

The impact of the COVID-19 pandemic on alloplastic breast reconstruction: An analysis of national outcomes

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Abstract

Background: Immediate alloplastic breast reconstruction shifted to the outpatient setting during the COVID-19 pandemic to conserve inpatient hospital beds while providing timely oncologic care. We examine the National Surgical Quality Improvement Program (NSQIP) database for trends in and safety of outpatient breast reconstruction during the pandemic.

Methods: NSQIP data were filtered for immediate alloplastic breast reconstructions between April and December of 2019 (before-COVID) and 2020 (during-COVID); the proportion of outpatient procedures was compared. Thirty-day complications were compared for noninferiority between propensity-matched outpatients and inpatients utilizing a 1% risk difference margin.

Results: During COVID, immediate alloplastic breast reconstruction cases decreased (4083 vs. 4677) and were more frequently outpatient (31% vs. 10%, $p < 0.001$). Outpatients had lower rates of smoking (6.8% vs. 8.4%, $p = 0.03$) and obesity (26% vs. 33%, $p < 0.001$). Surgical complication rates of outpatient procedures were noninferior to propensity-matched inpatients (5.0% vs. 5.5%, $p = 0.03$ noninferiority). Reoperation rates were lower in propensity-matched outpatients (5.2% vs. 8.0%, $p = 0.003$).

Conclusion: Immediate alloplastic breast reconstruction shifted towards outpatient procedures during the COVID-19 pandemic with noninferior complication rates. Therefore, a paradigm shift towards outpatient reconstruction for certain patients may be safe. However, decreased reoperations in outpatients may represent undiagnosed complications and warrant further investigation.

KEYWORDS

alloplastic breast reconstruction, breast reconstruction, COVID-19, immediate breast reconstruction, outpatient breast reconstruction, surgical complications

1 | INTRODUCTION

In recent years, an increasing number of women with early-stage breast cancer have opted for mastectomy over breast-conserving surgery.¹⁻³ While not all patients desire reconstruction, more than 130 000 breast reconstructions are performed annually, with alloplastic procedures representing approximately 75% of these.⁴ The ideal timing for breast reconstruction is a multifactorial decision based on desired reconstructive approach, other medical comorbidities, and whether the patient will require adjuvant radiotherapy. Immediate reconstruction at the time of mastectomy offers psychological and economic benefits and therefore makes up the majority of breast reconstructions⁴⁻⁸; however, it has been associated with higher rates of surgical complications.^{9,10} Traditionally, immediate reconstructions have been done on an inpatient basis to monitor drain output, provide pain control, and assess for complications such as hematoma and skin necrosis. In recent years, some centers have begun to offer immediate alloplastic reconstruction as an outpatient procedure, mirroring trends observed for isolated mastectomy and delayed alloplastic reconstruction.^{11,12} Advances in the regional blockade and perioperative blocks have decreased postoperative pain, aiding this shift toward outpatient surgery.¹³ Some studies have demonstrated higher patient satisfaction, lower costs, and comparable safety with outpatient surgery but were limited by smaller sample sizes, and this model has accounted for a minority of procedures in recent years.¹⁴⁻¹⁷

One factor which may accelerate the paradigm shift toward outpatient immediate reconstruction is the SARS-CoV-2 coronavirus disease 2019 (COVID-19) pandemic. In early 2020, both the American College of Surgeons and the American Society of Plastic Surgeons (ASPS) issued recommendations that all nonurgent elective surgeries be canceled or postponed. In addition, they recommended that urgent elective procedures be shifted to the outpatient setting to conserve inpatient resources, specifically intensive care unit beds, and decrease the risk of transmission of the novel coronavirus.¹⁸⁻²¹ Overall, there was a sharp decline in elective surgical volumes across multiple specialties, including oncologic surgery.²²⁻²⁴ Given that cancer patients are at higher risk for serious complications and mortality from COVID-19,^{25,26} these recommendations provided a strong incentive to provide immediate reconstruction in the outpatient setting. To conserve resources while still providing care for breast cancer patients, some centers pivoted to "high-efficiency" same-day protocols with encouraging early outcomes.²⁷⁻³⁰

Despite the observed delays and global decreases in elective surgical volumes, relatively little is known about the effects of the COVID-19 pandemic on outcomes of breast reconstruction on a national scale. Understanding how these necessary changes have affected outcomes will inform decision-making for breast cancer surgeons and patients, as the availability of inpatient surgery returns. To evaluate these trends in a large, national cohort, we surveyed the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database³¹ to identify patients undergoing immediate alloplastic breast reconstruction to describe aggregate

changes in surgical volume, patient demographics, comorbidities, procedure setting, early complications, and reoperation rates as a result of the COVID-19 pandemic.

