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Abdominal Panniculectomy: An Analysis of Outcomes in 238 Consecutive Patients over 10 Years

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Background: Panniculectomy is a commonly performed body contouring procedure to address skin laxity and its related complications. This study aimed to assess clinical outcomes of abdominal panniculectomy and identify predictors of complications at a tertiary academic healthcare center.

Methods: A retrospective review of patients who underwent panniculectomy between January 2010 and January 2020 at our institution was performed. Exclusion criteria were a history of prior panniculectomy or abdominoplasty. Patient characteristics and clinical outcomes were collected. Univariate and multivariable analyses were performed to assess the risk factors of complications.

Results: The mean age in the included 238 patients was 51.7 ± 12.7 years, and the mean body mass index (BMI) at the time of panniculectomy was 33 ± 7.5 kg/m^2. Median resection weight was 2.7 kg (range: 0.15–14.6) and median length of hospital stay was 2 days (range: 0–24). Mean follow-up time was 50 ± 37 months. The rate of major complications was 22.3%. Revision surgery was performed in 3.4% of the cases. Multivariable analyses demonstrated that increase in BMI ($P = 0.007$) and active smoking ($P = 0.026$) were significantly associated with increased odds of major complication, and increase in BMI ($P = 0.0004$), history of venous thromboembolism ($P = 0.034$) and having a concomitant ventral hernia repair ($P = 0.0044$) were significantly associated with having a length of hospital stay of 3 days or more.

Conclusions: Panniculectomy is generally safe to perform, with major postoperative complication rate of 22.3% in our series. Increase in BMI and active smoking were significantly associated with having a major complication. Higher BMI, concomitant hernia repair, and a history of venous thromboembolism were associated with length of hospital stay of 3 days or more. *(Plast Reconstr Surg Glob Open 2021;9:e3955; doi: 10.1097/GOX.0000000000003955; Published online 24 November 2021.)*

INTRODUCTION

As the rate of obesity in the United States increases, there has also been a rise in the number of patients who seek out bariatric surgery followed by body contouring surgery. The abdomen is one of the most targeted areas for body contouring in patients after significant weight loss or pregnancy.[1] Abdominal panniculectomy is a commonly performed procedure to address skin laxity and its related complications such as recurrent intertriginous dermatitis. Patients who undergo abdominal panniculectomy often have comorbidities and persistent high body mass index (BMI) despite attempted medical or surgical weight loss.

The benefits of abdominal panniculectomy have been well documented in the literature, and these include the improvement of one's physical and mental health through greater mobility, posture, improved skin hygiene, decreased intertriginous infection rates, increased self-esteem, and body image satisfaction.[2–4] However, historically this procedure has been associated with increased complication rates such as wound infection, dehiscence, seroma, and venous thromboembolism (VTE). Certain patient characteristics have been previously correlated with an increase in risk of postoperative complications following a panniculectomy. These include age 65 years or older, high BMI, smoking, and diabetes mellitus.[5–7]

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As the number of patients seeking out abdominal panniculectomy increases, understanding of modifiable risk factors to mitigate complications has become paramount to improve safety associated with this procedure. In this study, we assessed clinical outcomes of abdominal panniculectomies performed at our tertiary academic hospital over the last 10 years and aimed to identify predictors of postoperative complications.

