

# Comparative Analysis of Prepectoral versus Subpectoral Implant-based Breast Reconstruction

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**Background:** Recent advances in mastectomy and reconstruction have allowed for an evolution in implant-based breast reconstruction to a muscle-sparing, prepectoral approach. Advantages of this technique may include reductions in postoperative pain, shorter hospitalization, less narcotic usage, and improved aesthetic outcomes. Postoperative complication rates are described as comparable to subpectoral techniques; however, little comparative data exist to adequately assess prepectoral versus subpectoral implant placement.

**Methods:** To address this knowledge gap, we performed a single institution retrospective review of 186 (83 prepectoral, 103 subpectoral) consecutive immediate breast reconstructions. All cases were tracked for a minimum of 2 years between 2016 and 2021.

**Results:** Prepectoral patients demonstrated an overall higher seroma rate ( $P = 0.001$ ), with all other postoperative complications being comparable. Prepectoral patients tolerated higher intraoperative tissue expander fill volumes ( $P < 0.001$ ), shorter hospital stays ( $P = 0.007$ ), fewer clinic visits for tissue expansion ( $P < 0.001$ ), and experienced less animation deformity ( $P = 0.005$ ). Both groups demonstrated similar pain scores ( $P = 0.65$ ) and needs for narcotics ( $P = 0.8$ ) as well as comparable scores of capsular contracture ( $P = 0.791$ ).

**Conclusions:** Our comparative analysis of consecutive immediate implant-based breast reconstructions finds prepectoral reconstruction to be safe and effective. Compared with subpectoral reconstruction, the prepectoral approach may offer quicker tissue expansion, less postoperative office visits, less need for muscle relaxants, and a shorter hospital stay with a comparable complication profile. (*Plast Reconstr Surg Glob Open* 2021;9:e3709; doi: [10.1097/GOX.0000000000003709](https://doi.org/10.1097/GOX.0000000000003709); Published online 27 July 2021.)

## INTRODUCTION

Over the last 20 years, the number of breast reconstructions performed in the United States has increased nearly 30%, with the vast majority being implant-based.<sup>1</sup> Implants were initially placed subcutaneously in the 1960s and 1970s.<sup>2</sup> However, this technique was abandoned in favor of total submuscular coverage due to issues with the overlying soft tissue that led to implant visibility, rippling, exposure, and capsular contracture.<sup>3,4</sup> Submuscular implant placement ameliorated many of these issues but

unfortunately created a new set of problems—including animation deformity, chest tightness, muscle spasm, and inadequate lower pole projection.<sup>5,6</sup> In response, the acellular dermal matrix (ADM) sling was introduced<sup>7</sup> to allow greater lower pole expansion and address the aforementioned issues with subcutaneous implant placement.<sup>8,9</sup> Despite these improvements, issues with animation deformity, chest discomfort, and pectoralis window-shading remain a significant problem for patients undergoing subpectoral reconstructions.

Technological advancements in tissue expander and implant design, acellular dermal matrices, fat grafting, and the ability to quantify mastectomy flap perfusion intraoperatively have allowed implant-based reconstruction to return to the prepectoral space using ADM coverage.<sup>10</sup> A significant advantage of prepectoral implant placement is the ability to avoid pectoralis elevation, which has obvious benefits in terms of animation deformity and chest discomfort. Other purported benefits include reductions in postoperative pain, less narcotic usage, shorter

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hospital stays, quicker expansion times, and improved aesthetic outcomes.<sup>11-18</sup> Postoperative complication rates for prepectoral and subpectoral breast reconstructions are reportedly similar; however, little comparative data exist.<sup>13,19,20</sup> The aim of the present study was to directly compare surgical outcomes between prepectoral and subpectoral breast reconstruction in consecutive patients at a single institution.

## METHODS

### Patient Data Collection

This study was approved by the institutional review board. The study was conducted as a retrospective review of 186 (83 prepectoral, 103 subpectoral) consecutive patients who underwent immediate tissue expander or permanent implant breast reconstruction following therapeutic or prophylactic mastectomy between September 2016 and March 2019. Charts were reviewed for a minimum of 2 years following the initial operation to obtain relevant demographic data, procedure characteristics, and postoperative complication rates.

Postoperative complications were categorized as either major or minor. Major complications were those requiring admission to the hospital and/or return to the operating room and included hematomas, infections requiring IV antibiotics or surgical intervention, mastectomy skin necrosis requiring surgical intervention, implant/tissue expander exposure, and total loss of reconstruction. Minor complications were those managed as outpatient and included seromas drained in the outpatient clinic, minor wound dehiscence, mastectomy skin necrosis managed with local wound care, and any infection effectively treated with oral antibiotics. Additional outcome measures included length of hospital stay, number of required TE fill visits, time to drain removal (days), hospital readmissions, number of surgical revisions, including fat grafting procedures and total volume of grafted fat (ml).