2 | MATERIALS AND METHODS

This study was designated as nonhuman subjects research due to the deidentified nature of the data and thus exempt from IRB approval. To isolate the effects of COVID-19, which was widespread in the United States by April 2020,³² the NSQIP database was first filtered for procedures that took place in April through December 2019 and April through December 2020. These groups were then searched for implant- and expander-based breast reconstruction using the following current procedural terminology (CPT) codes: 19340, insertion of breast implant on the day of mastectomy (direct-to-implant) and 19357, tissue expander placement, with simultaneous mastectomy (CPT codes 19301-19307). Patients with CPT codes corresponding to more than one of these procedures were presumed to have undergone bilateral reconstruction. Procedures were also filtered by the International Classification of Diseases (ICD-10) diagnosis code to isolate patients with breast cancer or carcinoma in situ diagnoses (categories C50, D05, or Z85.3) or undergoing prophylactic mastectomy (Z40.01, Z80.3). Patients undergoing concurrent autologous breast reconstruction were excluded (CPT codes 19361, 19364, 19367, 19368, 19369).

The procedures fitting these inclusion criteria formed the before-COVID and during-COVID groups, containing 4677 and 4083 procedures, respectively. Patient demographic data corresponding to each of these procedures was extracted, including age at operation, sex, race, ethnicity, height, and weight. Body mass index (BMI) was calculated from height and weight measures where available. Relevant comorbidities were also collected: smoking status within 1 year, diabetes, hypertension requiring medication, chronic steroid use, presence of disseminated cancer, severe chronic obstructive pulmonary disease (COPD), congestive heart failure within 30 days of surgery, and American Society of Anesthesiologists (ASA) classification. Perioperative data recorded were operative time and CPT codes of all simultaneous procedures.

The primary outcome of interest was the incidence of surgical complications within 30 days postoperatively, defined as a composite of wound dehiscence and superficial, deep, and organ/space surgical site infections. Secondary outcomes included unplanned reoperations within 30 days, length of stay postoperatively, and medical complications within 30 days, a composite of occurrences of deep venous thrombosis (DVT), pulmonary embolism, pneumonia, reintubation, acute kidney injury, urinary tract infection, sepsis, stroke, myocardial infarction, and cardiac arrest. Unplanned reoperations were then categorized into procedures for hematoma/seroma drainage, implant removal, drainage/debridement of infected structures, wound repairs, or other utilizing CPT and ICD-10 diagnosis codes. All complications and reoperations were calculated per patient.

To further examine the safety of outpatient reconstruction specifically, procedures from 2019 to 2020 were pooled and subsequently divided into cohorts based on inpatient or outpatient (postoperative length of stay 0 days) procedures. Demographic, perioperative, and outcomes data were compared between groups as above.

2.1 | Statistical analysis

Kolmogorov–Smirnov tests were performed to assess the normality of continuous variables, and these were reported as mean \pm standard deviation or median (interquartile range [IQR]). χ^2 and Fisher's exact tests were performed to compare categorical data as appropriate, and Mann–Whitney *U* tests were performed to compare numerical data. Post hoc Fisher's exact tests with a Holm–Bonferroni correction for multiple comparisons were performed when indicated for categorical variables with more than two groups. The pairwise deletion was utilized when records were missing data to maximize data retained. *p* Values were obtained from two-tailed tests, and the significance level was predefined at $\alpha = 0.05$.

To establish the safety of breast reconstruction in the COVID era, noninferiority tests were performed utilizing the Farrington–Manning approach and a risk difference margin of 1%.³³ In noninferiority analyses, *p* values were one-sided, with a significance level of $\alpha = 0.05$.

Multivariable logistic regression was performed to further identify predictors independently associated with surgical complications. Year of operation, outpatient setting, and variables with pairwise associations with surgical complications with $p < 0.20$ were included as factors in the regression.

