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EPIDEMIOLOGY

Is immediate breast reconstruction safe in women over 70? An analysis of the National Surgical Quality Improvement Program (NSQIP) database

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Abstract

Purpose The safety of immediate breast reconstruction (IBR) in older women is largely unknown. This study aimed to determine the 30-day postoperative complication rates following IBR (implant-based or autologous) in older women (≥ 70 years) with breast cancer and to compare them to younger women (18–69 years).

Methods The National Surgical Quality Improvement Program (NSQIP) database was used to identify women with in situ or invasive breast cancer who underwent IBR (2005–2016). Outcomes included 30-day postoperative morbidity and mortality, which were compared across age groups stratified by type of reconstruction.

Results Of 28,850 women who underwent implant-based and 9123 who underwent autologous reconstruction, older women comprised 6.5% and 5.7% of the sample, respectively. Compared to younger women, older women had more comorbidities, shorter operative times, and longer length of hospital stay. In the implant-based reconstruction group, the 30-day morbidity rate was significantly higher in older women (7.5% vs 5.3%, $p < 0.0001$) due to higher rates of infectious, pulmonary, and venous thromboembolic events. Wound morbidity and prosthesis failure occurred equally among age groups. In the autologous reconstruction group, there was no statistically significant difference in the 30-day morbidity rates (older 9.5% vs younger 11.6%, $p = 0.15$). Both wound morbidity and flap failure rates were similar between the two age groups. For both reconstruction techniques, mortality within 30 days of breast surgery was rare.

Conclusion Immediate breast reconstruction is safe in older women. These data support the notion that surgeons should discuss IBR as a safe and integral part of cancer treatment in well-selected older women.

Keywords Aged · Breast neoplasm · Breast reconstruction · Postoperative outcomes

Abbreviations

ASA	American Society of Anesthesiology
BMI	Body mass index
CHF	Congestive heart failure
COPD	Chronic obstructive pulmonary disease
CPT	Current procedural terminology
DCIS	Ductal carcinoma in situ
DM	Diabetes mellitus
IBR	Immediate breast reconstruction
ICD-9	International Classification of Diseases Ninth Revision
LN	Lymph node
NSQIP	National Surgical Quality Improvement Program
PACE	Preoperative Assessment of Cancer in the Elderly
PCI	Percutaneous coronary intervention
PUF	Participant user data file

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SSI Surgical site infection
SURPAS Surgical Risk Preoperative Assessment System

Introduction

Breast cancer patient demographics are changing. Older women (age ≥ 70) are rapidly becoming the largest age group with breast cancer [1]. Therefore, age-specific treatment recommendations are becoming the norm to allow clinicians and patients make informed, patient-centered treatment decisions [2].

Breast cancer treatment involves surgical resection of the primary tumor, and in some cases, reconstruction. Breast reconstruction provides important psychosocial and quality of life benefits [3–6], all of which have been well documented in older women [7, 8]. In fact, older women who undergo reconstruction are generally satisfied with their decision, regardless of whether they experienced a complication or not [9, 10], and can even achieve similar or even higher levels of satisfaction and quality of life scores than younger women [7, 11–13].

Timing of breast reconstruction may be performed as an immediate or delayed procedure. Immediate breast reconstruction (IBR) has become more popular and is increasingly considered as standard of care [14–16]. Compared to a delayed approach, IBR offers the potential benefit of fewer operations, decreased costs, better aesthetic outcomes, and reduced psychological distress for patients [17–20].

Despite the benefits, many older women are not offered breast reconstruction as often as their younger counterparts [6–8, 10, 21–23]. Breast reconstruction rates in older women range from 4 to 14%, whereas rates of up to 42% have been reported in younger women [23–26]. The low uptake has been attributed to unfounded perceptions by both patients and surgeons that older women have higher complication rates and less interest in their body image [6, 10, 27, 28]. Other reasons include chronologic age alone [23, 24], comorbidities thought to preclude reconstructive surgery [29], and unequal access to institutions that offer IBR [22].