Postoperative pain was quantified through documented pain scores using a 10-point scale, prescriptions for muscle relaxants, and narcotic use.

### Operative Technique

Subpectoral reconstructions were performed via a partial muscle coverage technique using ADM (Alloderm LifeCell, Branchburg, N.J.) for coverage of the lower pole. Prepectoral reconstructions were performed in the subcutaneous pocket with complete ADM coverage, anterior ADM coverage, or without ADM depending on quality of native tissue coverage and surgeon preference. The decision to proceed with a direct-to-permanent implant reconstruction versus a tissue expander was based on the surgeon's clinical assessment. Flap viability was assessed with SPY angiography (Stryker, Kalamazoo, Mich.). Preoperative antibiotics were administered according to surgical care improvement project guidelines.

### Statistical Analysis

Comparisons between subpectoral and prepectoral groups were performed via chi-squared tests for categorical data and two-tailed *t*-tests for continuous variables. Variables with smaller frequencies necessitated the use of Fisher exact tests. For bilateral procedures the mastectomy weights, intraoperative TE fill volumes, and volume of fat grafting was averaged between the left and right breasts. Logistical regression modeling was performed to investigate potential covariates between outcomes of interest. All analyses were performed using SAS V9.4 (SAS Institute, Cary, N.C.).

## RESULTS

Comparison of patient demographic data is shown in [Table 1](#). Although all charts were followed for a minimum of 2 years, the prepectoral cohort had a shorter length of follow-up when considering the last documented encounter addressing their reconstruction compared with

**Table 1. Patient Characteristics**

Characteristic	Prepectoral (%) N = 83	Subpectoral (%) N = 103	P	Total (%) N = 186
No. reconstructions	83	103		186
Mean age ± SD, y	47.88 ± 11.90	49.90 ± 12.46	0.263	49.00 ± 12.22
Mean length of follow-up, mo	15.59 ± 8.98	21.39 ± 12.00	<0.001*	18.80 ± 11.11
Mean BMI	28.12 ± 6.41	26.14 ± 5.40	0.023*	27.03 ± 5.94
Race				
White	67 (80.7%)	92 (89.3%)	0.098	159 (85.5%)
Non-White	16 (19.3%)	11 (10.7%)		27 (14.5%)
Cancer stage				
0	15 (18.1%)	17 (16.5%)	0.206	32 (17.2%)
1	35 (42.2%)	30 (29.1%)		65 (34.9%)
2	20 (24.1%)	40 (38.8%)		60 (32.3%)
3	6 (7.2%)	5 (4.9%)		11 (5.9%)
4	2 (2.4%)	1 (1.0%)		3 (1.6%)
Prophylactic	5 (6.0%)	10 (9.7%)		15 (8.1%)
Chemotherapy				
Neoadjuvant (± adjuvant)	24 (28.9%)	28 (27.2%)	0.927	52 (28.0%)
Adjuvant	13 (15.7%)	15 (14.6%)		28 (15.1%)
Radiation	17 (20.5%)	31 (30.1%)	0.136	48 (25.8%)
Diabetes	2 (2.4%)	4 (3.9%)	0.693	6 (3.2%)
Smoking				
Never	63 (75.9%)	72 (69.9%)	0.362	135 (72.6%)
Past or present	20 (24.1%)	31 (30.1%)		51 (27.4%)

\*Statistically significant.

subpectoral cases (15.59 versus 21.39 months;  $P < 0.001$ ) given that it was the newer technique. Preoperative body mass index (BMI) was higher in the prepectoral group (28.12 versus 26.14;  $P = 0.023$ ). All other demographics were comparable.

Procedure characteristics were also studied (Table 2). We noted a significant difference in mean mastectomy weight (prepectoral 559.6g versus subpectoral 428.4g;  $P = 0.003$ ), which is consistent with the higher BMI of the cohort. Intraoperative fill volume (prepectoral 348.6ml versus subpectoral 234.8ml;  $P < 0.001$ ), and intraoperative fill volume as a percent of final fill volume (prepectoral 67.2 versus subpectoral 53.3;  $P < 0.001$ ) were significantly higher in the prepectoral group.