Given baseline differences in patients who underwent outpatient reconstruction, a propensity score-matched analysis was performed to minimize differences between inpatient and outpatient cohorts with respect to known potential confounders. The covariates upon which patients were matched were again identified by pairwise associations with surgical complications with $p < 0.20$, with the exclusion of operative time, which is not defined before the decision to pursue an inpatient or an outpatient procedure, and COPD, which had a low count ($n = 4$ in the outpatient group), to prevent overfitting.³⁴ Surgery type was also added as a matching covariate. Propensity scores were calculated by a logistic regression model utilizing an optimal fixed ratio algorithm, minimizing the total difference in propensity scores across groups. A 1:1 match ratio and a caliper width of 0.25 standard deviations of the logit of the propensity score were used. The distribution of potential confounders before and after propensity score matching was evaluated by standardized mean differences (SMD), where an $SMD \leq 0.10$ is considered nonsignificant. For categorical variables with more than 2 levels, the match was evaluated using χ^2 tests.

Listwise deletion was utilized in logistic regression and propensity score analyses, excluding all records missing any of the predictor variables. All statistical analyses were performed in SAS Studio software version 3.8 (SAS Institute Inc.).

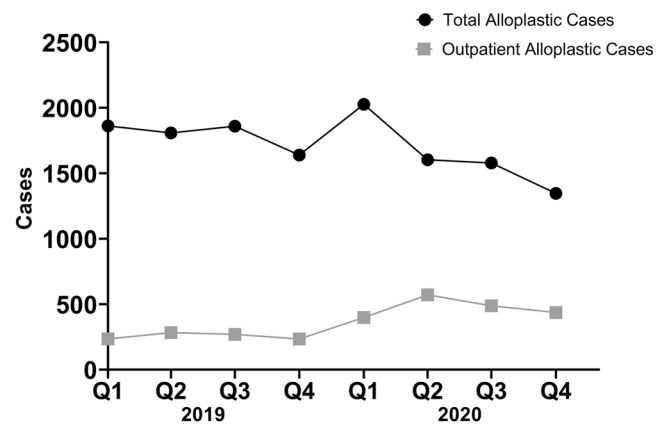


FIGURE 1 Case volume of all immediate alloplastic breast reconstructions recorded in the National Surgical Quality Improvement Program over 2019 and 2020, and outpatient immediate alloplastic reconstructions. The proportion of outpatient reconstructions was significantly higher for each quarter in 2020 than in the corresponding quarter in 2019 ($p < 0.001$)

3 | RESULTS

During the COVID-19 pandemic, breast reconstruction case volumes and overall surgical case volume reported in the NSQIP database decreased (Figure 1). The database contains a total of 806 016 procedures from April to December 2019 and 644 061 from these months in 2020. In the before-COVID period, 4677 direct-to-implant and immediate tissue expander procedures were reported, accounting for 580 per 100 000 total cases. In the corresponding months of 2020, 4083 of the same procedures were reported, a decrease of 13%; however, these made up 633 per 100 000 of all the surgeries reported, a significant increase in proportion ($p = 0.001$, Table 1). Notably, there was an increase in the proportion of alloplastic reconstructions performed as outpatient procedures from 10% before COVID to 31% in 2020 during COVID ($p < 0.001$), a change that is seen most prominently in Quarter 2 of 2020 but is consistently elevated for the remainder of the year ($p < 0.001$ each quarter).

Patients underwent reconstruction at a median of 50 years of age (IQR: 42–60). Demographics differed between the before-COVID and during-COVID cohorts, with the latter group being more often African American (13% vs. 11%) and less often white (80% vs. 82%, $p = 0.003$), and more often of Hispanic ethnicity (11% vs. 9.5%, $p = 0.01$; Table 1). Comorbidities generally did not differ across the two cohorts, with the exception of overall higher ASA class in the during-COVID group (65% vs. 67% Class II, 31% vs. 28% Class III, $p = 0.01$). During the pandemic, fewer direct-to-implant procedures were performed than before COVID (13% vs. 17%, $p < 0.001$), and the use of acellular dermal matrix became more common (Table 2).

Rates of postoperative complications, however, did not significantly increase. In the before-COVID cohort, there were 306 surgical complications (6.5%, 95% confidence interval [CI]: 5.9%–7.3%), while in the during-COVID cohort, there were 244 (6.0%, 95% CI: 5.3%–6.8%, $p = 0.001$ for noninferiority; Table 3; Figure 2A). The

TABLE 1 Demographic data and comorbidities of immediate alloplastic breast reconstruction patients before- and during-COVID