PATIENTS AND METHODS

Study Design and Patient Selection

Following approval by our institutional review board, a retrospective electronic chart review of consecutive patients aged 18 years or older who underwent abdominal panniculectomy at our institution between January 2010 and January 2020 was performed. Patients with a history of panniculectomy, abdominoplasty, or circumferential belt lipectomy, and patients with less than 3 months follow-up were excluded from this study. Only procedures performed by plastic surgeons were included. The type of surgery was defined by Common Procedural Terminology codes using CPT code 15830 without an adjunct CPT code 15847 (abdominoplasty) and confirmed by a review of the operative note. Demographics included gender, age, BMI at the time of panniculectomy, mean maximum historical BMI; comorbidities included smoking status, history of VTE, hypertension, diabetes mellitus, dyslipidemia, coronary artery disease, history of bariatric surgery, laparotomy, and history of weight loss by diet & exercise. In patients who had weight loss, BMI reduction rate was calculated by the following formula: (maximum BMI – BMI at the time of panniculectomy)/maximum BMI. Clinical characteristics including type of panniculectomy [transverse skin excision versus inverted-T (fleur-de-lis)], having a concomitant ventral hernia repair or concomitant suction-assisted lipectomy, and length of stay (LOS) in the hospital following panniculectomy were recorded. Major postoperative complications included surgical site infection (SSI) defined according to the Centers for Disease Control and Prevention guidelines of SSI,[8] hematoma requiring evacuation, seroma requiring intervention, and open wound that required surgical intervention. Minor complications included wounds or incisional dehiscence managed with dressing care, and scar related problems that were managed medically. The rate of postoperative VTE was noted. The rate and indication of revision surgery were also recorded. BMI at the time of panniculectomy was classified according to The World Health Organization (WHO) Obesity Classification.[9] Patients with BMI less than 30 kg/m^2 were grouped as nonobese patients. The smoking status was categorized as (1) active smoker, defined as a person who currently smoked at least one cigarette a day or smoked within 30 days before the surgery; (2) former smoker, defined as a person who had smoked more than 100 cigarettes in their lifetime and did not smoke within 30 days before the surgery; and (3) never smoker, defined as a person who never smoked or smoked less than 100 cigarettes in their lifetime.

Takeaways

Question: What are the modifiable risk factors for complications following abdominal panniculectomy?

Findings: In 238 abdominal panniculectomies, the rate of major complications was 22.3%. Multivariable analyses demonstrated that increase in BMI and active smoking were significantly associated with increased odds of major complications. Increase in BMI, history of VTE and having a concomitant ventral hernia repair were significantly associated with having a length of stay of 3 or more days.

Meaning: Patients should be counseled about modifiable risk factors such as obesity and smoking prior to panniculectomy.

Surgical Technique

Markings for a panniculectomy are performed with the patient in a standing position along the lower abdominal crease. The midline abdominal incision is marked approximately 7 cm above the vaginal commissure. If the mons is ptotic, the lowest part of the incision runs into the mons, accounting for a mons lift. The lateral extension is made as lateral as possible to include the skin redundancy on each side and minimize standing cones. Depending on the extent of abdominal skin redundancy, the patient's history of skin rashes and involvement of the umbilicus, an umbilicoplasty may be necessary to excise additional abdominal skin around the umbilicus, or in some scenarios, an umbilical amputation may be necessary. A discussion regarding the management of the umbilicus in these situations is had with the patient preoperatively.

The lower abdominal incision is made in a standard fashion followed by Bovie cautery dissection to the rectus abdominis fascia. Any sizable perforators are ligated with vascular hemoclips and divided. The dissection continues to the level of planned markings of the abdominal skin rolls. The dissection is limited to the abdominal skin redundancy. Lateral abdominal wall perforators are preserved. If required, discontinuous undermining is performed laterally in a supra-fascial manner when a fleur-de-lis excision is planned. The patient's table is reflexed up at 20-degrees to mark out the superior transverse incision for resection. The amount of abdominal skin to be excised is then determined using Pitanguy clamps. The amount of tension at the time of closure is minimal. Closure proceeds in layers using 2.0 PDS for Scarpa's fascia, 3 0 Monocryl (Ethicon, Inc., Cornelia, Ga.) for deep dermal closure and a running 3.0 Monocryl Ethicon, Inc., Cornelia, Ga.). Two 15-round channel drains are placed through lateral stab incisions. Tranexamic acid is applied through the drains and left in the wound for 30 minutes before activation of the drain bulb. EXPAREL (Pacira BioSciences, Inc., Swindon, UK), bupivacaine liposome injectable suspension, is injected around the incisions and as the transversus abdominis plane blocks. An abdominal binder is applied only when the patient is ambulating. In select patients, postdischarge deep venous thrombosis prophylaxis is prescribed for 7 days. Surgical antimicrobial

prophylaxis included one dose of weight appropriate intravenous first generation cephalosporin within 1 hour before making the incision, and two doses postoperatively.

