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Advanced Age Is a Risk Factor for Complications Following Abdominal Panniculectomy

Michael J. Cammarata[1] · Rami S. Kantar[1] · William J. Rifkin[1] · Jason A. Greenfield[1] · Jamie P. Levine[1] · Daniel J. Ceradini[1]

Abstract

Background Widespread adoption of bariatric surgery in the treatment of obesity has led to greater numbers of patients seeking panniculectomy, including aged patients, who represent a rapidly growing proportion of the U.S population. Although the quality of life and functional benefits of abdominal panniculectomy have been established, its safety in patients 65 years and older has not been evaluated.

Methods The American College of Surgeons National Surgical Quality Improvements (ACS-NSQIP) database was used to identify patients undergoing panniculectomy between 2010 and 2015. Age 65 years and older was the risk factor of interest, and primary outcomes included 30-day wound complications, overall complications, reoperation, readmission, and mortality. Multivariate regression was performed to control for confounders.

Results Review of the database identified 7030 patients who underwent abdominal panniculectomy. When stratified by age, 6455 (91.8%) of patients were younger than 65, and 575 (8.2%) were 65 or older. Multivariate regression analysis demonstrated that age over 65 was a significant independent risk factor for wound complications (OR = 1.81; 95% CI 1.35–2.42; $p < 0.001$) and all complications (OR = 1.46; 95% CI 1.15–1.87; $p = 0.002$). BMI, smoking, diabetes, and partial or total dependence were also identified as significant independent risk factors for wound and all complications.

Conclusion Our analysis demonstrates that advanced age is an independent risk factor for wound and overall complications following abdominal panniculectomy. These results highlight the importance of preoperative evaluation and optimization of modifiable preoperative risk factors as well as close postoperative follow-up for safe outcomes in patients 65 and older.

Keywords Panniculectomy · Abdominal panniculectomy · Advanced age · Body contouring · Bariatric surgery

Introduction

The prevalence of obesity among individuals of working age is estimated to be around 26% and is on the rise in the United Sates (U.S) [1]. Similarly, bariatric surgery is becoming an increasingly popular therapeutic option for obesity, with a resultant growing number of patients, including aged patients, who require surgical excision of excessive abdominal tissue following massive weight loss. Abdominal panniculectomy is one of the most frequently performed body-contouring procedures following massive weight loss, involves surgical excision of excessive abdominal skin and subcutaneous tissue of the lower abdomen, and has been shown to improve patient mobility, hygiene, and overall quality of life [2, 3].

The U.S population is aging, with individuals that are 65 years or older accounting for nearly 15% of the entire population [4], and it is estimated that patients aged 65 years or more account for 40% of the overall U.S surgical patient population [5]. Aged patients warrant special preoperative consideration and assessment of geriatric manifestations such as frailty and functional impairments that increase their risk for adverse postoperative outcomes [6, 7]. These patients are also characterized by age-related physiological cardiovascular and respiratory changes that affect their perioperative course significantly [8], and numerous studies have previously reported an increased risk of postoperative morbidity and/or mortality in aged patients undergoing various surgical procedures [9–13].

✉ Daniel J. Ceradini
Daniel.Ceradini@nyumc.org

1 Hansjörg Wyss Department of Plastic Surgery, New York University Langone Medical Center, 540 1st Avenue, Lab 2-3, New York, NY 10016, USA

Nevertheless, postoperative outcomes in aged patients undergoing abdominal panniculectomy remain poorly defined. Previous studies that have evaluated complication rates following abdominal panniculectomy were either limited in size, or did not evaluate the association between age and complications directly [14–17]. Furthermore, data regarding outcomes following abdominal dermolipectomy in aged patients is conflicting, with some studies suggesting no significant association, while other studies identified an increased risk of postoperative complications in the aged patient population [18–21]. With this in mind, the goal of our study was to evaluate risk factors and postoperative outcomes in aged patients undergoing abdominal panniculectomy through a large national and validated surgical database.

Methods

Database and Patient Population

For the purpose of this study, database Participant Use Files (PUF) from the years 2010 to 2015 were reviewed. The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) is a prospective, risk-adjusted, outcomes-based registry that records demographic, perioperative, and 30-day postoperative de-identified patient information [22]. The database is compliant with the Health Insurance Portability and Accountability Act (HIPAA) and is exempt from institutional review board (IRB) review. A retrospective review of ACS-NSQIP was performed for the following current procedure terminology (CPT) code: 15830 (excision, excessive skin and subcutaneous tissue (includes lipectomy); abdomen, infraumbilical panniculectomy). Cases recorded with a primary abdominoplasty CPT code (CPT 15847 (excision, excessive skin and subcutaneous tissue (includes lipectomy); abdomen (e.g., abdominoplasty) (includes umbilical transposition and fascial plication)) were not included in our study. The current procedural terminology (CPT) code 15830 is the code through which abdominal panniculectomy is coded in the U.S. The code refers to excision of excessive skin and subcutaneous tissue (including lipectomy) of the abdomen. We did not include cases coded as 15847 as these represent abdominoplasty cases and we wanted to avoid combining all of these cases within the same group.