Current data do not support the notion that older women have more complication rates after IBR [6, 7, 20, 21, 30–34]. However, these studies are limited by the lack of detailed analyses [7, 33, 34]. Current data also derive from small, non-comparative single institution studies or large population-level studies that do not compare to younger patients or have varying definitions of older women [6, 20, 21, 30–32].

The rising interest among older women for IBR along with its well-known benefits emphasizes the need for developing age-specific data about IBR postoperative outcomes. These data would be useful to allow surgeons to appropriately counsel older women about the risks of breast reconstruction. This study aims to contribute to this knowledge gap by determining the 30-day postoperative complication rates of older women (≥ 70 years old) with breast cancer who underwent IBR (implant-based or autologous) and compare them to younger women (18–69 years old).

Methods

Data source

A retrospective analysis of the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) participant user data file (PUF) database from 2005 to 2016 was performed. NSQIP is a valuable tool to assess postoperative complications. It is a widely used and validated outcome-based clinical registry of select 30-day postoperative complications of patients who undergo surgery at over 716 participating hospitals across the world. NSQIP collects data on a representative sample of patients undergoing major surgery from member hospitals. Highly trained abstractors collect patient demographics, preoperative risk factors, surgical variables, and morbidity and mortality up to 30 days after surgery. The reproducibility of this data abstraction is periodically checked by repeat abstraction of a sample. Ethics Review Board has deemed this retrospective review of de-identified data exempt from institutional review. De-identified patient information is freely available to all institutional members who comply with the NSQIP data use agreement.

Participants

Women 18 years old or older with a postoperative diagnosis of ductal carcinoma in situ (DCIS) [International Classification of Diseases Ninth Revision (ICD-9) code 233.0] or invasive breast cancer (ICD-9 code 174.0–9) who underwent IBR were identified using the following current procedural terminology (CPT) codes: 19340, 19342, and 19357 for prosthesis-based reconstruction and 19361, 19364, and 19367–9 for autologous reconstruction. IBR was defined as any event in which a reconstruction CPT code accompanied a mastectomy code (CPT codes 19180, 19240, 19303, 19307) on the same date. Exclusion criteria were as follows: males, concurrent non-breast surgery, concurrent surgical procedures in the breast (e.g., revision or removal of implant or nipple reconstruction), and patients' missing data for any of the previous exclusion criterion. Lymph node (LN) surgeries were captured with CPT codes 19162, 19302, 19240, 19307, 38740, 38745, 38500, 38525, 38792, and 38900.

IBR was defined as breast reconstruction performed at the time of mastectomy. Patients were classified as younger (18–69 years old) and older (≥ 70 years old) adult. There is no consensus on what defines "older" women. This study

defined older women as women ≥ 70 years old, following the recommendations proposed by the Breast International Group [2] and because breast cancer guidelines recommend screening women up to the age of 69 [35].

Covariates

Extracted data included patient demographics (age and race), comorbidities [smoking, alcohol consumption, diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), previous percutaneous coronary intervention (PCI), hypertension, bleeding disorder, and steroid use], type of tumor (in situ or invasive breast cancer), receipt of chemotherapy 30 days before surgery, surgical variables (type of reconstruction and LN surgery), operative time, and length of stay, as defined in the NSQIP database user guide [36]. Data on tumor stage, comorbidity treatment, and cause of death are not captured by the NSQIP database. The American Society of Anesthesiology (ASA) score was used as a surrogate for the severity of systemic comorbidities.

Outcomes

Outcomes included 30-day morbidity (surgical and medical complications), 30-day all-cause mortality, and overall 30-day complications. Extracted surgical complications included superficial, deep, and organ space surgical site infection (SSI); wound disruption; bleeding requiring transfusion and prosthesis or flap failure. Extracted medical complications included urinary tract infection, cardiac arrest, myocardial infarction, mechanical ventilation for > 48 h, pneumonia, re-intubation, septic shock, deep venous thrombosis, pulmonary embolism, progressive renal failure, acute renal failure, and stroke. Thirty-day morbidity was defined using clinically meaningful Surgical Risk Preoperative Assessment System (SURPAS) clusters as described by Meguid et al. [37]. To mitigate the confusion in interpretation typically associated with numerous different NSQIP outcomes, modified SURPAS clusters (infectious, cardiac/transfusion, pulmonary, venous thromboembolic, renal, neurologic, and prosthesis/flap morbidity) were used. This approach utilizes factor analysis and clinical judgment to define clinically interpretable complication clusters in lieu of the main NSQIP postoperative morbidities. All-cause mortality was defined as any death as NSQIP does not capture details regarding underlying cause. Overall complication was defined as the presence of any complication or death from any cause.

