

Lateral and Inferior Implant Malposition in Prosthetic Breast Reconstruction: Incidence and Risk Factors

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Background: Implant malposition is one of the most common causes for revision after prosthetic breast reconstruction. There is a paucity of research on the incidence, etiology and risk factors for implant malposition in this setting.

Methods: Retrospective review of a single surgeon's prosthetic breast reconstructions was performed. Variables collected included age, BMI, radiation, chemotherapy, implant characteristics and malposition location (inferior or lateral). Binary logistic regression identified risk factors for malposition. Chi-square test assessed malposition rate as a function of implant volume to BMI subgroups.

Results: Of 836 breasts, 82 (9.8%) exhibited implant malposition. Risk factors for any malposition were older age (OR 1.05, 95% CI 1.02-1.07), BMI<25 (OR 1.64, 95% CI 1.00-2.70) and bilateral reconstruction (OR 13.41, 95% CI 8.50-21.16). Risk factors for inferior malposition were older age (OR 1.04, 95% CI 1.01-1.06), BMI<25 (OR 3.43, 95% CI 1.88-6.26) and bilateral reconstructions (OR 11.50, 95% CI 6.79-19.49), while risk factors for lateral malposition were only older age (OR 1.05, 95% CI 1.02-1.08) and bilateral reconstructions (OR 7.08, 95% CI 4.09-12.26). Post-mastectomy radiation was protective against lateral malposition (OR 0.30, 95% CI 0.10-0.88). Stratification by implant volume and BMI demonstrated patient subgroups with distinct patterns of malposition (incidence 0.0% versus 10.9%, $P = 0.001$).

Conclusions: This is the first study to identify risk factors for implant malposition after prosthetic breast reconstruction. Different risk factors contributed to malposition in different directions. The effect of implant size on malposition was mediated through BMI, highlighting the interplay of implant and patient characteristics with respect to malposition. (*Plast Reconstr Surg Glob Open* 2020;8:e2752; doi: 10.1097/GOX.0000000000002752; Published online 21 May 2020.)

INTRODUCTION

Implant malposition is the second most common reason for revisionary surgery after breast augmentation and is similarly one of the most common reasons for revisionary surgery after breast reconstruction.¹⁻³ It has been reported as high as 12% after primary breast augmentation and may be even higher after breast reconstruction

given larger dissections, loss of soft tissue support, and need for larger implants to replace the removed breast.⁴

Etiologies of implant malposition depend on a complex interplay of prosthesis properties, patient soft tissue anatomy, and surgeon dissection technique. Because of these various etiologies, a variety of surgical treatments have been proposed, each with their own proclaimed success. Suture capsulorrhaphy was one of the first described techniques by Spear and Little⁵ in the 1980s. The advent of biologic meshes brought acellular dermal matrices into play, which attempt to restore soft tissue structural support to the breast.^{6,7} More recently, creative approaches to correct malposition have been described, including the use of the shoelace breast cast and neo-pocket creation.⁸⁻¹⁰ Although all these techniques have been described, few studies have examined risk factors for implant malposition in the reconstructive population.

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Thus, we endeavored to answer 4 questions: (1) can we characterize the frequency and location of implant malposition in the breast reconstruction population? (2) what are the risk factors for implant malposition? (3) do risk factors differ with direction of malposition? and (4) how do implant and patient characteristics interact with each other to impact malposition risk?

METHODS

Patients and Data

After Institutional Review Board approval, a retrospective chart review was performed on patients who underwent consecutive 2-stage subpectoral breast reconstruction by the senior author between 2004 and 2016. Exclusion criteria included patients with autologous-only tissue reconstruction, prepectoral reconstruction, and direct-to-implant reconstruction.

Variables of interest included demographic, comorbid, and operative data. Specifically, we collected patient age at the time of breast reconstruction, body mass index (BMI), smoking status, history of hypertension or diabetes, history of breast irradiation, laterality of breast reconstruction, implant size, implant surface texture, direction of implant malposition (inferior or lateral), and last follow-up date. The direction of implant malposition was defined as the portion of the breast pocket requiring capsulorrhaphy, with inferior malposition requiring IMF capsulorrhaphy and lateral malposition requiring capsulorrhaphy lateral to the IMF. [Figure 1](#) demonstrates a patient with inferior and lateral malposition of the right breast implant.