Study Design

Database review was performed for the selected CPT code, and cases with missing age, gender, weight, height, and wound classification were excluded from analysis. Age greater than or equal to 65 years was the risk factor of interest in this study [23]. Patient preoperative demographics, clinical factors, and medical comorbidities at time of surgery were analyzed. Variables with predominantly missing data were excluded from the analysis. Primary outcomes of the study included: wound complications, overall complications, reoperation, readmission, and mortality. Wound complications were a composite outcome that consisted of superficial incisional surgical site infection, deep incisional surgical site infection, or wound dehiscence. Overall complications was a composite outcome that included developing any of the following: wound complications, reoperation, readmission, mortality, postoperative bleeding or transfusion requirement, deep venous thrombosis (DVT), pulmonary embolism (PE), myocardial infarction (MI), urinary tract infection (UTI), or sepsis. Secondary outcomes included operative time, hospital length of stay (LOS), postoperative bleeding or transfusion requirement, DVT, PE, MI, UTI, and sepsis.

Statistical Analysis

Continuous variables are reported as "mean ± standard deviation (SD)" while categorical variables are reported as frequencies and percentages within their corresponding groups. Univariate analysis was performed using chi-square or Fisher's exact test ($n < 10$) for categorical variables, and student's t test for continuous variables. Potential confounders were controlled for using multivariate logistic and linear regression analyses. Variables included in our regression models consisted of age, body mass index (BMI), gender, history of smoking, coronary artery disease (CAD), hypertension, diabetes, chronic obstructive pulmonary disease (COPD), bleeding disorder, steroid use, functional status, American Society of Anesthesiology (ASA) classification, race, surgical team specialty, and wound classification. Statistical significance was defined as p value less than 0.05. All data analyses were performed using SPSS version 23.0 (IBM Corp., Armonk, NY).

Results

Review of the database identified 7030 patients who underwent abdominal panniculectomy. Descriptive statistics of patient preoperative variables and characteristics are included in Table 1. Evaluation of primary outcomes showed the rate of wound complications was 7.0%, while the rate of overall complications was 13.5%. Thirty-day rates of reoperation, readmission, and mortality were 3.7%, 0.7%, and 0.1% respectively. The mean operative time (mean ± SD) was 176.0 ± 90.4 minutes and the mean hospital length of stay (mean ± SD) was 1.8 ± 7.2 days (Table 2).

When patients were stratified by age, 6455 (91.8%) were younger than 65 years of age and 575 (8.2%) were 65 or older. Patients 65 or older had a significantly higher BMI (34.2 ± 9.6

Table 1 Descriptive statistics of preoperative variables

Variable ($n = 7030$)	n (%)
Age in years (mean ± SD)	46.4 ± 12.0
BMI (mean ± SD)	31.8 ± 9.5
Male	800 (11.4)
Obese	3403 (48.4)
Smoker	719 (10.2)
CAD	57 (0.8)
Hypertension	1884 (26.8)
Diabetes	770 (10.9)
COPD	113 (1.6)
Bleeding disorder	83 (1.2)
Steroid use	93 (1.3)
Functional status	
Independent	6934 (98.6)
Partial or totally dependent	101 (1.4)
ASA class	
Lower than 3	5375 (76.4)
3 or higher	1650 (23.5)
Race	
American Indian or Alaska Native	38 (0.5)
Asian	84 (1.2)
Black or African American	768 (10.9)
Native Hawaiian/Pacific Islander	21 (0.3)
White	5082 (85.2)
Surgical specialty	
Plastic surgery	5604 (79.7)
General surgery	1431 (20.3)
Wound classification	
Clean	6406 (91.1)
Clean/contaminated	392 (5.6)
Contaminated	130 (1.8)
Dirty/infected	107 (1.5)