	Apr–Dec 2019 (n = 4677)	Apr–Dec 2020 (n = 4083)	p Value
Cases per 100 000 in NSQIP	580	633	0.001
Outpatient operation, n (%)	476 (10)	1271 (31)	<0.001
Age (IQR)	50 (43–60)	50 (42–59)	0.10
Race, n (%)			0.005
American Indian or Alaskan Native	12 (0.3)	13 (0.4)	
Asian	225 (5.6)	200 (5.7)	
Black or African American	423 (11)	471 (13)	
Native Hawaiian or Pacific Islander	19 (0.5)	11 (0.3)	
White	3316 (83)	2841 (80)	
Hispanic ethnicity, n (%)	399 (9.5)	416 (11)	0.02
BMI (IQR)	26.9 (23.2–31.4)	26.9 (23.2–31.5)	0.67
Smoker within 1 year, n (%)	395 (8.5)	313 (7.7)	0.18
Diabetes, n (%)			0.81
Insulin	70 (1.5)	64 (1.6)	
Noninsulin	238 (5.1)	219 (5.4)	
No diabetes	4369 (93)	3800 (93)	
Hypertension on medication, n (%)	1075 (23)	997 (24)	0.12
Steroid use, n (%)	112 (2.4)	115 (2.8)	0.22
Disseminated cancer, n (%)	54 (1.2)	42 (1.0)	0.57
History of severe COPD, n (%)	28 (0.6)	25 (0.6)	>0.9
CHF within 30 days, n (%)	2 (0.04)	4 (0.1)	0.43
ASA classification, n (%)			0.01
Class I	231 (4.9)	177 (4.3)	
Class II	3138 (67)	2636 (65)	
Class III	1296 (28)	1258 (31)	
Class IV	12 (0.3)	10 (0.3)	

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; IQR, interquartile range; NSQIP, National Surgical Quality Improvement Program.

incidence of medical complications in the during-COVID cohort was 1.1% (95% CI: 0.8%–1.4%), noninferior to the 1.5% in the before-COVID cohort (95% CI: 1.2%–1.9%, $p < 0.001$). The rate of reoperations during COVID was 7.5% (95% CI: 6.7%–8.3%), also noninferior to before COVID (7.4%, $p = 0.049$).

To adjust for patients' baseline differences, multivariable logistic regression was performed. Bivariate analyses identified age, BMI, operative time, race, ethnicity, diabetes, smoking, hypertension, and COPD as being potentially associated with surgical complication rates ($p < 0.2$); thus, these were included alongside the year of operation and outpatient procedure as covariates in the regression. The results confirmed that when accounting for the potential confounders listed above, the year of operation was not associated with surgical

complications, with an odds ratio (OR) of 0.93 (95% CI: 0.76–1.14, $p = 0.48$). Outpatient status was similarly independent of surgical complications (OR: 0.90, 95% CI: 0.68–1.20, $p = 0.48$; Table 4).

To verify these findings, analyses were performed utilizing outpatient surgery as the exposure of interest. Baseline data of patients undergoing inpatient and outpatient surgery did differ significantly, with outpatients tending to have fewer comorbidities, including lower rates of obesity and smoking, and lower ASA class ($p < 0.05$ for all; Table S1). Outpatient procedures were more often direct-to-implant (23% vs. 13%, $p < 0.001$) and had shorter operative times ($p < 0.001$).

To minimize the impact of these baseline differences, propensity score-matched outpatient and inpatient cohorts were generated,

matched on age, BMI, race, ethnicity, diabetes, smoking, hypertension, and procedure type. The resulting groups encompassed 1371 patients each, with a good balance of all specified covariates (Tables 5 and S2). In these matched groups, outpatient surgery was noninferior to inpatient surgery in all measured domains. Outpatients had a 5.0% incidence of surgical complications (95% CI: 3.9%–6.3%) as compared to 5.5% in inpatients ($p=0.03$ for noninferiority). Similarly, outpatients had noninferior rates of medical complications (0.8%, 95% CI: 0.4%–1.4%; vs. 1.4%) and reoperations (5.2%, 95% CI: 4.1%–6.5%; vs. 8.0%; $p < 0.001$ for noninferiority for both; Table 6, Figure 2B).

However, the incidence of secondary operations was also statistically significantly lower in the outpatient cohort, largely driven by a decrease in operations for hematoma and seroma drainage to 1.4%, half of the 2.8% seen in the inpatient cohort ($p=0.003$; Table 6). This decrease was present primarily during postoperative days 0–1 (0.6% vs. 1.4%, $p=0.03$), but trended towards significance during days 2–30 (0.8% vs. 1.5%, $p=0.10$). Reoperations for implant removal, infectious complications, and wound repair did not differ significantly ($p \geq 0.44$).