Statistical Analysis

Descriptive statistical analysis, with results described by mean and SD, was performed. Univariate analysis and χ^2 tests were performed to compare demographics between patients with and without implant malposition. Binary logistic regression was performed to compare risk factors between cohorts. The application of a formula-based rule on implant size and BMI segmented the sample into several subgroups. χ^2 test was used to assess differences in malposition rates across these subgroups.

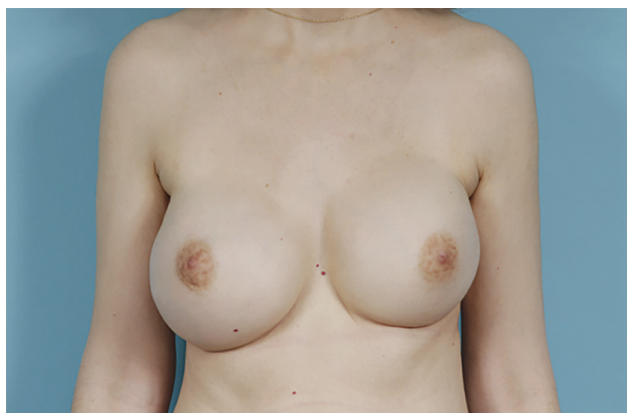


Fig. 1. Example of a patient who required correction for inferior and lateral implant malposition of the right breast.

Statistical significance was defined at a *P* value of <0.05 . All statistical analysis was carried out with SPSS version 22.0.0 (IBM).

RESULTS

Demographics

In total, 836 breasts were identified for analysis. The average age was 48.5 (SD, 10.7), average BMI was 26.4 (SD, 5.8), and 19.4% were current or former smokers. One hundred forty-six breasts (17.5%) had adjuvant radiation, and 319 breasts (38.2%) had adjuvant chemotherapy. Of the 836 breasts, 82 breasts (9.8%) exhibited implant malposition. Breasts with implant malposition were less likely to receive adjuvant radiation (7.3% versus 18.6%; $P = 0.01$), were more likely to be in bilateral reconstructions (64.6% versus 21.6%; $P < 0.001$), and had a higher average implant volume (525 versus 493 mL; $P = 0.05$). Demographics of breasts with and without malposition are reported in [Table 1](#). Patients with implant malposition had a significantly longer follow-up period than patients without implant malposition (38.3 versus 27.8 months; $P < 0.001$).

Of the breasts with implant malposition, 57 (69.5%) were inferior and 49 (59.8%) were lateral. Twenty-four breasts (29.3%) exhibited both inferior and lateral malpositions. Breasts with lateral malposition had significantly higher BMI (27.9 versus 25.2; $P = 0.02$) and were less likely to receive radiation (0% versus 10.5%; $P = 0.03$). Demographics of inferior and lateral malposition cohorts are reported in [Table 2](#).

Risk Factors for Implant Malposition

Older age [odds ratio (OR), 1.05; 95% CI, 1.02–1.07], BMI <25 (OR, 1.64; 95% CI, 1.00–2.70), and bilateral reconstruction (OR, 13.41; 95% CI, 8.50–21.16) were risk factors for any implant malposition. Fifty-seven breasts (69.5%) exhibited inferior malposition, and 49 breasts (59.8%) exhibited lateral malposition. Older age (OR, 1.04; 95% CI, 1.01–1.06), BMI <25 (OR, 3.43; 95% CI, 1.88–6.26), and bilateral reconstructions (OR, 11.50; 95% CI, 6.79–19.49) were risk factors for inferior malposition. Older age (OR, 1.05; 95% CI, 1.02–1.08) and bilateral reconstructions (OR, 7.08; 95% CI, 4.09–12.26) were risk factors for lateral malposition. Postmastectomy radiation was protective against lateral malposition (OR, 0.30; 95% CI, 0.10–0.88). BMI was not a risk factor for lateral malposition. Implant characteristics (surface texture and volume) also were not risk factors for any malposition. Risk factors for implant malposition are reported in [Table 3](#).