SD standard deviation, *BMI* body mass index, *CAD* coronary artery disease, *COPD* chronic obstructive pulmonary disease, *ASA* American Society of Anesthesiology

vs. 31.6 ± 9.5; $p < 0.001$), percentage of males (17.9% vs. 10.8%; $p < 0.001$), and were significantly less likely to be smokers (3.7% vs. 10.8%; $p < 0.001$). Patients 65 or older had significantly higher rates of CAD (2.3% vs. 0.7%; $p < 0.001$), hypertension (62.1% vs. 23.6%; $p < 0.001$), diabetes (27.3% vs. 9.5%; $p < 0.001$), COPD (4.5% vs. 1.3%; $p < 0.001$), and bleeding disorders (2.3% vs. 1.1%; $p < 0.001$). There were significant differences between both groups in functional status ($p < 0.001$), ASA class ($p < 0.001$), racial distribution ($p < 0.001$), the surgical team specialty distribution ($p < 0.001$), and distribution of wound classification ($p < 0.001$) (Table 3).

Univariate analysis of primary and secondary outcomes stratified by age showed that patients 65 or older had

Table 2 Descriptive statistics of surgical and medical outcomes

Variable ($n = 7030$)	n (%)
Primary outcomes	
Wound complications	491 (7.0)
Complications	953 (13.5)
Reoperation	260 (3.7)
Readmission	46 (0.7)
Mortality	2 (0.1)
Secondary outcomes	
Operative time in minutes (mean ± SD)	176.0 ± 90.4
Hospital LOS in days (mean ± SD)	1.8 ± 7.2
Bleeding/transfusion	320 (4.5)
DVT	34 (0.5)
PE	23 (0.3)
MI	3 (0.1)
UTI	46 (0.7)
Sepsis	59 (0.8)

LOS length of stay (days), *SD* standard deviation, *DVT* deep venous thrombosis, *PE* pulmonary embolism, *MI* myocardial infarction, *UTI* urinary tract infection

significantly higher rates of wound complications (14.6% vs. 6.3%; $p < 0.001$) and overall complications (23.3% vs. 12.7%; $p < 0.001$), as well as a significantly shorter operative time (156.7 ± 80.0 vs. 177.7 ± 91.1; $p < 0.001$), and significantly longer hospital LOS (2.4 ± 3.7 vs. 1.7 ± 7.4; $p < 0.02$) (Table 4).

Multivariate regression analysis demonstrated that age 65 or older was an independent risk factor for wound complications (OR = 1.81; 95% CI 1.35–2.42; $p < 0.001$), and overall complications (OR = 1.46; 95% CI 1.15–1.87; $p = 0.002$). BMI (OR = 1.03; 95% CI 1.02–1.04; $p < 0.001$ and OR = 1.04; 95% CI 1.03–1.05; $p < 0.001$), smoking (OR = 1.54; 95% CI 1.14–2.10; $p < 0.001$ and OR = 1.46; 95% CI 1.15–1.85; $p = 0.002$), diabetes (OR = 1.46; 95% CI 1.15–1.86; $p = 0.002$ and OR = 1.26; 95% CI 1.04–1.51; $p = 0.02$), and partially or totally dependent functional status (OR = 2.25; 95% CI 1.35–3.75; $p = 0.002$ and OR = 3.53; 95% CI 2.20–5.70; $p < 0.001$) were also significant independent risk factors for wound and overall complications, respectively (Table 5).

Multivariate analysis also showed that BMI was an independent significant risk factor for longer operative time ($\beta = 0.61$; 95% CI 0.33–0.90; $p < 0.001$) and hospital LOS ($\beta = 0.06$; 95% CI 0.04–0.08; $p < 0.001$) (Table 6).

Discussion

The U.S population is aging rapidly, and individuals 60 years and older are projected to comprise more than a quarter of the population by 2050 [24]. Similarly, the rates of obesity and