Statistics

Baseline variables were compared between groups using the χ^2 test for categorical variables and Wilcoxon Rank Sum test for continuous variables. All tests were 2-sided with a p value of < 0.05 considered statistically significant. Data management and analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Study cohort

Figure 1 illustrates the cohort development process. A total of 37,973 women met the inclusion criteria. Immediate implant-based reconstruction took place in 28,850 women of which 1876 (6.5%) were older women. Immediate autologous reconstruction took place in 9123 women of which 517 (5.7%) were older women.

Immediate implant-based reconstruction

Patient and treatment characteristics of women who underwent immediate implant-based reconstruction are summarized in Table 1. Overall, the cohort was predominantly composed of Caucasian women with invasive tumors. Older women who underwent immediate implant-based reconstruction had a higher body mass index (BMI); comorbidities seen in a greater proportion of these women included increased alcohol consumption, diabetes mellitus (DM), dyspnea, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), prior percutaneous coronary intervention (PCI), hypertension, and bleeding disorders. Based on the ASA class, older women were more likely than young women to have severe systemic diseases, therefore higher ASA (ASA ≥ III: 31.6% vs 21.2%, $p < 0.0001$). Older women were less likely to have received neoadjuvant chemotherapy (1.1% vs 2.3%, $p < 0.0001$) and lymph node (LN) surgery (53.4% vs 88.8%, $p < 0.0001$). Older women also had shorter operative times (154 min vs 195 min, $p < 0.001$), but longer length of stay (3 days vs 2 days, $p < 0.0001$).

Table 2 summarizes the 30-day postoperative morbidity and all-cause mortality of women who underwent immediate implant-based reconstruction by age group. Complication rates were low for both groups and major complications (such as cardiac arrest, myocardial infarction, stroke, sepsis, shock, re-intubation, and prolonged ventilator dependency) were rare. Thirty-day morbidity was significantly higher in older women when compared to younger women (7.5% vs 5.3%, $p < 0.0001$). Complications occurring in higher rates among older women compared to younger women included

