123.1	140.6	133.7	0.0
Total SD 30–39 (%)	10.5	14.9	17.9	15.1	0.0
n < 30 yrs old	103	93	73	22	6
Total avg < 30 (%)	118.4	125.5	138.6	133.1	144.6
Total SD < 30 (%)	10.9	22.3	16.7	34.4	12.4

Patients were analyzed in three cohorts: under 30, between 30 and 39, and over 40 years old.

Although opinions differ as to ideal breast shape and the ratio of upper-pole to lower-pole fullness,[18–22] the achievement of the patient's and surgeon's planned aesthetic outcome is ultimately completed as the final implant position is reached. The N:IMF distance is critical to controlling the final implant position, especially with respect to the nipple-areolar complex at the end of surgery. The tissue qualities of the IMF itself also affect the final implant position. Variations in the strength of this facial and ligamentous network which mark the supporting "shelf" of the breast contribute to the phenomenon of more or less tissue recruitment from the lower chest

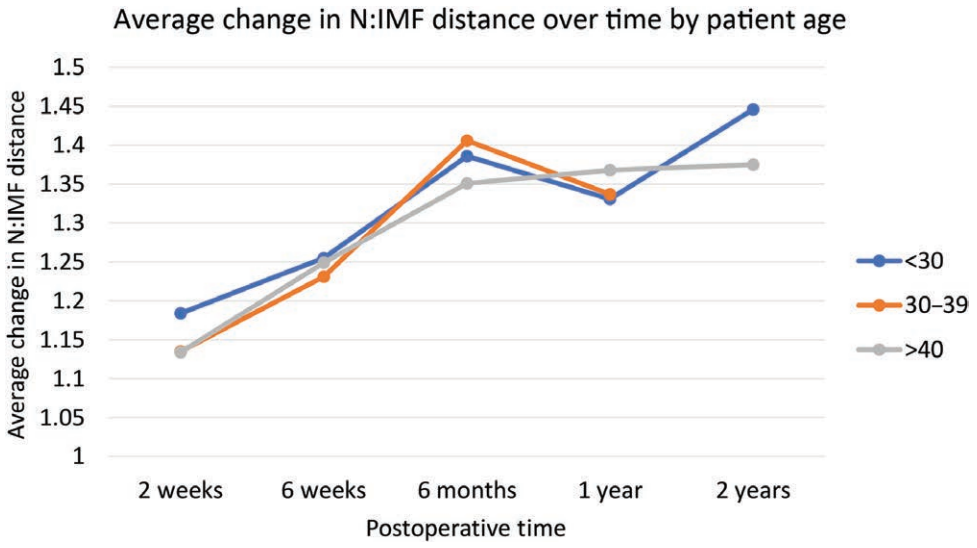

Fig. 5. Average changes in N:IMF distance in patients over time as a function of age. Patients were analyzed in three cohorts: under 30 years old, between 30 and 39 years old, and over 40 years old.

Table 4. Average Change in N:IMF Distance in Patients over Time as a Function of Implant Fill Material (Silicone or Saline)

		2 wks	6 wks	6 mo	1 yr	2 yrs
Saline	n	105	108	90	27	6
	Avg (%)	115.9	125.1	138.0	138.5	142.5
	SD (%)	9.5	14.4	18.5	18.4	54.7
Silicone	n	124	135	97	17	2
	Avg (%)	114.2	125.2	140.3	135.4	146.8
	SD (%)	11.5	13.1	17.7	14.9	4.0

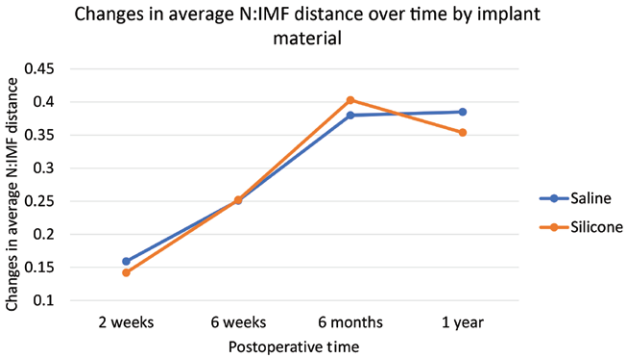

Fig. 6. Average change in N:IMF distance in patients over time as a function of implant fill material (silicone or saline).