Statistical Analysis

Descriptive statistics (including medians, percentages and ranges) were used to present the data. Univariate and multivariable logistic regression analyses were performed to assess the associations between variables and postoperative complications. All of the analyses were performed with JMP Statistical Software (v14) (JMP. SAS Institute Inc., Cary, N.C., 1989–2019.) An alpha error of 0.05 was used, and *P* values of less than 0.05 were considered statistically significant.

RESULTS

Two-hundred-thirty-eight consecutive patients were included in this study. Twenty-eight (12%) were men and 210 (88%) were women. The mean age was 51.7 ± 12.7 years and mean BMI at panniculectomy was 33 ± 7.5 kg/m^2. Eighty-four (35%) patients had a BMI ≥ 35 kg/m^2 at time of panniculectomy (WHO Class II and III obesity). The mean maximum historical BMI was 47.2 ± 13.3 kg/m^2. Comorbidities included dyslipidemia (46.2%), hypertension (42.4%), hypertension (29.4%), diabetes mellitus (13.5%), history of smoking (42.4%), and history of VTE (13.5%). Most patients in this cohort (n = 204, 85.7%) had a history of weight loss before panniculectomy by either bariatric surgery (n = 153, 75%) or lifestyle changes (n = 51, 25%). Of the bariatric surgery group, 71% were laparoscopic and 29% were performed by laparotomy. None of these procedures were performed at the same surgical session of panniculectomy.[10] The most common bariatric procedure was Roux-en-Y gastric bypass surgery (n = 110, 72%). Transverse skin excision was utilized in 138 (58%) cases whereas a fleur-de-lis excision pattern in 100 (42%). Concurrent procedures included ventral hernia repair in 76 (32%) cases and liposuction in 29 (12%) cases. The median resection weight was 2.7 kg (approximately 6 pounds; range: 0.15–14.6) and median LOS was 2 days (range: 0–24). The mean follow-up was 50 ± 37 months (4.2 years). Table 1 summarizes the patient and clinical characteristics. An example patient is demonstrated in Figures 1 and 2. The rate of major complications (Table 2) was 22.3% [SSI (n = 27, 11.4%); seroma requiring drainage (n = 12, 5%); wound requiring surgical intervention (n = 10, 4.2%); hematoma requiring evacuation (n = 4, 1.7%)]. The most common minor complication was wound dehiscence that occurred in 30 (12.6%) cases (see Table 3). Revision surgery was performed in eight (3.4%) cases to address persistent skin laxity (n = 5), scar (n = 2) and standing cones (n = 1). VTE occurred in five (2.1%) patients.

Univariate analyses demonstrated that WHO Class III obesity (OR = 4.06, 95% CI [1.63–10.1], *P* = 0.0026) and being an active smoker (OR = 3.57, 95% CI [1.16–11], *P* = 0.027) significantly increased the odds of having a major complication. Hypertension significantly increased the odds of having seroma that requires intervention (OR = 4.4, 95% CI [1.15–16.6], *P* = 0.03). In addition,

Table 1. Patient Demographics and Clinical Characteristics

	n
Patients	238
Gender	
Men (%)	28 (11.8)
Women (%)	210 (88.2)
Mean age (SD), y	51.7 (12.7)
Hypertension (%)	101 (42.4)
Diabetes mellitus (%)	70 (29.4)
Dyslipidemia (%)	110 (46.2)
Coronary artery disease (%)	31 (13)
History of VTE (%)	32 (13.5)
History of smoking (%)	101 (42.4)
Never smoker	137 (57.6%)
Former smoker	87 (36.6%)
Active smoker	14 (5.9%)
History of bariatric surgery (%)	153 (64.3)
History of open abdominal surgery (%)	169 (71.0)
Mean BMI at panniculectomy (SD), kg/m^2	33 (7.5)
Mean maximum historical BMI (SD), kg/m^2	47.2 (13.4)
Obesity status at the time of panniculectomy	
Nonobese	85 (35.7)
Class I obesity	67 (28.2)
Class II obesity	49 (20.6)
Class III obesity	35 (14.7)
Missing	2 (0.8))
Fleur-de-lis (%)	100 (42)
Mean BMI reduction rate (SD)*	0.28 (0.17)
Concomitant SAL (%)	29 (12.2)
Concomitant ventral hernia repair (%)	76 (31.9)
Median resection weight (range), kg	2.7 (0.15–14.6)
Median length of hospital stay (range), d	2 (0–24)
Mean follow-up (SD), mo	49.5 (37.2)