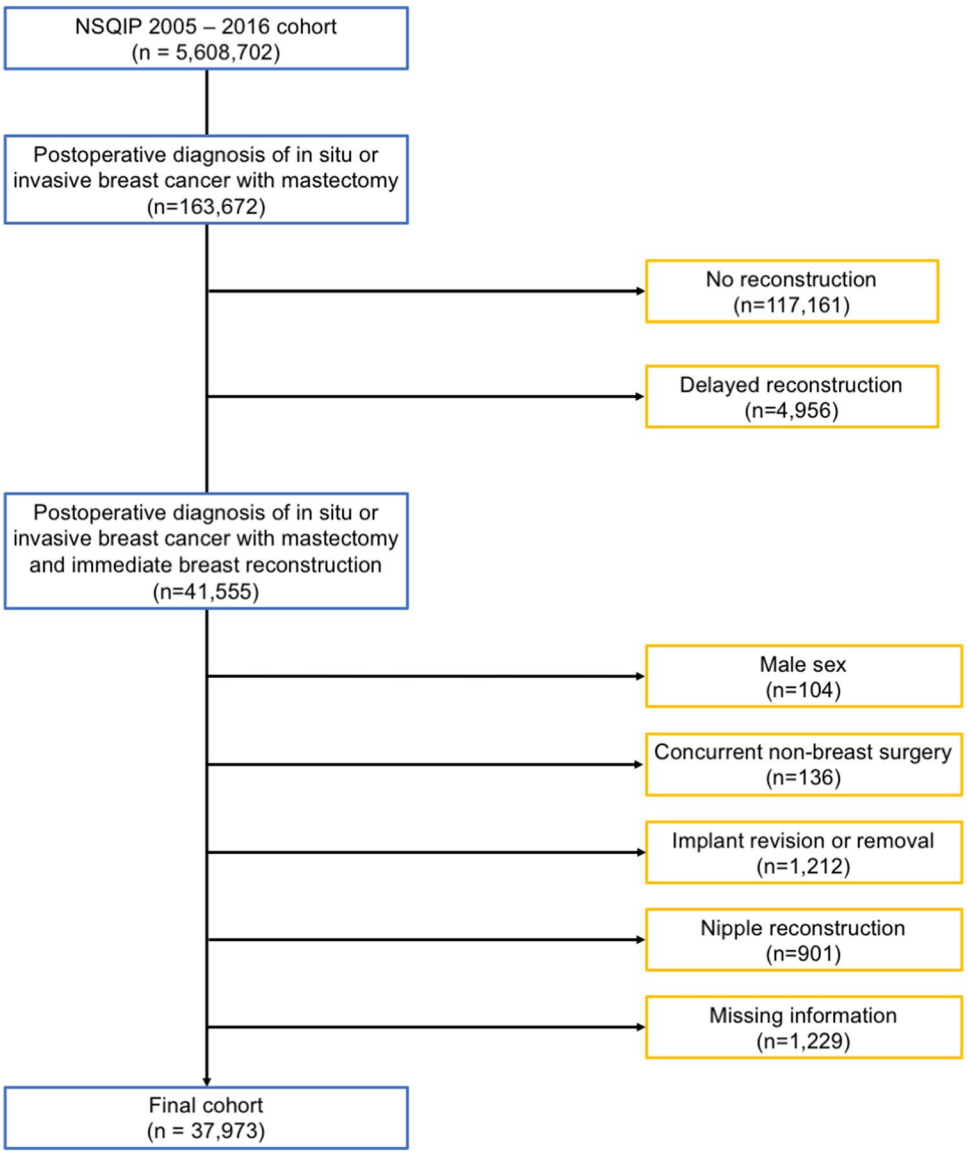

Fig. 1 Patient selection strategy identifying older women with breast cancer who underwent immediate breast reconstruction (IBR) in the 2005–2016 American College of Surgeons National Surgical Quality Improvement Program (NSQIP) participant use data file (PUF) database

infectious (6% vs 4%, $p < 0.0001$), pulmonary (0.3% vs 0.1%, $p = 0.004$), and venous thromboembolic (0.8% vs 0.3%, $p = 0.005$) clusters. Wound complication rates were generally similar between both age groups except for superficial surgical site infection (SSI), which was significantly more frequent in older women (2.8% vs 1.6%, $p < 0.0001$). Bleeding requiring transfusion was rare in both age groups (older: 0.6% vs younger: 0.7%, $p = 0.87$). Prosthesis failure rates were equal in both groups (0.4%). Thirty-day all-cause mortality was a rare event (older 0.05% vs younger 0.02%, $p = 0.31$).

Immediate autologous reconstruction

Patient and treatment characteristics of women who underwent autologous reconstruction are summarized in Table 3. This cohort was predominantly composed of Caucasian women with invasive tumors. Older women had significantly higher rates of comorbidities such as alcohol consumption, DM, dyspnea, COPD, CHF, previous PCI, hypertension, and bleeding disorders. A higher ASA class was more frequently observed in older women (ASA ≥ III: 38.3% vs 24%, $p < 0.0001$). Older women less frequently received neoadjuvant chemotherapy (1.7% vs 3.6%, $p < 0.0001$) and underwent LN surgery (61.9% vs 86.7%, $p < 0.0001$). Operative times were shorter (157 min vs 273 min, $p < 0.0001$), while length of stay was longer (4 days vs 2 days, $p < 0.0001$) among older women.