We observed no significant differences in the rates of major complications between the two groups (Table 3). Patients having undergone prepectoral reconstructions were significantly more likely to experience a minor complication (prepectoral 21.7% versus subpectoral 7.8%;  $P = 0.006$ ) most commonly a postoperative seroma (prepectoral 20.5% versus subpectoral 4.9%;  $P = 0.001$ ). Logistic regression modeling demonstrated neither BMI, mastectomy weight, nor ADM usage as independent predictors of postoperative seroma.

The prepectoral group was more likely to be discharged from the hospital within 23 hours (outpatient) versus an inpatient admission (prepectoral 49.4% versus subpectoral 30.1%;  $P = 0.007$ ) (Table 4). Postoperatively, the prepectoral group required significantly fewer clinic visits to reach goal tissue expander volume (prepectoral 2.04 days versus subpectoral 3.34 days;  $P < 0.001$ ). The groups had differing numbers of total surgical revisions ( $P = 0.017$ ); however, the number of fat grafting procedures performed ( $P = 0.163$ ) and the volume of fat grafted between the two groups ( $P = 0.476$ ) were similar. The prepectoral group experienced less animation deformity ( $P = 0.005$ ). Both cohorts received similar Baker scores for capsular contracture ( $P = 0.791$ ).

Prepectoral and subpectoral reconstructions demonstrated similar pain scores as well as postoperative narcotic needs (Table 5). Patients who underwent subpectoral

implant placement required significantly more prescriptions for muscle relaxants ( $P < 0.001$ ).

## DISCUSSION

This comparative study demonstrates no significant difference in major complications or reconstructive failure between prepectoral and subpectoral immediate implant-based breast reconstruction. This observation is consistent with the published literature.<sup>19–21</sup> A key, but not novel, finding in our study was the higher incidence of minor complications attributed to the increased seroma rate in the prepectoral group.<sup>22–24</sup> In the subpectoral plane, the implant is physically supported by the tight pectoralis muscle anteriorly and the mastectomy skin flap is allowed to adhere and vascularize to the underlying soft tissue. In prepectoral reconstruction the implant and/or ADM create a barrier between the mastectomy flap and the underlying pectoralis muscle, forming a space for fluid to easily accumulate. Importantly, our multivariate analysis dismissed a causal relationship between higher BMI, mastectomy weight, and ADM usage with seroma rates in the prepectoral group. This suggests the higher seroma rates were due, in fact, to the implant location in the prepectoral space and not the higher BMI/mastectomy weight of the prepectoral cohort or use of an ADM. Despite the increased seroma rate in prepectoral reconstructions, no difference was observed in the rate of implant infection or reconstructive failure, with the majority treated in the office with aspiration. Since this study was undertaken, we have developed new postoperative protocols that include incisional wounds vacs, surgical tape bras, and restricted range of motion in an attempt to decrease the seroma rate.

A purported advantage of prepectoral implant placement is higher intraoperative TE fill volumes and fewer clinic visits to reach goal expander volume.<sup>15,19</sup> Our prepectoral patients tolerated significantly larger intraoperative fill volumes and the intraoperative fill represented a larger percentage of the goal fill volume. This increased efficiency translated to fewer clinic visits to reach goal expander volume. Fewer TE fills present several potential

**Table 2. Procedure Characteristics**

Characteristic	Prepectoral (%) N = 83	Subpectoral (%) N = 103	P	Total (%) N = 186
Laterality				
Unilateral	37 (44.6%)	52 (50.5%)	0.423	89 (47.8%)
Bilateral	46 (55.4%)	51 (49.5%)		97 (52.2%)
Surgery type				
Immediate TE	57 (68.7%)	81 (78.6%)	0.123	138 (74.2%)
Immediate implant	26 (31.3%)	22 (21.4%)		48 (25.8%)
Total surgery time (min)	335.10 ± 72.54	331.37 ± 75.42	0.743	333.16 ± 73.86
ADM usage				
Yes	58 (69.9%)	93 (90.3%)	<0.001*	151 (81.2%)
No	25 (30.1%)	10 (9.7%)		35 (18.8%)
Mean mastectomy weight (g)	559.61 ± 346.75	428.49 ± 237.31	0.003*	487.00 ± 297.68
Missing**	26	22		48
Intraoperative TE fill (ml)	348.68 ± 200.19	234.81 ± 127.00	<0.001*	281.85 ± 170.19
as % of final fill volume	67.26 ± 23.76	53.33 ± 22.32	<0.001*	58.59 ± 24.01
Missing**	31	31		62

\*Statistically significant.

\*\*Indicates the number missing from sample size indicated in the table header.