*In patients who had weight loss.

patients with WHO Class II obesity (OR = 3.95, 95% CI [1.12–13.9], *P* = 0.032) and patients with WHO Class III obesity (OR = 7.01, 95% CI [1.99–24.7], *P* = 0.002) had increased odds of having SSI when compared with nonobese patients. Furthermore, increase in BMI (OR = 1.07 per 1 kg/m^2 increase, 95% CI [1.03–1.12], *P* = 0.0002), history of VTE (OR = 2.51, 95% CI [1.18–5.35], *P* = 0.014) and having a concomitant ventral hernia repair (OR= 2.34, 95% CI [1.33–4.12], *P* = 0.003) were independently associated with having a LOS of 3 days or more. Moreover, there was no significant association between variables and the odds of having a VTE after panniculectomy. Lastly, among patients who lost weight, the rate of BMI reduction and the type of panniculectomy was significantly associated. Patients with a BMI reduction rate of 30% or more were more likely to undergo inverted-T panniculectomy rather than the transverse incision (OR = 2.4, 95% CI [1.43–4.13], *P* = 0.0009). Other variables such as gender, resection weight, and type of panniculectomy were not associated with outcome measures. Univariate analysis results assessing the association between the variables and the outcome of having a major complication are summarized in Table 4.

Multivariable analyses demonstrated that increase in BMI (adjusted OR = 1.06 per 1 kg/m^2 increase, 95% CI [1.02–1.11], *P* = 0.007) and active smoking (aOR = 3.79, 95% CI [1.18–12.1], *P* = 0.026) were significantly associated with increased odds of major complication; and increase in BMI (aOR = 1.07, 95% CI [1.03–1.12], *P* = 0.0004), history of VTE (aOR = 2.33, 95% CI [1.07–5.1], *P* = 0.034) and having a concomitant ventral hernia repair (aOR = 2.36, 95% CI [1.31–4.28], *P* = 0.0044) were significantly associated with increased odds of having

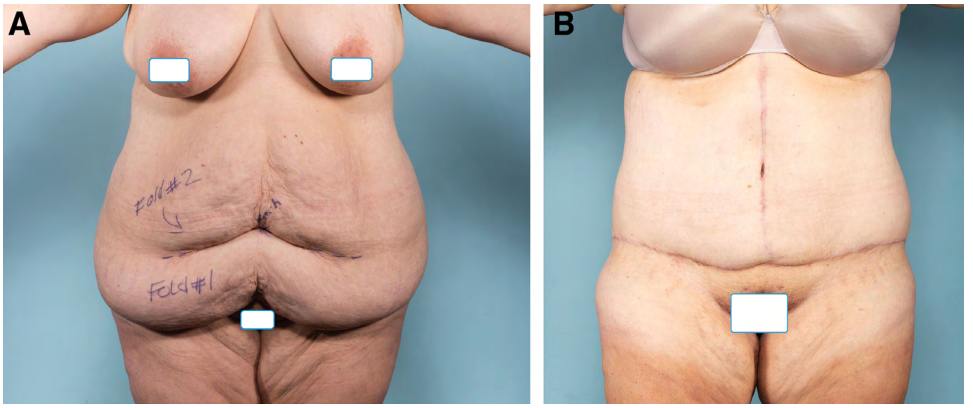

Fig. 1. Preoperative and postoperative images of a 41-year-old female patient who underwent an inverted-T panniculectomy/ anterior views. A, Anterior view of the preoperative image. B, Anterior view of the 6-months postoperative image.