Table 3 Univariate analysis of preoperative variables stratified by age

Variable (n = 7030)	Younger than 65 (n = 6455) n (%)	Age 65 or more (n = 575) n (%)	p
Age (mean ± SD)	44.4 ± 10.4	68.8 ± 3.6	< 0.001
BMI (mean ± SD)	31.6 ± 9.5	34.2 ± 9.6	< 0.001
Male	697 (10.8)	103 (17.9)	< 0.001
Smoker	698 (10.8)	21 (3.7)	< 0.001
CAD	44 (0.7)	13 (2.3)	< 0.001
Hypertension	1527 (23.6)	357 (62.1)	< 0.001
Diabetes	613 (9.5)	157 (27.3)	< 0.001
COPD	87 (1.3)	26 (4.5)	< 0.001
Bleeding disorder	70 (1.1)	13 (2.3)	0.01
Steroid use	82 (1.3)	11 (1.9)	0.20
Functional status			
Independent	6379 (98.7)	555 (96.5)	< 0.001
Partial or totally dependent	81 (1.3)	2.0 (3.5)	
ASA class			
Lower than 3	5091 (78.9)	284 (49.6)	< 0.001
3 or higher	1361 (21.1)	289 (50.4)	
Race			
American Indian or Alaska Native	38 (0.7)	0 (0)	< 0.001
Asian	83 (1.5)	1 (0.2)	
Black or African American	746 (13.6)	22 (4.2)	
Native Hawaiian/Pacific Islander	18 (0.3)	3 (0.6)	
White	4586 (83.8)	496 (95.0)	
Surgical specialty			
Plastic surgery	5197 (80.4)	407 (70.8)	< 0.001
General surgery	1263 (19.6)	168 (29.2)	
Wound classification			
Clean	5909 (91.5)	497 (86.4)	< 0.001
Clean/contaminated	352 (5.4)	40 (7.0)	
Contaminated	1103 (1.6)	27 (4.7)	
Dirty/infected	96 (1.5)	11 (1.9)	

SD standard deviation, *BMI* body mass index, *CAD* coronary artery disease, *COPD* chronic obstructive pulmonary disease, *ASA* American Society of Anesthesiology, *p* p value

widespread use of bariatric surgery have led to a corresponding "weight-loss epidemic" [25], with greater numbers of patients, including aged patients, necessitating abdominal panniculectomy [26–29]. Excess abdominal tissue can lead to poor hygiene [25], recurrent infections in intertriginous areas [17], psychological distress [30], as well as decreased quality of life secondary to difficulties with ambulation and sexual functioning [17]. While abdominal panniculectomy may lead to the resolution of these symptoms, the procedure is associated with significant complication rates [15, 17, 31]. Given the decreased physiological reserve in aged patients, and the anticipated increased need for this procedure in this age group, we sought to evaluate the safety of abdominal panniculectomy in the aged patient population using a validated national database.

Advanced age is associated with a greater prevalence of multiple medical comorbidities that warrant perioperative consideration [32, 33]. Multivariate regression analysis in our study identified diabetes, smoking, and increasing BMI as independent risk factors for postoperative wound complications and overall complications following abdominal panniculectomy. These findings reiterate and verify previously identified risk factors for complications following abdominal panniculectomy, as diabetes has previously been shown to be a significant risk factor for postoperative wound complications [34]. Similarly, smoking has been associated with increased complications after abdominal dermolipectomy such as seroma and skin necrosis [25, 35], and is well known to induce tissue hypoxia and impair wound healing [36]. Similarly, BMI was also found to be a significant predictor of wound and overall complications after panniculectomy [14]. In abdominal dermolipectomy, maximum BMI and change in BMI were also found to be positively associated with wound complications [18, 37]. These findings may be

Table 4 Univariate analysis of outcomes stratified by age

Variable ($n = 7030$)	Younger than 65 ($n = 6455$) n (%)	Age 65 or more ($n = 575$) n (%)	p
Primary outcomes			
Wound complications	407 (6.3)	84 (14.6)	< 0.001
Complications	819 (12.7)	134 (23.3)	< 0.001
Reoperation	231 (3.6)	29 (5.0)	0.07
Readmission	42 (1.0)	4 (1.0)	0.96
Mortality	1 (0.1)	1 (0.2)	0.03
Secondary outcomes			
Operative time (mean ± SD)	177.7 ± 91.1	156.7 ± 80.0	< 0.001
Hospital LOS (mean ± SD)	1.7 ± 7.4	2.4 ± 3.7	0.02
Bleeding/transfusion	290 (4.5)	30 (5.2)	0.42
DVT	32 (0.5)	2 (0.3)	0.63
PE	19 (0.3)	4 (0.7)	0.11
MI	2 (0)	1 (0.2)	0.11
UTI	40 (0.6)	6 (1.0)	0.23
Sepsis	51 (0.8)	8 (1.4)	0.13

LOS length of stay (days), *SD* standard deviation, *DVT* deep venous thrombosis, *PE* pulmonary embolism, *MI* myocardial infarction, *UTI* urinary tract infection, *p* p value

explained by the obesity wound milieu which is known to be associated with compromised wound healing [38]. The risks imposed by these various comorbidities, combined with the poor physiologic reserve associated with advanced age and increased susceptibility to anesthetic-induced vasoplegia and atelectasis [21, 39], highlight the importance of preoperative medical evaluation, prevention, and screening for modifiable risk factors in patients 65 and over. Current guidelines recommend that aged patients undergo preoperative evaluation of renal function and albumin levels [23]. In aged patients, particular attention should be made to hemoglobin evaluation, given that undetected preoperative anemia was shown to increase 30-day mortality following major non-cardiac surgery [40, 41]. Patient-specific comorbidities should guide decision-making to pursue additional preoperative evaluations, while factors such as glucose control, smoking status, weight, and nutritional balance, should be stable and optimized prior to surgery.