Table 4 summarizes the 30-day postoperative morbidity and all-cause mortality of women who underwent immediate autologous reconstruction by age group. There was no statistically significant difference in overall morbidity between older and younger women (9.5% vs 11.6%, $p = 0.15$). Complications within SURPAS clusters were equally frequent

Table 1 Patient and treatment characteristics of women who underwent immediate implant-based reconstruction

Variable[a]	Younger ($n = 26{,}974$)	Older ($n = 1876$)	p value
Age (y), median (IQR)	50 (44–58)	73 (71–77)	< 0.0001
BMI (kg/m^2), median (IQR)[b]	25.7 (22.5–30.4)	27.1 (23.8–30.9)	< 0.0001
Race			
White	21,217 (78.7)	1524 (81.2)	
African American	2094 (7.8)	127 (6.8)	
American Indian	57 (0.2)	0 (0)	< 0.0001
Asian	1136 (4.2)	35 (1.9)	
Hispanic	61 (0.2)	3 (0.2)	
Native Hawaiian	93 (0.3)	5 (0.3)	
Unknown	2316 (8.6)	182 (9.7)	
Comorbidities			
Smoking	3427 (12.7)	105 (5.6)	< 0.0001
Alcohol consumption	4657 (17.3)	516 (27.5)	< 0.0001
Diabetes mellitus	1328 (4.9)	220 (11.7)	< 0.0001
Dyspnea	654 (2.4)	145 (7.7)	< 0.0001
COPD	201 (0.8)	73 (3.9)	< 0.0001
CHF	12 (0.04)	7 (0.4)	< 0.0001
Previous PCI	50 (0.2)	34 (1.8)	< 0.0001
Hypertension	5940 (22.0)	1203 (64.1)	< 0.0001
Bleeding disorder	178 (0.7)	26 (1.4)	0.0003
Steroid use	422 (1.6)	39 (2.1)	0.09
ASA class			
I	2295 (8.5)	39 (2.1)	< 0.0001
II	18,970 (70.3)	1244 (66.3)	
III	5612 (20.8)	570 (30.4)	
IV	97 (0.4)	23 (1.2)	
Tumor histology			
In situ	5592 (20.7)	310 (16.5)	< 0.0001
Invasive	21,382 (79.3)	1566 (83.5)	
Year of operation			
2005–2006	1315 (4.9)	141 (7.5)	< 0.0001
2007–2010	6706 (24.9)	540 (28.8)	
2011–2013	10,968 (40.7)	689 (36.7)	
2014–2016	7985 (29.6)	506 (27.0)	
Neoadjuvant chemotherapy[c]	622 (2.3)	20 (1.1)	< 0.0001
Lymph node surgery[d]	23,949 (88.8)	1002 (53.4)	< 0.0001
Operative time (min), median (IQR)	195 (147–255)	154 (113–206)	< 0.0001
Length of stay (d), median (IQR)	2 (1–2)	3 (2–3)	< 0.0001

ASA American Society of Anesthesiology, *BMI* body mass index, *CHF* congestive heart failure, *COPD* chronic obstructive pulmonary disease, *d* days, *IQR* interquartile range, *min* minutes, *PCI* percutaneous coronary intervention

[a]Denotes *n*, (%) unless otherwise specified

[b]Calculated using height and weight

[c]Up to 30 days pre-operatively

[d]Includes sentinel lymph node biopsy and/or axillary lymph node dissection

between both groups except for the cardiac/transfusion cluster. Complications belonging to the cardiac/transfusion cluster were significantly less frequent among older women relative to younger women (3.1% vs 5.1%, $p = 0.04$), primarily due to differences in rates of bleeding requiring transfusion (older 2.9% vs younger 5.1%, $p = 0.03$). Wound complication rates were similar between age groups. Flap failure was uncommon in both older and younger women (0.4% vs 1.2%,

Table 2 Thirty-day postoperative morbidity by Surgical Risk Preoperative Assessment System (SURPAS) clusters for patients who underwent immediate implant-based reconstruction