4 | DISCUSSION

In this study, a 13% decrease in immediate alloplastic breast reconstruction cases was observed during the COVID-19 pandemic in the United States, with a concurrent increase in the proportion performed as outpatient procedures, from 10% to 31%. Noninferiority of alloplastic reconstruction both during the COVID-19 pandemic and in the outpatient setting was demonstrated, the latter utilizing a propensity-score matched analysis. Outpatient reconstruction was associated with surgical complications in 5.0% of patients, medical complications such as DVTs and urinary tract infections in 0.8%, and unplanned reoperations in 5.2% of patients, with no significant increase over inpatient reconstructions.

TABLE 2 Surgical characteristics of implant and expander-based breast reconstruction before and during COVID

	Apr–Dec 2019 (<i>n</i> = 4677)	Apr–Dec 2020 (<i>n</i> = 4083)	<i>p</i> Value
Procedure type, <i>n</i> (%)			<0.001
Direct-to-implant	794 (17)	541 (13)	
Tissue expander	2119 (45)	2018 (49)	
Bilateral direct-to-implant	389 (8.3)	307 (7.5)	
Bilateral tissue expanders	1312 (28)	1154 (28)	
Combination of tissue expander and implant	63 (1.4)	63 (1.5)	
Prophylactic mastectomy, <i>n</i> (%)	291 (6.2)	232 (5.7)	0.29
Use of acellular dermal matrix, <i>n</i> (%)	2968 (63)	2702 (66)	0.008
Operative time, min (IQR)	195 (149–253)	200 (151–256)	0.009

Abbreviation: IQR, interquartile range.

Despite the decrease in overall recorded case volumes in NSQIP, immediate alloplastic breast reconstruction made up a significantly larger proportion of the cases represented in the NSQIP database in the included months in 2020 than in the same months in 2019. This

TABLE 3 Postoperative outcomes by cohort

	Apr–Dec 2019 (<i>n</i> = 4677)	Apr–Dec 2020 (<i>n</i> = 4083)	<i>p</i> Value
Days to discharge	1.2 ± 0.8	0.9 ± 0.9	<0.001
Reoperations, <i>n</i> (%)	345 (7.4)	304 (7.5)	>0.9
Hematoma/seroma drainage	135 (2.9)	98 (2.4)	0.16
Implant removal	79 (1.7)	68 (1.7)	>0.9
Debridement, abscess drainage	147 (3.1)	121 (3.0)	0.63
Wound repair	36 (0.8)	37 (0.9)	0.48
Any surgical complication, <i>n</i> (%)	306 (6.5)	244 (6.0)	0.28
Dehiscence	47 (1.0)	36 (0.9)	0.55
Superficial SSI	126 (2.7)	87 (2.1)	0.09
Deep SSI	28 (0.6)	31 (0.8)	0.36
Organ/space SSI	123 (2.6)	102 (2.5)	0.70
Any medical complication, <i>n</i> (%)	70 (1.5)	44 (1.1)	0.08
DVTs	7 (0.2)	9 (0.2)	0.44
Pulmonary embolism	11 (0.2)	9 (0.2)	0.89
Urinary tract infection	15 (0.3)	6 (0.2)	0.10
Pneumonia	2 (0.04)	3 (0.1)	0.67

Abbreviations: DVTs, deep venous thromboses; SSI, surgical site infection.