**Table 3. Postoperative Complications**

Characteristic	Prepectoral (%) N = 83	Subpectoral (%) [N = 103]	P	Total (%) N = 186
Any complication				
Yes	38 (45.8%)	36 (35.0%)	0.134	74 (39.8%)
No	45 (54.2%)	67 (65.0%)		112 (60.2%)
Major complication				
Yes	25 (30.1%)	31 (30.1%)	0.997	56 (30.1%)
No	58 (69.9%)	72 (69.9%)		130 (69.9%)
Minor complication				
Yes	18 (21.7%)	8 (7.8%)	0.006*	26 (14.0%)
No	65 (78.3%)	95 (92.2%)		160 (86.0%)
Infection				
Yes	19 (22.9%)	25 (24.3%)	0.826	44 (23.7%)
No	64 (77.1%)	78 (75.7%)		141 (76.3%)
Infection treatment				
Surgery	14 (73.7%)	19 (76.0%)	1.000	33 (75.0%)
Oral antibiotics	1 (5.3%)	2 (8.0%)		3 (6.8%)
IV antibiotics	4 (21.1%)	4 (16.0%)		8 (18.2%)
Mastectomy skin necrosis				
Inpatient	5 (6.0%)	2 (1.9%)	0.245	7 (3.8%)
Outpatient	0 (0.0%)	1 (1.0%)		1 (0.5%)
None	78 (94.0%)	100 (97.1%)		178 (95.7%)
Seroma				
Yes	17 (20.5%)	5 (4.9%)	0.001*	22 (11.8%)
No	66 (79.5%)	98 (95.1%)		164 (88.2%)
Loss of TE/implant†				
Yes	11 (13.3%)	22 (21.4%)	0.150	33 (17.7%)
No	72 (86.7%)	81 (78.6%)		153 (82.3%)
Hematoma				
Yes	4 (4.8%)	5 (4.9%)	1.000	9 (4.8%)
No	79 (95.2%)	98 (95.1%)		177 (95.2%)
Implant exposure				
Yes	1 (1.2%)	2 (1.9%)	1.000	3 (1.6%)
No	82 (98.8%)	101 (98.1%)		183 (98.4%)
Wound dehiscence				
Yes	3 (3.6%)	0 (0.0%)	0.087	3 (1.6%)
No	80 (96.4%)	103 (100.0%)		183 (98.4%)
Animation deformity				
Yes	1 (1.2%)	12 (11.7%)	0.005*	13 (7.0%)
No	82 (98.8%)	91 (88.3%)		173 (93.0%)
Capsular contracture				
Baker grade 2	16 (19.3%)	20 (19.4%)	0.791	36 (19.4%)
Baker grade 3	5 (6.0%)	7 (6.8%)		12 (6.5%)
Baker grade 4	4 (4.8%)	3 (2.9%)		7 (3.8%)

\*Statistically significant.

†Loss of TE/implant means the device was removed and not replaced or removed and replaced due to a complication.

**Table 4. Operative Outcomes**

Characteristic	Prepectoral (%) N = 83	Subpectoral (%) N = 103	P	Total (%) N = 186
Mean no. clinic visits for TE expansion ± SD	2.04 ± 1.49	3.34 ± 1.40	<0.001*	2.78 ± 1.57
Missing	27	29		56
Mean time to drain removal (d) ± SD	26.90 ± 11.66	26.24 ± 10.84	0.702	26.54 ± 11.19
Missing**	5	10		15
Mean no. hospital readmissions ± SD	0.51 ± 1.03	0.46 ± 0.80	0.583	0.49 ± 0.91
Type of hospitalization				
Inpatient	42 (50.6%)	72 (69.9%)	0.007*	114 (61.3%)
Outpatient	41 (49.4%)	31 (30.1%)	0.007*	72 (38.7%)
No. surgical revisions				
0	18 (21.7%)	30 (29.1%)	0.017*	48 (25.8%)
1	56 (67.5%)	49 (47.6%)		105 (56.5%)
2	9 (10.8%)	20 (19.4%)		29 (15.6%)
>2	0 (0.0%)	4 (3.9%)		4 (2.2%)
No. fat grafting procedures				
0	44 (53.0%)	60 (58.3%)	0.163	104 (55.9%)
1	33 (39.8%)	29 (28.2%)		62 (33.3%)
2	6 (7.2%)	11 (10.7%)		17 (9.1%)
>2	0 (0.0%)	3 (2.9%)		3 (1.6%)
Mean (ml) fat grafted ± SD	103.37 ± 61.25	113.93 ± 71.15	0.476	108.91 ± 66.43
Missing**	44	60		104

\*Statistically significant.