Table 5. Mean, Median, and Mode of Implant Size (in cm³) by Implant Fill Material (Silicone vs Saline)

Implant Type	Silicone (cm³)	Saline (cm³)
Mean	359	425
Median	375	400
Mode	375	400

and upper abdomen onto the lower pole of the breast.[23–25] All of these considerations define the final implant–soft tissue relationship at the completion of surgery and are addressed in the multiple tissue-based planning systems utilized to minimize reoperative surgery.[26,27]

The introduction of Tebbet's dual-plane techniques suggested a means of customizing the muscle coverage (and therefore compliance) of the lower pole of breasts to meet the aforementioned anatomic variables of this area while maintaining the benefits of upper pole muscle coverage.[9] In this way, muscle coverage of the upper pole of the implant would still minimize upper-pole rippling, palpability, and capsular contracture rates. Thus, muscle coverage of the upper pole of a breast implant could be preserved by a dual-plane III dissection, even though the inferior extent of the muscle would be separated from the bottom half of a breast with pseudoptosis. Therefore, muscle in this area would not be present to interfere with the implant dropping into and expanding this empty lower pole, as was described to avoid mastopexy.[9,28] On the opposite end of the spectrum of lower-pole characteristics, the dual-plane III procedure was also suggested to be a means to intentionally increase to lower-pole compliance and allow an implant to expand the bottom of the breast in the correction of the constricted lower pole.[9,14,15,29]

These factors affecting the patient's implant–soft tissue relationship do not disappear at the end of surgery. Smooth implants descend in the weeks, months, and years following their placement to varying degrees. Therefore, the strength or compliance of the lower-pole soft-tissue envelope should determine the settling of the implant and stretching of the lower pole over time postoperatively.[2,12,17,28,30,31] Therefore, variations in the technique proposed to manipulate lower-pole compliance, such as those described by Tebbets, must be expected to affect not only implant position at the end of surgery but also implant descent and "settling" postoperatively.[9]

This prospective study was designed to test the underlying assumption that dual-plane dissection type does, in fact, affect lower-pole compliance to a degree that is

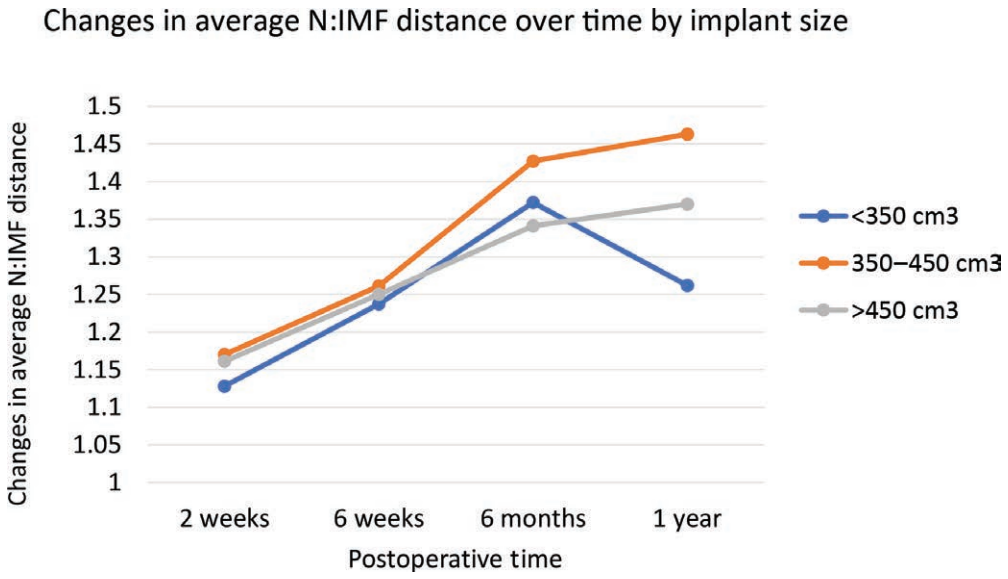

Fig. 7. Average change in N:IMF distance over time as a function of fill size. Patients were analyzed in three cohorts: under 350, between 350 and 450, and over 450 cm³.

Table 6. Average Change in N:IMF Distance over Time as a Function of Fill Size

		2 wks	6 wks	6 mo	1 yr	2 yrs
<350 cm^3	n	63	73	69	16	2
	Avg (%)	112.9	123.7	137.3	126.3	137.5
	SD (%)	10.8	15.2	16.3	12.1	0
350–450 cm^3	n	116	122	87	19	4
	Avg (%)	117.0	126.1	142.7	146.3	152.00
	SD (%)	10.3	13.2	19.9	16.5	6.50
>450 cm^3	n	39	41	27	6	2
	Avg (%)	116.1	125.0	134.2	137.0	130.0
	SD (%)	11.4	13.5	15.2	14.2	0.00

Patients were analyzed in three cohorts: under 350, between 350 and 450, and over 450 cm^3.

clinically significant. If this could be better understood and dissection type could be proven to predictably influence not just intraoperative implant position, but also postoperative implant settling, then such information could be considered alongside tissue-based planning systems to help surgeons predictably rely upon dissection plane choices to best achieve desired lower-pole fill and final implant position.