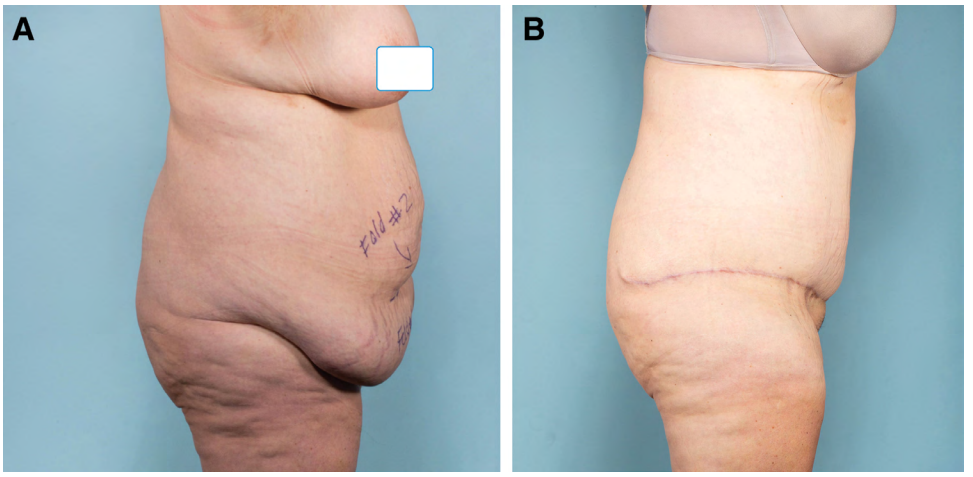

Fig. 2. Preoperative and postoperative images of a 41-year-old female patient who underwent an inverted-T panniculectomy/lateral views. A, Lateral view of the preoperative image. B, Lateral view of the 6-months postoperative image.

a LOS of 3 days or more. Tables 5 and 6 summarize the results of multivariable analyses.

DISCUSSION

The history of abdominal panniculectomy goes back to the beginning of the 20th century when it was pioneered by Kelly[11] and Peters.[12] Since then, it has been a useful body contouring procedure for surgeons to address the excessive abdominal panniculus, which may develop after weight changes, pregnancy, prior surgery, or a combination of the above.[5,7,10,13–21] With the increased popularity of bariatric surgery and advances in nonsurgical weight loss techniques, abdominal panniculectomy continues to be a commonly sought procedure in plastic surgery.[5–7,10,13–17,22,23] It has shown promising results in improving the quality of life, functional status (including sexual functioning and ambulation), and in treating the psychological distress in these patients.[7,23] On the other hand, panniculectomy itself carries a high risk of postoperative wound complications and other morbidities such VTE.[7,18,23] Therefore, identifying the risk factors for these complications in large patient cohorts with long-term follow up has a significant value for perioperative planning, reducing postoperative complications, and patient counseling.

Table 2. Major Complications

	n (%)
Major complications	53 (22.3)
SSI	27 (11.3)
Seroma*	12 (5)
Wound*	10 (4.2)
Hematoma*	4 (1.7)

*Requiring aspiration, drainage, evacuation, or surgical intervention.

Table 3. Minor Complications

	n (%)
Minor complications	77 (32.4)
Wound dehiscence	30 (12.6)
Fat necrosis	27 (11.3)
Hypertrophic scar	9 (3.8)
Suture granuloma	4 (1.7)
Scar contracture	4 (1.7)
Partial thickness skin necrosis	3 (1.3)

Table 4. Univariate Analysis Assessing the Predictors of Having a Major Complication