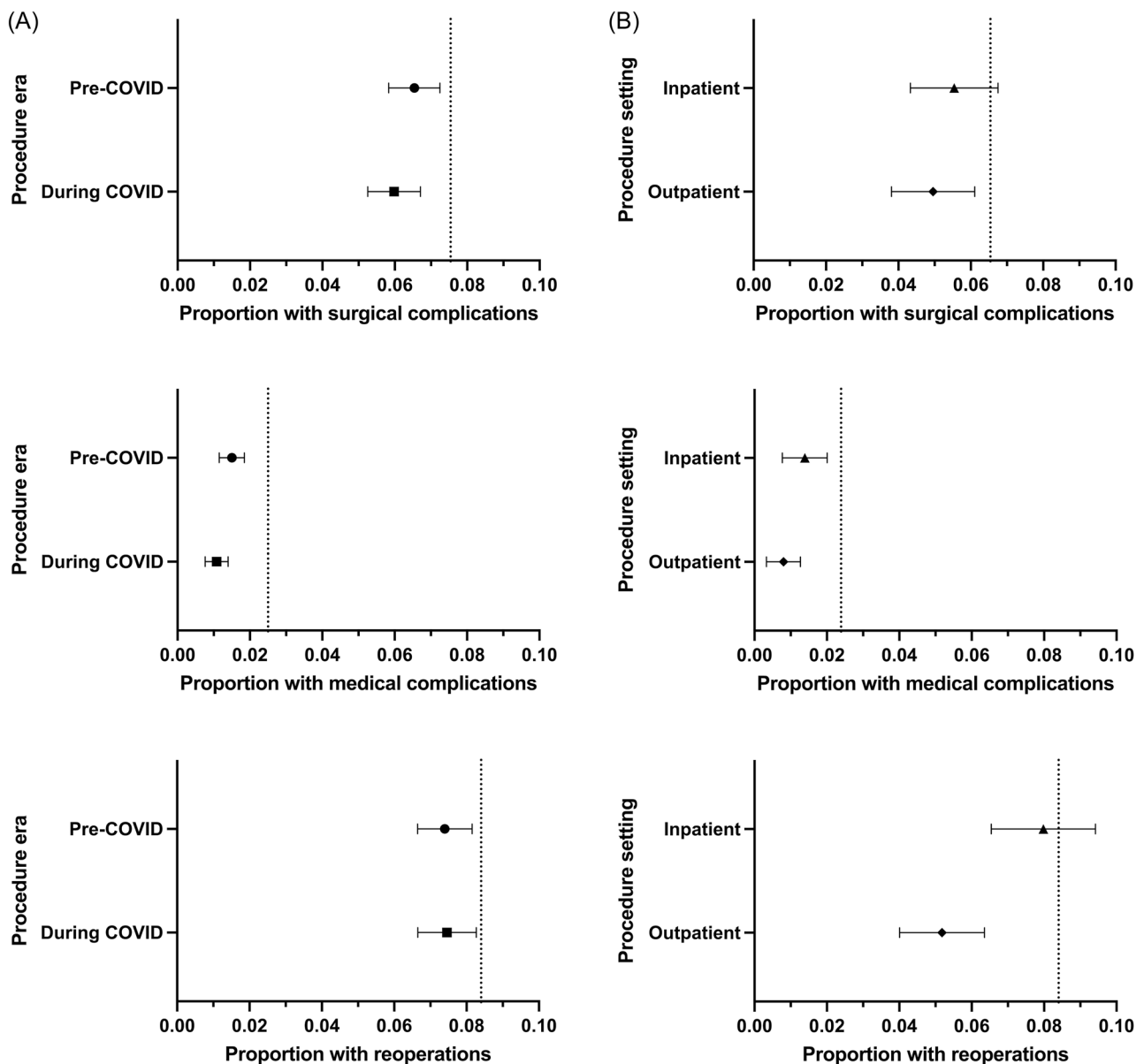


FIGURE 2 Incidence of surgical complications, medical complications, and reoperations in (A) 2019 versus 2020 and (B) inpatient versus outpatient reconstruction. A dashed line indicates a noninferiority margin of a 1 percentage point increase in complications. Horizontal lines indicate 95% confidence intervals

trend may represent the rather unique characteristics of immediate alloplastic breast reconstruction as particularly amenable to continuation during the pandemic: it is simultaneously semi-urgent, given its relationship to oncologic care, and can be performed on an outpatient basis with reasonable precedent.^{12,35} Thus, while elective, nononcologic surgeries such as benign gynecologic procedures, as well as more complex inpatient procedures such as colorectal cancer resection, experienced 39%–60% volume reductions, the relatively milder decrease in alloplastic breast reconstruction may have led to a relative overrepresentation in the NSQIP database.^{36,37}

These findings are consistent with a recent national survey of members of the ASPS, which reported an increase in breast reconstruction cases from 136 000 in 2019 to almost 138 000 in

2020 among its members.⁴ At the same time, the ASPS recommended in March 2020 that autologous reconstructions are delayed and immediate alloplastic reconstruction be performed on a case-by-case basis, depending on resource availability, the patient's comorbidities, and the likelihood of complications. Several studies performed since have shown the strict institutional restrictions placed on all autologous breast reconstructions, with 47.7% of surgeons reporting performing only alloplastic reconstructions during the pandemic, while 15.9% reported restrictions on all forms of breast reconstruction.^{30,38–40}