Variable, *n* (%)	Younger (*n* = 26,974)	Older (*n* = 1876)	*p* value
Infectious cluster	1087 (4.0)	113 (6.0)	< 0.0001
Wound disruption	174 (0.7)	15 (0.8)	0.42
Superficial surgical site infection	434 (1.6)	53 (2.8)	< 0.0001
Deep surgical site infection	259 (1.0)	22 (1.2)	0.36
Organ space surgical site infection	225 (0.8)	16 (0.9)	0.93
Sepsis	94 (0.4)	7 (0.4)	0.87
Urinary tract infection	48 (0.2)	11 (0.6)	0.0002
Cardiac/transfusion cluster	185 (0.7)	12 (0.6)	0.81
Cardiac arrest	2 (0.01)	0 (0)	0.90
Myocardial infarction	2 (0.01)	0 (0)	0.71
Bleeding requiring transfusion	181 (0.7)	12 (0.6)	0.87
Pulmonary cluster	25 (0.1)	6 (0.3)	0.004
Mechanical ventilator > 48 h	3 (0.01)	0 (0)	0.65
Pneumonia	15 (0.1)	3 (0.2)	0.08
Re-intubation	4 (0.01)	1 (0.1)	0.22
Septic shock	9 (0.03)	2 (0.1)	0.22
Venous thromboembolic cluster	92 (0.3)	14 (0.8)	0.005
Deep venous thrombosis	52 (0.2)	9 (0.5)	0.009
Pulmonary embolism	48 (0.2)	9 (0.5)	0.004
Renal cluster	5 (0.02)	1 (0.05)	0.31
Progressive renal failure	3 (0.01)	0 (0)	0.65
Acute renal failure	2 (0.01)	1 (0.05)	0.06
Neurological cluster	4 (0.01)	0 (0)	0.60
Stroke	4 (0.01)	0 (0)	0.60
Prosthesis failure	94 (0.4)	7 (0.4)	0.40
Overall morbidity	1434 (5.3)	140 (7.5)	< 0.0001
All-cause mortality	5 (0.02)	1 (0.05)	0.31
Overall complication	1438 (5.3)	140 (7.5)	< 0.0001

$p = 0.09$). Thirty-day all-cause mortality was rare, but higher in older women (0.39% vs 0.05%, $p = 0.003$).

Discussion

This study examined the complication rates of older women with breast cancer who underwent IBR and compared them to younger women. Older women comprised a small proportion of women who underwent IBR. In the implant-based reconstruction group, the morbidity rate was marginally higher in older women due to more infectious, pulmonary, and venous thromboembolic events. In the autologous reconstruction group, older women had similar complication rates to younger women. Wound complications and prosthesis failure occurred equally among age groups in both reconstruction techniques. All-cause mortality within 30 days was rare in both age groups across both reconstruction techniques.

Overall complication rates were slightly higher in older women in keeping with data shown in other studies. The incidence of postoperative complications in older women with breast cancer who undergo IBR varies considerably in the literature. A recent systematic review reported a range of 6.8–77% for older patients vs 14.2–49.8% in younger women [6]. However, given that the cohort of older women had so many more comorbidities than younger women, the absolute difference in complication rates between these two age groups is surprisingly small.

In patients who underwent immediate implant-based reconstruction, older women had a significantly higher rate of superficial SSI compared to younger women. The rates reported in this study are similar to that in the literature (3.2%) [38]. However, these data should be interpreted with caution because NSQIP only captures SSIs within the first 30 postoperative days. Most surgical site infections after implant-based reconstruction develop at a later stage, with 88% occurring within the first 90 postoperative days [39–41]. In one study, the average time to infection was 67 days in direct-to-implant reconstruction with use of acellular dermal matrix and 100 days with a tissue expander cohort [40]. Surgical site infection risk factors for

Table 3 Patient and treatment characteristics of women who underwent immediate autologous reconstruction