Implant Malposition as a Function of BMI and Implant Volume

We next compared implant malposition rates based on the ratio relationship of implant volume to BMI ([Fig. 2](#)). Breasts with high implant volume-to-BMI ratios were more likely to exhibit malposition. A formula was used to describe the relationship between implant volume and BMI with respect to malposition rates. When implant volume was within the range of $20 \times \text{BMI} - 300 \pm 100$ mL,

Table 1. Demographics of All Patients

	Total (n = 836)	Without Implant Malposition (n = 754)	With Implant Malposition (n = 82)	P
Age, mean (SD)	48.5 (10.7)	48.3 (10.7)	50.4 (10.1)	0.10
BMI, mean (SD)	26.4 (5.8)	26.5 (5.8)	26.1 (5.6)	0.61
Diabetes, n (%)	38 (4.5)	34 (4.5)	4 (4.9)	0.88
Hypertension, n (%)	143 (17.1)	129 (17.1)	14 (17.1)	0.99
Current or former smoker, n (%)	162 (19.4)	142 (18.8)	20 (24.4)	0.23
Adjuvant radiation, n (%)	146 (17.5)	140 (18.6)	6 (7.3)	0.01*
Adjuvant chemotherapy, n (%)	319 (38.2)	294 (39.0)	25 (30.5)	0.13
Bilateral mastectomy, n (%)	216 (25.8)	163 (21.6)	53 (64.6)	<0.001*
Textured implant, n (%)	255 (30.5)	234 (31.0)	21 (25.6)	0.31
Smooth implant, n (%)	581 (69.5)	520 (69.0)	61 (74.4)	—
Implant volume (mL)	493 (154)	490 (152)	525 (170)	0.05*

*P < 0.05.

Table 2. Demographics of Patients with Malposition

	Inferior Malposition (n = 57)	Lateral Malposition (n = 49)	P
Age, mean (SD)	50.3 (11.0)	51.7 (9.2)	0.49
BMI, mean (SD)	25.2 (5.2)	27.9 (5.8)	0.02*
Diabetes, n (%)	3 (5.9)	3 (6.1)	0.59
Hypertension, n (%)	11 (19.3)	8 (16.3)	0.80
Current or former smoker, n (%)	14 (24.6)	16 (32.7)	0.39
Adjuvant radiation, n (%)	6 (10.5)	0 (0)	0.03*
Adjuvant chemotherapy, n (%)	17 (29.8)	13 (26.5)	0.83
Bilateral mastectomy, n (%)	37 (64.9)	32 (65.3)	1.0
Textured implant, n (%)	15 (26.3)	11 (22.4)	0.66
Smooth implant, n (%)	42 (73.7)	38 (77.6)	0.66
Implant volume (mL)	518 (156)	572 (179)	0.10

*P < 0.05.

Table 3. Risk Factors for Implant Malposition

	Any Malposition (n = 82), OR (95% CI)	Inferior Malposition (n = 57), OR (95% CI)	Lateral Malposition (n = 49), OR (95% CI)
Age	1.05 (1.02–1.07)*	1.04 (1.01–1.06)*	1.05 (1.02–1.08)*
BMI <25	1.64 (1.00–2.70)*	3.43 (1.88–6.26)*	0.57 (0.30–1.07)
Diabetes	1.32 (0.45–3.89)	1.54 (0.44–5.41)	1.34 (0.40–4.47)
Hypertension	0.74 (0.41–1.36)	0.87 (0.43–1.76)	0.67 (0.32–1.39)
Current or former smoker	1.15 (0.69–1.93)	1.45 (0.81–2.57)	1.33 (0.71–2.47)
Postmastectomy radiation	0.64 (0.34–1.23)	0.97 (0.248–1.99)	0.30 (0.10–0.88)*
Chemotherapy	1.35 (0.83–2.18)	1.230 (0.74–2.27)	0.96 (0.653–1.73)
Bilateral reconstruction	13.41 (8.50–21.16)*	11.50 (6.79–19.49)*	7.08 (4.09–12.26)*
Implant surface texturing	0.83 (0.50–1.39)	0.82 (0.46–1.47)	0.89 (0.46–1.72)
Implant volume (mL)	1.00 (0.99–1.00)	1.00 (0.99–1.00)	1.00 (0.99–1.00)

*P < 0.05.

delineated by “Zone 1” in Figure 2, the incidence of malposition was significantly lower versus the rest of the sample (0.0% versus 10.9%; P = 0.001). A minority of breasts (n = 84, 10%) were captured in zone 1. Continued stratification by parallel thresholds at intervals of 200 mL (ie, “Zone 2” and “Zone 3”) demonstrated a statistically significant stepwise increase in malposition incidence as implant volume increased relative to BMI (0.0%, 9.1%, and 12.8% in zones 1, 2, and 3, respectively; P = 0.003). A small number of cases (n = 10, 1%) fell into an “Indeterminate Zone”—which captured cases with small implant volumes relative to BMI—in which 2 cases of malposition (20%) were observed.