Somewhat counterintuitively, there was a decrease in direct-to-implant reconstruction during the pandemic, with more patients undergoing tissue expander placement, despite the likely need for more

frequent office visits for expansion and a possible second operation for exchange for permanent implants. However, given the multitude of patient and surgeon factors that inform the decision between the implant

and tissue expander placement, such as incision type, preoperative breast size, and intraoperative mastectomy skin flap quality, it is unlikely that the coronavirus pandemic was the sole causative factor for this shift.^{41–43}

TABLE 4 Results of multivariate logistic regression to identify predictors of surgical complications

Variable	Odds ratio (95% confidence interval)	p Value
Outpatient procedure	0.90 (0.68, 1.20)	0.48
Procedure in 2020	0.93 (0.76, 1.14)	0.48
Age, years	1.003 (0.994, 1.013)	0.49
BMI	1.04 (1.02, 1.05)	<0.001
Operative time, min	1.003 (1.002, 1.004)	<0.001
Race (reference: White)		
American Indian or Alaskan Native	1.05 (0.34, 6.38)	0.60
Asian	0.49 (0.27, 0.91)	0.02
Black or African American	0.78 (0.57, 1.05)	0.1
Native Hawaiian or Pacific Islander	0.47 (0.06, 3.47)	0.46
Hispanic ethnicity	1.14 (0.81, 1.59)	0.46
Diabetes (reference: no diabetes)		
Insulin-dependent diabetes	1.39 (0.73, 2.66)	0.32
Noninsulin-dependent diabetes	1.51 (1.06, 2.16)	0.02
Smoking	1.55 (1.14, 2.10)	0.005
Hypertension	1.41 (1.12, 1.79)	0.004
COPD	3.29 (1.63, 6.63)	<0.001

Note: Model adjusted $R^2 = 0.0433$.

Abbreviations: BMI, body mass index; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

In addition, our findings of outpatient alloplastic breast reconstruction during the COVID era being noninferior to the historic standard of care comport with the results of several single-institution studies. Of note, Faulkner et al. examined immediate reconstruction during the first 3 months of COVID-19 restrictions and found no difference in operative and nonoperative complications in comparison to the 3 preceding months, with an emphasis on same-day discharge whenever medically possible.⁴⁴ Other centers had begun a shift towards outpatient procedures even before the pandemic, with similarly encouraging results.^{14,17} In this study, outpatient reconstruction was also noninferior in medical complication rates. While these outcomes were rare and not individually significant, decreases in venous thromboses and thromboembolic events with outpatient operations have been shown with other surgical procedures when performed in the outpatient setting compared to inpatient and may be attributable to early mobilization.^{14,45,46}

Importantly, outpatient reconstruction had a significantly lower rate of unplanned secondary procedures than did inpatient operations, in particular for drainage of hematoma and seroma. There are several potential explanations for this trend, the most concerning of which is the potential undertreatment of outpatients due to a lack of observation or close follow-up on a postoperative day 1—particularly relevant for the diagnosis of hematomas. Dumestre et al. previously demonstrated no association between outpatient reconstruction and hematoma formation, though in a relatively small cohort of 69 patients.¹⁷ Seth et al. similarly examined a large cohort of immediate breast reconstructions and determined that no patient or surgical factors independently increase the risk of hematoma, although the postoperative length of stay was not analyzed.⁴⁷ The literature seems to show that the incidence of hematoma development is relatively constant across patients, which suggests the decrease observed here could represent underdiagnosis and undertreatment. Although an uncommon complication, the development of hematoma and seroma after an outpatient reconstruction may warrant further investigation; in particular, as the pandemic continues, and

TABLE 5 Standardized mean differences (SMDs) for covariates used in propensity score matching

Variable	Inpatients, unmatched (n = 6027)	Outpatients, unmatched (n = 1371)	Prematch SMD	Inpatients, matched (n = 1371)	Outpatients, matched (n = 1371)	Postmatch SMD
Age	50 (43–60)	51 (43–61)	0.05	50 (43–60)	51 (43–61)	0.05
Hispanic ethnicity	407 (6.8)	155 (11)	-0.16	147 (11)	155 (11)	-0.02
BMI	27.1 (23.4–31.8)	26.3 (22.8–30.4)	-0.16	26.0 (22.7–30.3)	26.3 (22.8–30.4)	0.02
Smoking	501 (8.3)	90 (6.6)	0.07	91 (6.6)	90 (6.6)	0.003
Hypertension	1488 (25)	339 (25)	-0.001	329 (24)	339 (25)	-0.02

Note: Covariates were chosen by bivariate analysis showing association with surgical complications with $p < 0.20$, with the addition of surgery type. Race, diabetes, and surgery type are shown separately in Table S2. Age and BMI are reported as median (IQR), and the remaining variables are reported as counts (%).