Variable[a]	Younger ($n = 8606$)	Older ($n = 517$)	p value
Age (y), median (IQR)	52 (46–59)	73 (71–77)	< 0.0001
BMI (kg/m^2), median (IQR)[b]	27.5 (23.9–31.9)	27.5 (24.0–31.8)	0.68
Race			
White	6401 (74.4)	381 (73.7)	
African American	994 (11.6)	60 (11.6)	
American Indian	21 (0.2)	0 (0)	0.75
Asian	324 (3.8)	18 (3.5)	
Hispanic	38 (0.4)	1 (0.2)	
Native Hawaiian	25 (0.3)	1 (0.2)	
Unknown	803 (9.3)	56 (10.8)	
Comorbidities			
Smoking	1052 (12.2)	47 (9.1)	0.03
Alcohol consumption	1129 (13.1)	156 (30.2)	< 0.0001
Diabetes mellitus	563 (6.5)	87 (16.8)	< 0.0001
Dyspnea	342 (4.0)	46 (8.9)	< 0.0001
COPD	85 (1.0)	24 (4.6)	< 0.0001
CHF	8 (0.1)	3 (0.6)	0.002
Previous PCI	27 (0.3)	10 (1.9)	< 0.0001
Hypertension	2315 (26.9)	331 (64.0)	< 0.0001
Bleeding disorder	61 (0.7)	8 (1.6)	0.03
Steroid use	149 (1.7)	10 (1.9)	0.73
ASA class			
I	592 (6.9)	13 (2.5)	< 0.0001
II	5944 (69.1)	306 (59.2)	
III	2028 (23.6)	184 (35.6)	
IV	42 (0.5)	14 (2.7)	
Tumor histology			
In situ	1746 (20.3)	81 (15.7)	0.01
Invasive	6860 (79.7)	436 (84.3)	
Year of operation			
2005–2006	1253 (14.6)	47 (9.1)	
2007–2010	2539 (29.5)	128 (24.8)	
2011–2013	2896 (33.7)	212 (41.0)	< 0.0001
2014–2016	1918 (22.3)	130 (25.2)	
Neoadjuvant chemotherapy[c]	312 (3.6)	9 (1.7)	< 0.0001
Lymph node surgery[d]	7457 (86.7)	320 (61.9)	< 0.0001
Operative time (min), median (IQR)	273 (173–426)	157 (105–253)	< 0.0001
Length of stay (d), median (IQR)	2 (2–4)	4 (3–5)	< 0.0001

ASA American Society of Anesthesiology, *BMI* body mass index, *CHF* congestive heart failure, *COPD* chronic obstructive pulmonary disease, *d* days, *IQR* interquartile range, *min* minutes, *PCI* percutaneous coronary intervention, *y* years old

[a]Denotes *n*, (%) unless otherwise specified

[b]Calculated using height and weight

[c]Up to 30 days pre-operatively

[d]Includes sentinel lymph node biopsy and/or axillary lymph node dissection

implant-based reconstruction include type of reconstruction, obesity, ASA class ≥ 3, smoking, diabetes, and bleeding disorders [42–45]. The cohort of older women in this study had predominantly higher rates of most of these risk factors, possibly explaining the difference in SSI rates between age groups. Given that SSIs compromise cosmesis and prolong length of stay [46], it is important to note that older women are more susceptible. Although meticulous attention to

Table 4 Thirty-day postoperative morbidity by Surgical Risk Preoperative Assessment System (SURPAS) clusters for patients who underwent immediate autologous reconstruction

Variable, *n* (%)	Younger (*n* = 8606)	Elderly (*n* = 517)	*p* value
Infectious cluster	452 (5.3)	28 (5.4)	0.87
Wound disruption	75 (0.9)	3 (0.6)	0.48
Superficial surgical site infection	207 (2.4)	16 (3.1)	0.32
Deep surgical site infection	117 (1.4)	7 (1.4)	0.99
Organ space surgical site infection	47 (0.6)	1 (0.2)	0.28
Sepsis	55 (0.6)	4 (0.8)	0.71
Urinary tract infection	40 (0.5)	3 (0.6)	0.71
Cardiac/transfusion cluster	441 (5.1)	16 (3.1)	0.04
Cardiac arrest	1 (0.01)	2 (0.4)	< 0.0001
Myocardial infarction	6 (0.1)	0 (0)	0.55
Bleeding requiring transfusion	437 (5.1)	15 (2.9)	0.03
Pulmonary cluster	36 (0.4)	4 (0.8)	0.23
Mechanical ventilator >48 h	7 (0.1)	1 (0.2)	0.40
Pneumonia	23 (0.3)	2 (0.4)	0.61
Re-intubation	10 (0.1)	3 (0.6)	0.007
Septic shock	6 (0.1)	0 (0)	0.55
Venous thromboembolic cluster	67 (0.8)	4 (0.8)	0.99
Deep venous thrombosis	39 (0.5)	3 (0.6)	0.68
Pulmonary embolism	35 (0.4)	2 (0.4)	0.95
Renal cluster	8 (0.1)	0 (0)	0.49
Progressive renal failure	7 (0.1)	0 (0)	0.52
Acute renal failure	1 (0.01)	0 (0)	0.81
Neurological cluster	4 (0.1)	1 (0.2)	0.17
Stroke	4 (0.1)	1 (0.2)	0.17
Flap failure	102 (1.2)	2 (0.4)	0.09
Overall morbidity	994 (11.6)	49 (9.5)	0.15
All-cause mortality	4 (0.05)	2 (0.39)	0.003
Overall complication	996 (11.6)	49 (9.5)	0.15