Adjusted regression analysis in our study showed that age 65 years and older was an independent significant risk factor for postoperative wound complications and overall complications, even after adjusting for potential confounders and preoperative associated comorbidities. This finding is also in line with previous data suggesting that increasing age is an independent risk factor for postoperative morbidity and mortality across various disciplines within general surgery [42]. Despite these known risks of increasing age on postoperative complications, data in the literature specific to panniculectomy have been conflicting. Preoperative BMI, and not age, was a significant risk factor for complications in a cohort of 126 patients undergoing panniculectomy following bariatric surgery [14]. However, the analysis in the study was not stratified by age and was limited by sample size. Similarly, age was not associated with postoperative complications in another study evaluating patients undergoing abdominal panniculectomy [43]. Similar findings were

Table 5 Multivariate regression analysis of wound and all complications

Variable	Wound complications			Complications		
	OR	95% CI	p	OR	95% CI	p
Age 65 or more	1.81	1.35–2.42	< 0.001	1.46	1.15–1.87	0.002
BMI	1.03	1.02–1.04	< 0.001	1.04	1.03–1.05	< 0.001
Smoking	1.54	1.14–2.10	< 0.001	1.46	1.15–1.85	0.002
Diabetes	1.46	1.15–1.86	0.002	1.26	1.04–1.51	0.02
Partially or totally dependent	2.25	1.35–3.75	0.002	3.53	2.20–5.70	< 0.001

OR odds ratio, *CI* 95% confidence interval, *p* p value, *BMI* body mass index

Table 6 Multivariate regression analysis of operative time and hospital length of stay

Variable	Operative time			Hospital LOS		
	β	95% CI	p	β	95% CI	p
BMI	0.61	0.33–0.90	< 0.001	0.06	0.04–0.08	< 0.001

LOS length of stay, β beta coefficient, *CI* 95% confidence interval, *p* p value, *BMI* body mass index

observed in a series of 706 patients who underwent panniculectomy for massive weight loss following bariatric surgery [15]. In contrast, analysis of 183,914 patients from the CosmetAssure database, determined that aged patients experienced a significant increase in complications following abdominal dermolipectomy [21]. While overall complications may be attributed to decreased physiologic reserve [21], the increased risk of dehiscence and wound complications observed in our study could be due to the well-established detrimental effects of aging on all stages of wound healing [44, 45] and loss of tensile strength induced by weight loss [38], and highlight the importance of vigilant postoperative wound care and monitoring in this patient population. Given that these physiologic changes are inherent to the aging process and thus non-modifiable, the increased risk of wound and overall complications observed in the aged patient population should be discussed with the patient as part of the informed consent process prior to surgery [18].

Limitations of the database prevented us from analyzing the impact of pertinent variables such as the use of drains, prophylactic anticoagulation, and antibiotics. Furthermore, while seroma formation is one of the more common postoperative complications associated with abdominal panniculectomy [46–49], it is not recorded as a separate outcome within the NSQIP database. The dataset is further limited by its ability to only capture postoperative data within a 30-day window, and therefore may have underestimated the incidence of complications. Furthermore, the database does not unfortunately capture esthetic outcomes or surgeon-specific technique or surgical approach. Additionally, the database does not keep track of previous surgical history, which prevented us from accounting from determining whether the excessive soft tissue redundancy requiring panniculectomy was due to bariatric surgery or other causes. This is important as existing abdominal scars from bariatric surgery may affect skin flap circulation and increase the risk of wound complications [14, 25], and patients with massive weight loss are hypothesized to be at greater risk for developing wound complications [38]. Finally, the absence of data pertinent to patient functional status prevented from analyzing and correlating the degree of preoperative disability with need for surgery.

Conclusion

Our study suggests that age 65 and older is an independent risk factor for wound and overall complications following abdominal panniculectomy. Surgical teams performing the procedure should be aware of this non-modifiable risk factor, and manage patient postoperative expectations accordingly. Our analysis also highlights the importance of optimizing modifiable preoperative risk factors and heightened vigilance following abdominal panniculectomy in this patient population to ensure safe and optimal outcomes.

Disclaimer

The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS-NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

Compliance with Ethical Standards

Conflict of Interest   The authors declare that they have no conflict of interest.

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