Abbreviations: BMI, body mass index; SMD, standardized mean difference.

TABLE 6 Postoperative outcomes in inpatient and outpatient surgery with propensity score-matched cohorts

	Inpatient procedures (n = 1371)	Outpatient procedures (n = 1371)	p Value
Days to discharge	1.2 ± 0.6	0	-
Reoperations, n (%)	109 (8.0)	71 (5.2)	0.003
Hematoma/seroma drainage	39 (2.8)	19 (1.4)	0.008
Implant removal	24 (1.8)	19 (1.4)	0.44
Debridement, abscess drainage	38 (2.8)	33 (2.4)	0.55
Wound repair	12 (0.9)	10 (0.7)	0.67
Any surgical complication, n (%)	76 (5.5)	68 (5.0)	0.49
Dehiscence	7 (0.5)	8 (0.6)	0.80
Superficial SSI	29 (2.1)	29 (2.1)	>0.9
Deep SSI	9 (0.7)	8 (0.6)	0.81
Organ/space SSI	32 (2.3)	25 (1.8)	0.35
Any medical complication, n (%)	19 (1.4)	11 (0.8)	0.14
DVTs	3 (0.2)	2 (0.2)	0.65
Pulmonary embolism	6 (0.4)	1 (0.1)	0.059
Urinary tract infection	2 (0.2)	3 (0.2)	0.65
Pneumonia	1 (0.1)	1 (0.1)	>0.9

Abbreviations: DVTs, deep venous thromboses; SSI, surgical site infection.

outpatient alloplastic reconstruction continues to become more common, close postoperative follow-up and adequate patient education and counseling are crucial to identify true complication rates and improve the patient experience.

This study has several limitations inherent to retrospective studies and the nature of the NSQIP database. While it does report a plethora of postoperative complications, outcomes more specific to alloplastic breast reconstruction such as hematoma and seroma can only be inferred from ICD-10 and CPT codes associated with a secondary procedure or readmission; therefore, our findings may underestimate the true burden of these complications in this cohort and overlook patients who did not undergo drainage of the fluid collection. Similarly, the NSQIP does not provide details regarding the site of wound complications, thus precluding a per-breast analysis. As a result, our results may overestimate the incidence of wound complications on a per-implant basis; however, given that the rates of bilateral reconstruction were similar across cohorts, this effect is non-differential and should not alter the comparisons between years. Furthermore, specific patient and treatment characteristics such as cancer stage, adjuvant radiotherapy, prepectoral/subpectoral placement of implants, or the use of newer agents such as tranexamic acid to prevent hematoma are not reported in the database, and thus may confound our analysis of postoperative complications. Adjuvant use of tranexamic acid has become prevalent at our institution and others across the country during this time to mitigate hematoma formation. This therapeutic modality needs to be investigated further to examine the opportunity for conversion of inpatient procedures to outpatient procedures as the safety profile increases.⁴⁸ Similarly, because outcomes

beyond 30 days postoperatively are not available, the relationship between outpatient reconstruction and long-term complications and patient satisfaction could not be elucidated from these data.

Given that many of these procedures took place during a global pandemic and the waxing and waning nature of COVID-19 cases and restrictions, changes in patient behavior were likely heterogeneous. A survey of breast cancer patients in April 2020 showed that 14.4% of patients had a higher threshold for contacting their breast cancer physician due to the pandemic, and this number decreased to 7.5% in November 2020.⁴⁹

5 | CONCLUSION

In the context of the COVID-19 pandemic, at a time when conservation of hospital resources continues to be of great importance, we find that immediate alloplastic breast reconstruction is a generally safe procedure in the outpatient setting, with no increase in short-term surgical complications, medical complications, or reoperations. However, further prospective study is necessary to validate the decreased reoperation rates in outpatients and clarify possible underlying causes. Close postoperative follow-up, particularly in the initial days after surgery, remains essential in patients undergoing breast reconstruction in the inpatient or outpatient setting.

The COVID-19 pandemic has forced us to re-examine surgical dogma: crisis forces innovation. Healthier patients were given the opportunity to undergo what was previously an inpatient procedure

as an outpatient, with encouraging results; thus, what constitutes an acceptable outpatient procedure may now be continuously reevaluated in this ongoing time of need.

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CONFLICTS OF INTEREST

Justin M. Sacks is a cofounder and equity holder of LifeSprout, and a consultant for 3M. Other authors declare no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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