prophylactic antibiotics and wound care may provide some improvement, this is an area that requires further longitudinal study in older women.

The finding that immediate autologous breast reconstruction in older breast cancer patients is a viable option with an overall complication rate comparable to that of younger patients is in keeping with previous studies [7, 33, 47]. This is surprising as older women generally have higher rates of comorbidities [47, 48]. Autologous-specific complications such as flap failure tended to be lower in older women, but within previously reported rates (1.1–2.4%) [42]. This may relate to the lower rate of smoking among older women in this cohort. Additionally, it may be due to selection bias as only healthy older women would be offered autologous IBR. Other known risk factors for flap failure (e.g., type of autologous reconstruction, obesity, hypertension, recent surgery in the past 30 days, and prolonged operative time) were either unknown or absent in older women [42].

These data suggest that complication rates are not much higher in well-selected older women. Potential candidates for IBR include older women with good overall health and functional status, favorable tumor biology, and interest in breast reconstruction. Surgeons should be encouraged to have this discussion early on with their patients as it allows for better surgical planning [49]. Surgeons may benefit from using comprehensive geriatric assessment which is useful in assessing older women's postoperative outcomes by factoring in their functional status, comorbidities, mobility, nutrition, polypharmacy, and social support. These tools may help guide the discussion surgeons have with their patients regarding how to weigh postoperative complications with quality of life.

The following limitations should be considered when interpreting these data. First, the results may not be generalizable to all patients, particularly for women from underserviced areas and lower socioeconomic groups, who were not highly represented in this sample. NSQIP uses data predominantly from academic institutions located in the Western hemisphere which limits the applicability of these findings across international patient populations and institutions. The cohort of older women may not represent every older breast cancer patient, as these patients may have been more motivated to

seek reconstruction as well as have higher income to fund this surgery. This study also lacks information regarding why women underwent reconstruction, specifically if this was solely for cosmetic purposes or if there was any necessity to close a defect. Furthermore, we are unable to compare complication rates between methods of reconstruction as decisions for reconstruction often involve considerations of tumor characteristics, need for adjuvant treatment, body habitus, and patient preferences. The results are restricted by the type of information NSQIP collects, particularly short-term outcomes and lack of surgery-specific and oncologic data. For example, the prosthesis failure rate was below the reported range (0.8–2.7%) [50–53]. Given that implant failure tends to occur at a later stage [54], the low rate in this study likely reflects the short follow-up time captured by NSQIP. This study also cannot provide information regarding some surgery-specific postoperative complications including seroma, hematoma, and fat necrosis; nor does it reflect long-term morbidity data (e.g., flap and implant failure, lymphedema, chronic pain, fibrosis, cosmetic result, and neurosensory disturbances). Additionally, as with any large-volume dataset, there may be observer bias, underreporting, and limited accuracy and completeness of coding and data recording.

Conclusion

These data suggest IBR is safe in women over 70 years of age. Thirty-day postoperative complication rates were low in older women who underwent implant-based or autologous reconstruction. Immediate breast reconstruction may be an integral part of cancer treatment for both younger and older breast cancer patients. Patient selection is particularly important among older women, who may experience marginal increases in the rates of infectious, pulmonary, and venous thromboembolic morbidity, particularly if undergoing immediate implant-based reconstruction. This study supports the notion that surgeons should discuss IBR as a safe and integral part of cancer treatment in well-selected older women.

Compliance with ethical standards

Conflict of interest The authors have no conflict of interests to declare.

Ethical approval This article does not contain any studies with human participants performed by any of the authors.

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