This study characterized both intraoperative and postoperative lower-pole stretch. Patients' first postoperative IMF measurement at 2 weeks averaged 115% of the preoperative measurement. This lower-pole measurement increased to 139% by 6 months and stayed relatively the same at 143% at 2 years. As predicted upon beginning the study, this lower-pole stretch was least for type I dissections (138%) and most for type III dissections (142%), but this difference was not statistically significant at 6 months. This finding is of utmost importance, as this information was the key objective of the study.

At 2 years, the difference was larger between type I (131%) and type III (146%) but was not significant because of the small sample size. It is curious that the differences in lower-pole stretch increase between the three groups were decreased from 2 weeks until 6 months, possibly raising a question of whether the dissection type has more of an intraoperative effect than a postoperative effect. Further comparison of intraoperative versus postoperative lower-pole stretch should be a goal of further research, since such knowledge would guide intraoperative decisions about the appropriate implant position/height before finishing a surgery. Regardless, in this study, the percentage of postoperative N:IMF stretch was shown to have a major effect on the final implant position by approximately doubling the amount of stretch caused by initial placement of the implant during surgery. This

Table 7. Average Change in N:IMF Distance over Time as a Function of Implant Style/Profile (Moderate Profile, Moderate-plus Profile, High Profile, or Ultrahigh Profile)

		2 wks	6 wks	6 mo	1 yr	2 yrs
MOD	n	8	6	8	2	0
	Avg (%)	117.20	126.10	137.10	NA	NA
	SD (%)	7.60	17.30	26	NA	NA
Mod Plus	n	82	100	94	18	6
	Avg (%)	113.90	122.30	138.60	137.00	141.50
	SD (%)	10.29	12.85	17.16	12.70	12.50
HP	n	123	123	75	23	2
	Avg (%)	115.60	126.70	138.60	140.00	146.90
	SD (%)	10.30	14.20	16.30	18.50	4.40
UHP	n	9	8	7	0	0
	Avg (%)	129.00	135.40	157.70	NA	NA
	SD (%)	13.10	11.10	31	NA	NA

HP, high profile; MOD, moderate profile; UHP, ultra-high profile.

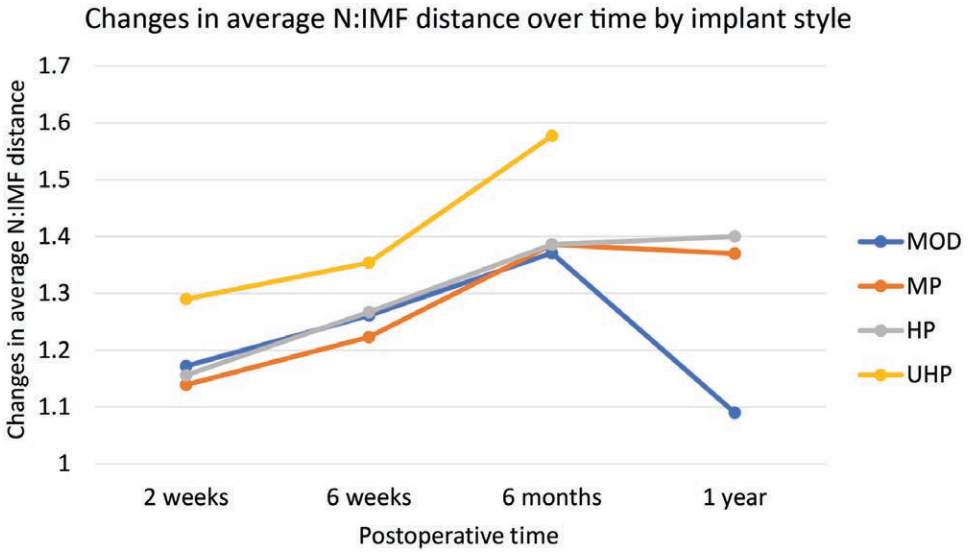

Fig. 8. Average change in N:IMF distance over time as a function of implant style/profile (moderate profile, moderate-plus profile, high profile, or ultrahigh profile).

Table 8. Mean, Median, and Mode of Implant Size (in cm³) by Implant Style/Profile (Moderate Profile, Moderate-plus Profile, High Profile, or Ultrahigh Profile)

Implant Profile	Moderate Profile	Moderate-plus Profile	High Profile	Ultrahigh Profile
Mean	343	379	408	450
Median	338	375	380	430
Mode	400	400	375	430

multiplies the importance of decisions affecting the balance between soft-tissue strength and compliance versus implant characteristics.

