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Implant Undersizing Increases Capsular Contracture Risk After Immediate Breast Reconstruction

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Abstract

Purpose

- **To identify clinical, surgical, and treatment-related predictors of capsular contracture (CC) after immediate implant-based breast reconstruction, focusing on implant size relative to mastectomy weight.**

Results

- Implant undersizing <80% of mastectomy weight independently increased CC risk (OR 2.35, P = 0.048).
- Subpectoral pocket placement (OR 4.15, P = 0.008) and postmastectomy radiotherapy (OR 4.99, P < 0.001) were additional independent predictors identified in multivariable analysis.
- Sensitivity analysis using a data-driven threshold (69.1%) confirmed robustness of the <80% cutoff.

Conclusion

- Implant undersizing <80% of mastectomy weight, subpectoral placement, and PMRT independently increased CC risk.
- Quantifying implant size relative to breast weight may assist in surgical planning and risk stratification for implant-based reconstruction.

Introduction

- Implant-based reconstruction is now the most common method after mastectomy.2
- Capsular contracture (CC) remains the most significant complication, occurring in 10–15% and often leading to implant failure (3, 4).
- Reported risk factors include postmastectomy radiotherapy (PMRT), infection, seroma, hematoma, and implant characteristics such as texture and pocket plane (5).
- The effect of implant size relative to breast volume remains unclear; augmentation studies implicate larger implants (6–8), but reconstructive data are limited.
- This study examined whether implant undersizing increases CC risk and identified other clinical and surgical predictors to optimize reconstructive outcomes.

Methods and Materials

- **Design**: Retrospective single-center study of patients who underwent immediate implant-based breast reconstruction after nipple- or skin-sparing mastectomy for breast malignancy (2004–2020).
- **Inclusion criteria**: Direct-to-implant (DTI) or two-stage tissue expander–implant (TEI) reconstruction.
- **Exclusion**: Autologous or prophylactic mastectomy, nipple/skin invasion, or <2-year follow-up.
- **Definitions:**
- **Capsular contracture (CC):** Baker grade ≥ II on exam or imaging.
- **Implant-to-breast ratio =**
  (Implant volume ÷ mastectomy specimen weight) × 100.
- **Cutoff selection:** Restricted cubic spline modeling and quartile-based sensitivity analysis were performed to explore the relationship between implant-to-breast ratio and CC risk and to define clinical cutoff categories (80% and 120%).
- **Primary outcome**: Clinically significant CC (Baker grade ≥ II).

Results

- CC rate; **10.8%** (50/415 cases)
- Median follow-up: 63.7 months

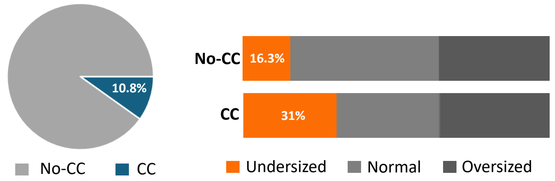


Figure 1. Capsular contracture rate and implant sizing distribution

- Spline modeling showed a U-shaped association between implant-to-breast ratio and CC risk, lowest near 110%.
- Undersizing <80% sharply increased CC risk, while oversizing ≥120% did not.
- Quartile analysis (85.9%, 160.8%) confirmed the validity of the 80–120% clinical categories.

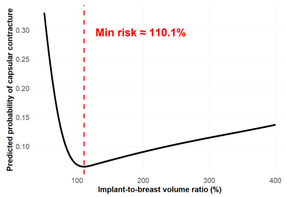


Figure 1. Restricted Cubic Spline for CC Risk

Table 1. Sensitivity analysis of cutpoint categories and CC risk

	OR	95% CI		*P*
85.9%~, <160.8% (Q2~3)	Ref			
<85.9% (<Q1)	2.17	1.03	4.59	0.040
160.8% ~ (Q4<)	1.26	0.53	2.87	0.580
80%~, <120%	Ref			
<80%	2.72	1.19	6.17	0.016
120%~	1.42	0.66	3.08	0.372

[1]CI= confidence interval; OR= odds ratio.

- Multivariable analyses revealed independent risk factors:
  Implant undersizing (<80%), subpectoral pocket, PMRT

Table 2. Independent predictors of CC

	Univariable analysis				Multivariable analysis			
	OR	95% CI		P	OR	95% CI		P
Breast surgery								
NSM	Ref							
SSM	2.20	1.15	4.20	0.017				
Reconstruction type								
DTI	Ref							
TEI	2.29	0.99	5.32	0.054				
Prior augmentation								
No	Ref							
Yes	0.86	0.34	2.13	0.740				
Implant shape								
Round	Ref							
Anatomical	1.44	0.75	2.75	0.275				
Implant texture								
Smooth	Ref							
Textured	0.99	0.52	1.88	0.977				
Implant size (vs. breast size)								
80-120%	Ref				Ref			
<80%	2.72	1.21	6.13	0.016	2.34	1.00	5.49	0.048
120%~	1.42	0.66	3.04	0.372	1.42	0.64	3.16	0.380
Implant pocket location								
Prepectoral	Ref				Ref			
Subpectoral	2.66	1.01	6.98	0.047	4.15	1.57	13.31	0.008
PMRT								
Not done	Ref				Ref			
Done	3.27	1.62	6.57	0.001	4.99	2.28	10.82	<0.001

[1]CI= confidence interval; OR= odds ratio.

- The association between implant undersizing (≤69.1%) and CC persisted after stepwise adjustment.
- Capsular contracture did not affect recurrence-free or overall survival.

Table 2. Adjusted models confirming robustness of undersizing effect

Variables	Adjusted OR (95% CI)	*P*
Implant size (69.1%~ vs. <69.1)	4.17 (1.89 - 9.20)	<0.001
Adjusted for		
PMRT	4.54 (4.95 - 10.16)	<0.001
Implant pocket location	3.71 (1.62 - 8.13)	0.001
PMRT + implant pocket location	3.79 (1.60 - 8.64)	0.002
PMRT + implant pocket location + breast surgery	3.46 (1.40 - 8.22)	0.006
PMRT + implant pocket location + breast surgery + reconstruction type	3.46 (1.40 - 8.22)	0.006

[1]CI= confidence interval; OR= odds ratio.

Discussion

- Implant undersizing (<80%) independently increased the risk of CC.
- Subpectoral placement and PMRT were additional independent predictors.
- Oversizing (≥120%) did not increase CC risk, suggesting that insufficient implant fill rather than overexpansion drives contracture.
- Mechanical tension imbalance and capsular fibrosis may underlie higher CC risk with undersized implants.
- Quantifying implant-to-breast ratio provides an objective metric for surgical planning and risk stratification.

Conclusions

- Implant undersizing (<80%), subpectoral placement, and PMRT independently increase CC risk.
- Oversizing (≥120%) does not contribute additional risk, highlighting the importance of balanced implant sizing.
- Maintaining an implant-to-breast ratio between 80–120% may reduce contracture without compromising aesthetics or safety.
- Quantitative assessment of implant sizing can support individualized surgical planning in implant-based reconstruction.

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