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The effects of body mass index on operative time and outcomes in nipple-sparing mastectomy

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ABSTRACT

Background: Nipple-sparing mastectomy (NSM) use is increasing. We investigated the relationships between body mass index (BMI), operative time (OT), and ischemic complications.
Methods: A single center, retrospective review was performed of NSMs from 2006 to 2018. Analysis included descriptive statistics, Wilcoxon rank-sum test and logistic regression.
Results: Among 294 patients, 510 breast reconstructions were performed (216 bilateral). Median OTs in the prosthetic-based (266 patients, 90.5%) and autologous tissue groups (28 patients, 9.5%) were 266 and 529 min, respectively. Median OTs ranged from 236 to 358 min for those with BMI <20 and ≥ 40, respectively. Increasing BMI correlated with OT ($r = 0.33$, $p < 0.001$) and was associated with slightly higher odds of major NAC ischemic complications (OR = 1.09, p = 0.02).
Conclusion: Higher BMI is associated with up to 50% longer OT, but is not a contraindication to NSM with reconstruction. Surgeons should recognize increased time and resource utilization.

Introduction

Nipple-sparing mastectomy (NSM) is a safe and effective procedure in selected patients, both prophylactically and oncologically.[1–4] Preservation of the nipple-areolar complex (NAC) affords better aesthetic outcomes and patient satisfaction[5] and has led to significant increases in the rates of patients undergoing NSM.[1]

Body mass index (BMI) has been associated with a number of surgical outcomes. In some surgical procedures increasing BMI has been shown to be associated with increased operative time (OT).[6–10] Increased OT has also been associated with increased morbidity in some studies.[11–13] The role that BMI plays in OT and whether it impacts postoperative morbidity has not been evaluated for patients undergoing NSM. Consistent factors associated with postoperative morbidity in NSM include perioperative tobacco use and previous breast/chest wall irradiation.[14–19] However, not all data support an association of increased BMI with a higher risk of complications.[19–23] One would expect BMI to also be related to longer OTs for NSM as higher BMI tends to be associated with larger breast size and greater surface area of dissection, but to date this has not been shown. The aim of this study is to assess the association between BMI and OT for NSM, and the clinical implications of these two factors.

Materials and methods

Data source and patient selection

We performed a retrospective review of a prospectively maintained breast surgery database of operations performed from June 2006 to June 2018. Patients that underwent attempted NSM with immediate autologous or prosthetic-based reconstructions were included in analysis. Pre-operative imaging and clinical assessments were used to determine candidacy for NSM. Frozen pathology of the nipple margin was obtained during the operation and a positive margin or surgeon discretion resulted in conversion to skin sparing mastectomy (SSM).

Electronic health records were used to collect additional pertinent data including any missing BMI data and OTs, which were defined by the first incision to placement of the last stitch, synonymous with “cut” to “close” times but distinct from anesthesia

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times. As each case had a surgical oncologist and a plastic surgeon, an attempt was made to collect their respective times, but was abandoned due to frequent overlap and unreliability of the transition time between surgeons in the available record. Start and end times were accurately identified in patients undergoing additional procedures (e.g. hysterectomy or oophorectomy); hence they were also included in analysis.

Our primary outcome was OT as a function of BMI. Secondary outcomes included incidence of ischemic/necrotic complications of the nipple-areola complex (NAC) and mastectomy skin flap. Nipple necrosis was graded on a scale from 1 to 4 as follows: 1 (minor) - nipple ischemia requiring no intervention but observation, 2 (moderate) - nipple ischemia requiring topical treatments, 3 (major) - nipple ischemia requiring surgical debridement, 4 - complete nipple loss. Skin flap findings were graded on a similar scale: 1 (mild) - skin ischemia, no treatment but observation, 2 (moderate) - skin ischemia requiring surgical debridement, 3 (major) - skin ischemia, major, requiring surgical intervention and further reconstruction (i.e. skin grafts).

Statistical analysis

Data was analyzed based on the type of breast reconstruction and bilateral versus unilateral by Wilcoxon rank-sum test and univariate logistic regression. A multivariable regression analysis was performed to determine the risk factors for ischemic complications. Patient BMI, OT, age, specimen mass, implant size, previous major breast surgery, radiation exposure, smoking habits, and active diabetes were recorded as patient factors. Statistical analysis was performed using SAS 9.4 (SAS Institute, Cary, NC). Two-sided p-values <0.05 were considered significant.