During the period of N:IMF measurements in the author's practice, it became clear that effects of patient variables collected in the raw data (beyond dissection type) presented useful data in and of themselves. It was for this reason that these variables were eventually reviewed independently although this had not been the original intent. This proved fruitful in demonstrating that age and implant material did not correlate with N:IMF increase.

Surprisingly, our data suggested that implant size did not correlate with lower-pole stretch (change in N:IMF postoperatively). In fact, when looking for a trend, the data demonstrated that the moderate range of implant sizes gave the largest stretch at each time point, suggesting no linear correlation at all. This is contrary to accepted thought and likely points to the lack of power in this study and the multiple confounding factors which make the evaluation of such an independent variable by direct linear regression less appropriate. Nonetheless, one can say that implant size alone was not a strong enough factor to have a visible effect above all of the other confounding variables.

In contrast, implant style was the only variable in the study which did predict an increase in N:IMF distance independently. Ultrahigh-profile implants did stretch the lower pole more than moderate profile, moderate-plus profile, or high-profile implants. This difference was consistent at 2 weeks, 6 weeks, and 6 months. These results were statistically significant at 6 months. This phenomenon has been previously attributed to soft-tissue thinning caused by greater pressure on the overlying soft tissue by a higher profile implant, which can be thought of as more weight per square inch of the lower old in axial section.[11,28,32] Of special note, long since the data collection for this study concluded, the author has noticed this increase in "bottoming out" of ultrahigh-profile implants to in fact be a concerning phenomenon which has since affected implant choice.

In summary, independent variable analysis showed that dual-plane dissection type correlated with lower-pole stretch (although not statistically significant), and implant style/profile did affect stretch significantly (for ultrahigh-profile implants versus other profiles). No other factor correlated with N:IMF increase, most notably implant size.

These findings must be viewed within the limitations of this study. Statistical significance related to trends found when comparing dual-plane dissection types would have been more likely with a larger study sample at each time point. Most importantly, large attrition of patients at later follow-up visits limited the ability to determine the long-term "natural history" of lower-pole stretch many years after surgery. More robust data could show much stronger trends (or an equally important lack thereof) or even statistical significance for many of the factors studied.

Another limitation of this study was its lack of consideration of the characteristics of the IMF itself. Histological characteristics of the IMF have been well characterized,[22–24, 33,34] but variations between patients in this histology translate to major clinical considerations.[16,35,36,38] Both loose and tight folds present unique challenges and the sequelae of underestimating this variable have been well documented.[3,16,17,21,28,35-37,39-40] This study did not include IMF tightness as an independent variable because no standard objective measurement of tightness of the IMF exists. Additionally, tuberous breast deformity patients were not included. There were patients who had type I constricted lower poles who likely were treated with Tebbetts type III dissections, but these data were not recorded. From the author's experience after reviewing these data and in the years after this study, it is suggested that lower-pole constrictions are best treated with high- or ultrahigh-profile implants and the use of a Tebbetts Type III dual-plane dissection plus scoring to the posterior breast tissue in the lower pole. Usually, the use of a compressive upper-pole elastic strap is preoperatively planned to further expand the lower pole by using the implant as an expander. This technique is also now used by the author for nulliparous patients with tight skin and a short N:IMF distance compared to the base width of the implant to prevent the postoperative appearance of a high-riding implant with a relatively low nipple.

Other variables likely affecting lower-pole stretch or its measurement include degree of stretching of the lower-pole skin applied when measurements are taken, the thickness of the lower-pole soft tissue, BMI, or a history of massive weight loss. Furthermore, lower-pole stretch might well be influenced by a history of pregnancy and/or breast feeding, since the breast tissue is already "prestretched." Such data were not recorded in this study. These characteristics provide more opportunity for future research.

In summary, this limited prospective longitudinal study of increase in N:IMF distance during the postoperative period in breast augmentation elucidated factors which do and do not seem to affect lower-pole stretch postoperatively. Although short of statistical significance in most comparisons (due to attrition in patient follow-up past 6 months), findings did show surprising trends or lack of trends for some variables. Dual-plane dissection type did show a trend in affecting lower-pole stretch. Ultrahigh-profile implants were statistically significant in causing greater postoperative lower-pole elongation. Review of these results demonstrates opportunities for future study to further clarify the importance of these and other variables, which is hoped to increase the science and decrease the ephemeral "art" of breast augmentation for practicing surgeons and for surgeons-in-training.

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