DISCUSSION

Implant malposition after prosthetic breast reconstruction leads to asymmetries, patient dissatisfaction, and ultimately the need for revisionary surgery after breast reconstruction. It has been reported as high as 12% at 10-year follow-up after primary breast augmentation. It

has been hypothesized that rates of malposition may be even higher in breast reconstruction.¹¹ We performed a single-surgeon series analysis on the rate of and risk factors leading to implant malposition in prosthetic breast reconstruction.

In the 836 breast reconstructions followed for an average of 3 years in this study, 9.8% exhibited malposition requiring revision surgery, comparable to rates of malposition reported in breast augmentation. We identified 3 significant risk factors for implant malposition in any direction: older age, lower BMI, and bilateral reconstructions. Considering these risk factors, we can develop a clinicopathologic rationale for the etiology of implant malposition. With implant placement, capsule formation starts almost immediately with the influx of inflammatory cells; however, we can assume that the structural integrity of this capsule will vary and depend on a calculus of implant characteristics and characteristics of the patient’s own biology.¹² We know the soft tissue changes with age, with thinning of the dermis, and a decrease in

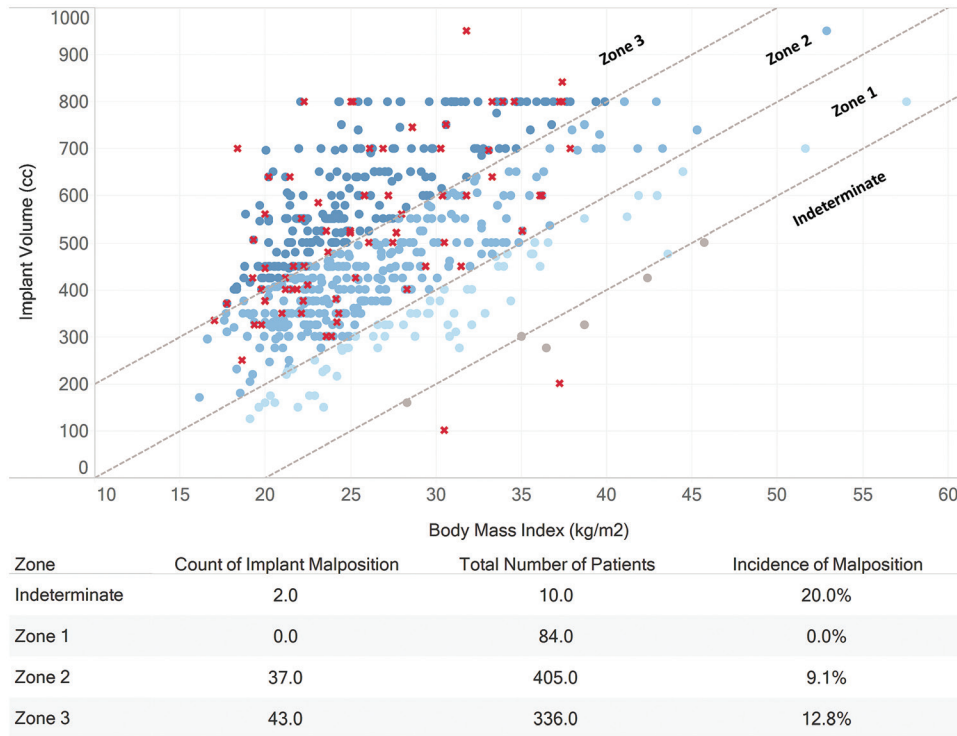


Fig. 2. Stratification of cases by implant volume and BMI. Zone 1 captures patients whose implant volumes are within $20 \times \text{BMI} - 300 \pm 100$ mL. Zone 2 captures the next larger 200 mL interval, and zone 3 captures all patients with implants even larger. The indeterminate zone captures patients with implants smaller than those in zone 1. Red “x” indicates patients who experienced malposition requiring revisionary surgery. The rate of malposition varied significantly across zones ($P = 0.003$).

collagen production.^{13,14} This may, in turn, contribute to weaker structure formation to support the weight of the implant in older patients, explaining the difference we see in malposition by patient age. Similarly, patients with lower BMIs may have weaker soft tissue structural support to overcome factors such as the weight of the implant and pectoralis muscle activation, increasing the risk of malposition in this cohort. Bilateral reconstructions may be a risk factor for malposition simply on the basis that it is not possible to perform a matching procedure on the contralateral breast, making any slight asymmetries between implants more apparent and, therefore, prone to revisionary impetus.