Results

Patient demographics

A total of 510 mastectomies were performed in 294 patients. Patient demographics and disease specific details can be found in Table 1. Median BMI for all patients was 23.4 (range 15.8–48.1). The

Table 1
Patient demographics and disease details.

	Autologous Reconstruction	Prosthetic Reconstruction	All Patients
n	28	266	294
BMI			
Median	27	23.3	23.4
Range	19.2, 39.4	15.8, 48.1	15.8, 48.1
Age			
Median	56	50	50
Range	40, 68	24, 82	24, 82
Race			
White	23	230	253
Hispanic	2	17	19
Asian/Pacific Islander	2	16	18
African American	0	3	3
Native American	1	0	1
Post menopause status			
No	6	158	164
Yes	22	108	130
Current tobacco use	3	9	12
Diabetes	2	7	9
Previous major breast surgery	9	63	72
Previous radiation exposure	7	16	23
Histology			
IDC	15	154	169
ILC	3	25	28
DCIS	8	58	66
benign	1	13	14
Mixed IDC/ILC	1	4	5
Tubular	0	1	1
Mucinous/Colloid	0	5	5
Other	0	6	6
Mean Tumor size (cm)	1.7 (1.5)	1.9 (1.3)	1.9 (1.9)
Grade			
Low	6	61	67
Med	8	116	124
High	14	104	118
Neoadjuvant treatment			
none	25	203	228
endocrine only	0	5	5
chemotherapy only	2	36	38
endocrine + another agent	0	3	3
Chemotherapy + targeted therapy	1	19	20

BMI = body mass index; IDC = invasive ductal carcinoma; ILC = invasive lobular carcinoma; DCIS = ductal carcinoma in situ.

Table 2
Surgical details.

	Autologous Reconstruction	Prosthetic Reconstruction	Total	p-value
NSM attempted (n)	28	266	294	
NSM completed (n)	24	248	272	
Time of surgery (minutes)				<.001[a]
Mean (SD)	530.6 (159.5)	269.7 (75.9)	294.5 (115.9)	
Median	528.5	266	271.5	
Range	313.0, 875.0	137.0, 738.0	137.0, 875.0	
Bilateral procedure				<.001[a]
no (n)	12	66	78	
time (min)	417 ± 86	219 ± 52		
yes (n)	17	199	216	
time (min)	616 ± 149	286 ± 75		
prophylactic (n)	15	185	200	
bilateral disease (n)	2	14	16	
Axillary Procedure (n)				
none	6	28	34	
SNLB	19	201	220	
SNLB + CLND	2	25	27	
ALND	1	12	13	
Mastectomy mass (grams)				<.001[a]
Median	527.3	305	316	
Range	122.0, 1134.0	84.5, 1304.0	84.5, 1304.0	

NSM = nipple-sparing mastectomy; SNLB = sentinel lymph node biopsy; CLND = completion lymph node dissection; ALND = axillary lymph node dissection.
[a] Wilcoxon rank sum p-value.

majority of women were white (83%) with a mean age of 50 years (±10.2). Approximately 25% of women had previous major breast surgery (n = 72), which we defined as breast augmentation, reduction mammoplasty, mastopexy, or lumpectomy with radiation. The most common specimen histology were invasive ductal carcinoma (57%) or ductal carcinoma in situ (22%). Neoadjuvant therapy was administered to 24% of patients.

Surgical details, Table 2

The majority of patients underwent bilateral NSM (n = 216, 73%), which added on average 1 h of OT ($p < 0.001$) to unilateral NSM. Median OT ranged from 236 min for those with BMI <20–358 min for those with BMI ≥40 (Fig. 1). Overall, 266 (90.5%) patients had implant/expander reconstruction (200 bilateral, 66 unilateral) and 28 patients (9.5%) had autologous tissue (primarily