\*\*Indicates the number missing from sample size indicated in the table header.

**Table 5. Pain Scores**

Characteristic	Prepectoral (%) N = 83	Subpectoral (%) N = 103	P	Total (%) N = 186
Mean baseline pain score ± SD	0.43 ± 1.34	0.40 ± 1.30	0.870	0.42 ± 1.31
Missing**	0	1		1
Mean POD1 pain score ± SD	4.65 ± 1.68	4.44 ± 2.19	0.649	4.60 ± 1.81
Missing**	20	83		103
Mean clinic visit #1 pain score ± SD	3.32 ± 3.07	2.80 ± 2.63	0.220	3.03 ± 2.84
Missing**	2	4		6
Mean clinic visit #2 pain score ± SD	2.19 ± 2.45	2.36 ± 2.63	0.685	2.28 ± 2.54
Missing**	6	13		19
Prescriptions for muscle relaxants				
0	71 (86.6%)	14 (13.7%)	<0.001*	85 (46.2%)
1	9 (11.0%)	69 (67.6%)		78 (42.4%)
>1	2 (2.4%)	19 (18.6%)		21 (11.4%)
Prescriptions for narcotics				
1	67 (81.7%)	84 (83.2%)	0.796	151 (82.5%)
>1	15 (18.3%)	17 (16.8%)		32 (17.5%)

\*Statistically significant.

\*\*Indicates the number missing from sample size indicated in the table header. POD1, postoperative day 1.

benefits, including a theoretical decrease in the risk of infection as you are accessing the device less, and fewer clinic visits making the reconstructive process more convenient for patients.

Proponents of subpectoral reconstruction theorize the lack of muscle coverage will lead to increased implant visibility and ultimately more surgical revisions, including fat grafting procedures. Although this theory makes some intuitive sense, our findings did not support it. We found a similar number of fat grafting procedures and volume of fat graft needed between the two groups. We believe refinements in oncologic technique, advances in silicone implant cohesivity, and the addition of ADM implant coverage account for this discrepancy. Furthermore, in the absence of pectoral manipulation, we saw less animation deformity in the prepectoral group; this aligns with recent data promoting subpectoral to prepectoral conversion for the treatment of animation deformity.<sup>25</sup>

Another important comparison highlighted in this study involves capsular contracture. Previously, Manrique et al reported similar rates of capsular contracture between prepectoral and subpectoral reconstructions with the majority scored as Baker I<sup>20</sup>; we report comparable scores between cohorts. The pathophysiology of capsular contracture is multifactorial, with the coverage provided by subpectoral implant placement postulated to decrease local inflammation and resultant capsule formation.<sup>26</sup> The data presented in this study do not support a biophysical argument for decreased contracture in subpectoral reconstruction but encourages further exploration of contributing immunobiological factors.

Although patient pain scores and subsequent narcotic consumption have historically not influenced technique in breast reconstruction, they are becoming increasingly relevant in the era of America's opioid epidemic.<sup>27</sup> The authors anticipated the observed decrease in the number of prescriptions for muscle relaxants given the lack of pectoralis elevation. However, pain scores and narcotics prescriptions were not statistically less for the prepectoral group as theorized. Recent studies have reached similar conclusions.<sup>28,29</sup> Most other studies evaluating

pain in prepectoral breast reconstruction have demonstrated lower pain scores, quicker upper limb recovery, and reduced analgesic needs<sup>12,13,30</sup>; however, these studies excluded patients with chronic pain and employed strict selection criteria for prepectoral reconstruction in terms of age, BMI, and other co-morbidities, thus limiting the generalizability of their results. One more inclusive study conducted by Walia et al found that prepectoral TE reconstruction patients had significantly lower postoperative pain scores, but also lower physical health scores.<sup>31</sup> Overall, the impact of implant placement on the postoperative pain experience requires further attention.

Interpretation of the current study's findings must consider its limitations. Data were collected retrospectively and only from a single institution. Four surgeons were involved, each potentially unique in their operative technique and use of ADM for prepectoral reconstruction. Longer follow-up will aid in determining if prepectoral reconstruction is a long-term viable alternative to subpectoral placement. Lack of patient-reported outcomes is an important limitation, as patients' satisfaction with their reconstruction could play a role in technique selection moving forward. Lastly, an objective study of the financial implications of prepectoral breast reconstruction is needed. In the present study, prepectoral patients were more often billed as outpatient and had shorter lengths of stay in the hospital, a finding consistent with the published literature.<sup>11,14,32</sup>

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