Risk factors for malposition varied depending on the location of the malposition. BMI <25 was a risk factor for inferior but not lateral malposition, whereas postmastectomy radiation was protective against lateral but not inferior malposition. Going back to capsule formation and structural support, lower BMI patients likely have less inferior soft tissue to counteract the pull of gravity and the push of the pectoralis on the implant, leading to inferior malposition. Univariate analysis showed that breasts with lateral malposition had higher BMI than those with inferior malposition (27.9 versus 25.2; $P = 0.02$). Higher BMI patients frequently have a larger volume of breast tissue laterally with larger dissection pockets after mastectomy, which likely contributes to the propensity for the implant to move laterally in this group of patients. Notably, the

senior author frequently performs prophylactic lateral capsulorrhaphy at the time of tissue expander to implant exchange in larger BMI patients with significant lateral dead space. This may explain why larger BMI was not a risk factor for lateral malposition on logistic regression despite the higher BMI seen in patients with lateral malposition. Interestingly, postmastectomy radiation was actually a protective factor against lateral malposition. Knowing radiation causes fibrosis, we can presume that this finding relates to radiation side effects leading to lateral soft tissue contracture which tightens the implant pocket.^{15,16}

Although implant volume was associated with malposition on univariate analysis, it was not an independent risk factor. In cosmetic breast augmentation, larger implant volume was associated with higher revision rates, which we would expect to similarly play out in the reconstruction population.¹⁷ However, the patient’s biology and the surgical technique were probably more important for avoiding malposition than the actual weight of the implant. Given that the risk of malposition likely depends on an interplay between implant characteristics and factors intrinsic to the patient’s biology, we further delved into the risk of implant malposition based on the relationship of implant volume to BMI. On a plot of implant volume versus BMI, we identified linear zones (Fig. 2) that demonstrated a significantly increased rate of malposition as implant volume increases relative to BMI (0.0%, 9.1%, and 12.8% in zones 1, 2, and 3, respectively; $P = 0.003$). In fact, there

was no occurrence of malposition among zone 1 patients, whose implant sizes were close to $20 \times \text{BMI} - 300$ (eg, a woman with a BMI of 25 receiving 200 mL implants). However, this described a minority of patients. Most patients received larger implants due to understandable factors such as matching the reconstructed breast to the contralateral breast, pocket size and filling dead space, and surgeon or patient preferences. We do not advocate that all breast reconstructions should fit into zone 1, but simply note that this observation highlights the interplay of implant and patient factors leading to malposition.

We found that lower implant volume-to-BMI ratios may also be associated with higher rates of malposition (Fig. 2), but we had too few observations to draw firm conclusions about patients falling into this indeterminate zone. Interestingly, a study looking at breast striae after augmentation similarly found that the risk of striae was higher in underweight women with larger implants, *but also* in overweight women with smaller implants.¹⁸ Thus, this seems to indicate a problem with implant to breast tissue volume match rather than solely a problem of overwhelming implant volume. Although lower implant volumes are not a risk factor for revision or reoperation in cosmetic augmentation, after breast reconstruction, the goal is to adequately fill an empty space. If the volume is inadequate, this leaves room in the breast pocket for the implant to shift, likely explaining the higher malposition rates in breasts with low implant volume-to-BMI ratios.

Surprisingly, implant surface texture is not a risk factor for malposition. It is possible that implant surface texture can both negatively and positively affect the likelihood of the implant to shift in its pocket, and these factors ultimately cancel out. For instance, smooth implants are prone to micromotion, which in theory could prevent precise healing of the breast pocket margins. Alternatively, textured implants are more prone to periprosthetic fluid collections which may, in turn, create inadvertent expansion of the breast pocket.¹⁹⁻²¹

Limitations of this study include its retrospective nature and inclusion of only patients with subpectoral breast reconstruction. Given the renewed interest in prepectoral breast reconstruction, future work should determine if risk factors for implant malposition differ with subpectoral and prepectoral implant placement.

CONCLUSIONS

This study characterizes implant malposition in the breast reconstruction population and is the first study to identify risk factors for malposition in this population, with an emphasis on how risk factors vary by malposition location. Implant malposition is common, occurring in almost 10% of patients. Risk factors for malposition vary by location, with lower BMI being a risk for inferior malposition, whereas postmastectomy radiation is protective against lateral malposition. Considering the interplay of implant and patient factors, a low incidence of malposition zone is identified by implant volume-to-BMI ratios. In summary, the risk of implant malposition is dependent on a multitude of implant, patient, and comorbid factors.

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