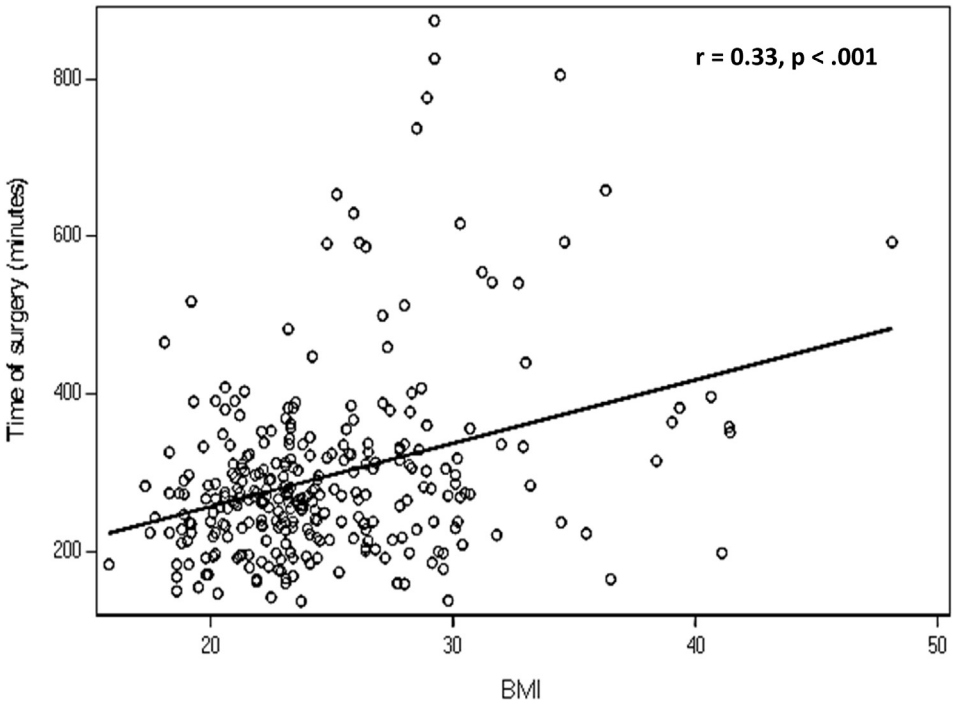

Fig. 1. Correlation of operative time and body mass index.

Table 3
Surgical outcomes.

	Autologous Reconstruction	Prosthetic Reconstruction	Total	p-value[a]
n	28	266	294	
Any Nipple complications, n (%)				
No	19 (68)	170 (64)	189 (64)	0.68
Yes	9 (32)	96 (36)	105 (36)	
Nipple complications - intervention, n (%)				0.002
Nipple ischemia requiring no intervention but observation (minor)	6 (67)	67 (70)	73 (70)	
Nipple ischemia requiring topical treatments (moderate)	3 (33)	4 (4)	7 (6)	
Nipple ischemia requiring surgical debridement (major)	0 (0)	25 (26)	25 (24)	
Complete nipple loss	0 (0)	0 (0)	0 (0)	
Skin flap complications, n (%)				
No	19 (68)	221 (83)	240 (82)	0.05
Yes	9 (32)	45 (17)	54 (18)	
Mastectomy flap complications - intervention, n (%)				
Skin ischemia treated with observation (mild)	3 (33)	11 (24)	14 (26)	0.60
Skin ischemia requiring surgical debridement (moderate)	6 (37)	30 (67)	36 (67)	
Skin ischemia requiring surgical intervention and further reconstruction (major)	0 (0)	4 (9)	4 (7)	
Seroma, n (%)				
No	25 (89)	230 (86)	255 (87)	0.68
Yes	3 (11)	36 (14)	39 (13)	
Hematoma, n (%)				
No	26 (93)	248 (93)	274 (93)	0.94
Yes	2 (7)	18 (7)	20 (7)	

[a] chi-square test.

free flap) reconstruction (16 bilateral, 12 unilateral). Median OT in the prosthetic group was 266 min (215 unilateral, 275 bilateral), and in the autologous tissue group was 529 min (387 unilateral, 591 bilateral). There were 22 attempted NSM that were converted to SSM due to intra-operative pathology (4.3%). Most women (88%) had some type of axillary procedure at the time of NSM with sentinel lymph node biopsy (73%) being most common.

Outcomes and analyses

In our cohort, higher BMI was associated with increased OT ($r = 0.33$, $p < 0.001$) in both the prosthetic and autologous groups. This association persisted when data were analyzed based on unilateral versus bilateral procedures and the type of axillary procedure performed.

The total incidence of NAC ischemic change of any degree was 35.7% (Table 3). Of these 105 patients, the majority (76%) required no intervention and 25 (24%) required intervention. There were no cases of complete nipple loss. Any degree of mastectomy skin flap necrosis was present among 54 patients (18.4%). Of these, 40 patients (66.7%) required debridement, while 4 patients (7.4%) required further reconstruction via tissue flap or grafting.

Risks factors associated with major ischemic complications of the NAC and mastectomy skin flap were analyzed using multivariable logistic regression. BMI was independently associated with higher odds of NAC ischemia requiring debridement (OR = 1.09, CI 1.01–1.12, $p = 0.02$), but was not associated with ischemia requiring debridement of mastectomy skin flaps. OT was not associated with significant ischemia of NACs or mastectomy skin flaps. No other patient factors increased the risk of ischemic complications (Table 4).

Discussion

Over the past decade there has been a substantial increase in patients undergoing NSM for both prophylactic and cancer operations without deleterious oncologic effect.[24–26] Some studies have shown improved patient satisfaction with NSM versus traditional mastectomies.[5,27,28] NSM is not without risk however, as there is substantial devascularization of the NAC predisposing to infection, poor wound healing, and necrosis. Within our cohort, a positive linear relationship existed between increasing BMI and longer OT regardless of type of reconstruction, axillary procedures, or laterality. Obesity was related to NAC requiring debridement but OT did not impact the rates of ischemic complication.

Absolute contraindications to NSM have been well established (evidence of NAC involvement, inflammatory breast cancer, Paget's disease, locally advanced breast cancer with skin involvement, and

Table 4
Regression analyses for ischemic complications requiring debridement.

	Nipple-Areola Complex				Mastectomy Skin Flap			
	OR	CI		p-value	OR	CI		p-value
BMI	1.09	1.01	1.12	0.02	0.97	0.90	1.05	0.46
Time of surgery (min)	1.00	0.99	1.00	0.17	1.00	0.99	1.00	0.18
Smoking history	1.86	0.39	8.83	0.43	0.47	0.06	3.73	0.48
Diabetes	3.26	0.64	16.58	0.16	1.86	0.37	9.27	0.45
Previous major breast surgery	0.97	0.37	2.53	0.95	1.03	0.48	2.23	0.94
Radiation history	2.51	0.78	8.05	0.12	1.36	0.44	4.23	0.59

OR = odds ratio; CI = confidence interval; BMI = body mass index.

pathologic nipple discharge).[25,29,30] However, other patient factors have been historically treated as relative contraindications based on surgeon preference. These factors include higher BMI, large and/or ptotic breasts, diabetes, tobacco use before surgery, neoadjuvant chemotherapy, history of radiation, previous breast surgery, tumor size (>2 cm), distance from nipple, and axillary node positivity. Several of these factors have shown conflicting data with respect to risk association. Accordingly, over time some centers have been less stringent on patient selection.[1,29,31]

BMI has been inconsistently associated with poorer outcomes in breast surgery, and specifically NSM. In this population, some studies support that higher BMI increases risk of NAC necrosis.[15,25,32,33] A similar trend has been documented for mastectomy skin flap necrosis in both autologous and prosthetic reconstruction.[17,34] However, others have found no increased ischemic risks with higher BMI in NSM patients.[20,22,35] Regression analysis of our patients showed a higher BMI led to slightly higher odds of ischemic complications of the NAC requiring intervention (OR = 1.09, CI 1.01–1.12), but not for mastectomy skin flap ischemia requiring intervention (OR = 0.97, $p = 0.46$).

Less well studied are the impacts of BMI on OTs across breast surgery, and the overall impact of OT on outcomes. Fischer et al.[8] examined the effect of obesity on outcomes for prosthetic and autologous breast reconstructions, and found increasing BMI led to longer OTs. Another plastic surgery review defined increased risk of complications in autologous and tissue expander reconstructions at 6.8 h and 3.1 h, respectively.[11] Hanwright et al.[36] performed multivariable analysis of 9786 patients undergoing reconstruction with tissue expanders and found that for each additional hour of surgery, the odds of morbidity increased 1.26 times ($p < 0.001$). These authors also found longer OT to be associated with more reoperations, prosthesis failure, and wound infections across multiple institutions, although the number of NSMs, if any, was not specified.

In today's healthcare system, efficient resource utilization and quality outcomes are essential. Selecting appropriate NSM candidates and planning their operative care is important first to the patients being cared for but also to institutional and surgical resources. The demonstration that BMI is related to OTs for NSM, in a positive linear relationship, confirms an intuitive relationship that helps surgeons and institutions appropriately plan operating suite resources more specifically to the patients being cared for. The modest relationship between BMI and ischemia risks of the NAC can allow surgeons to counsel patients more precisely regarding the risks of NSM and refine their selection criteria based on shared decision-making with this information.

Conclusions

Increasing BMI is associated with longer operative times for NSM and is modestly associated with NAC ischemia requiring intervention. BMI is not associated with ischemia of mastectomy skin flaps. Surgeons should appropriately counsel patients with higher BMIs considering NSM of their increased NAC ischemic risks and should allocate more operative time for such patients.

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Declaration of competing interest

The authors have no conflicts of interest to disclose.

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