Predictors of Having a Major Complication	Odds Ratio	95 % CI	*P*
Age at the time of panniculectomy	1.01	0.99–1.04	0.37
BMI at the time of panniculectomy	1.06*	1.02–1.1	0.007†
Obesity status			
Nonobese	Ref	Ref	Ref
Class I obesity	1.47	0.62–3.46	0.39
Class II obesity	2.2	0.91–5.3	0.08
Class III obesity	4.06	1.63–10.1	0.0026†
Diabetes mellitus	1.05	0.54–2.04	0.89
BMI reduction rate	0.47	0.072–3.11	0.43
Hypertension	1.05	0.57–1.95	0.87
Dyslipidemia	1.16	0.63–2.13	0.64
Coronary artery disease	1.02	0.41–2.52	0.96
Smoking			
Never smoker	Ref	Ref	Ref
Former smoker	0.8	0.41–1.58	0.53
Active smoker	3.57	1.16–11	0.0265†
History of VTE	1.72	0.76–3.9	0.19
History of bariatric surgery	0.88	0.47 - 1.66	0.69
History of open abdominal surgery	0.59	0.31–1.13	0.11
Resection weight	1	0.99–1	0.78
Type of incision			
Transverse	Ref	Ref	Ref
Fleur-de-lis	0.72	0.38–1.35	0.3
Concomitant ventral hernia repair	1.4	0.74–2.64	0.31
Concomitant SAL	0.37	0.11–1.26	0.11

*Ratio per 1 kg/m² increase.
†Statistically significant value. Statistical significance was obtained using logistic regression.
Ref, reference variable.

In this study, we reviewed our institutional experience with abdominal panniculectomy over the last 10 years and identified risk factors for postoperative complications. In this cohort of 238, patients had an average BMI of 33 kg/m², of which 69% had at least one comorbidity. The rate of major complications was 22.3%, which is similar to previous reports in the literature.[5–7,18] Multivariable analysis demonstrated that increase in BMI and active smoking increased the odds of having a major complication with adjusted odds ratios of 1.06 and 3.79, respectively. These findings were congruent with the previous literature.[5–7,18] In their retrospective review of 563 patients with an average BMI of 33.4 kg/m², Zannis et al[5] reported that smoking and higher BMI were significantly associated with having a wound complication. In their cohort, 22.8% of the patients had at least one wound complication following panniculectomy. Also, similarly to our study, a history of bariatric surgery was not significantly associated with increased odds of complications. In a recent retrospective study of 203 patients who underwent abdominal panniculectomy, Lesko et al[18] reported a complication rate of 21.2% which was also similar to our cohort. The authors reported a significantly higher odds of complication in patients with a BMI of 40 kg/m² or greater compared with nonobese patients. Similarly, the univariate analysis in our study demonstrated that patients with WHO Obesity Class III (BMI ≥ 40 kg/m²) had significantly increased odds of having a major complication when compared with nonobese patients. In a study reviewing the American College of Surgeons National Surgical Quality Improvements (ACS-NSQIP) database, Kantar et al[6] revealed that diabetes mellitus was associated with increased odds of having wound complications, including superficial, deep, and organ/space SSIs, whereas obesity and smoking were significantly associated with superficial and deep SSIs. A similar review of ACS-NSQIP database by Cammarata et al[7] identified age 65 years or older, diabetes mellitus, smoking, and increasing BMI as independent risk factors for postoperative wound and overall complications following abdominal panniculectomy. In our study, diabetes mellitus and age did not have significant associations with postoperative complications. This may be due to the relatively smaller sample size in our study (n = 238) compared with national database studies. However, unlike NSQIP studies that report 30-day outcomes only, our study included 238 patients with a mean follow up of 50 ± 37 months. Furthermore, multivariable analysis in our study demonstrated that increase in BMI, history of VTE, and having a concomitant ventral hernia repair were independently associated with increased odds of having an LOS of 3 days or more. This is helpful in counseling patients about their postoperative recovery and provides objective data for insurance carriers. Similarly, Cammarata et al[7] reported that increase in BMI was an independent risk factor for longer LOS.

Table 5. Multivariable Analysis to Assess Predictors of Having a Major Complication

Predictors of Major Wound Complication	Adjusted Odds Ratio	95% CI	*P*
BMI at the time of panniculectomy	1.06	1.02–1.11	0.0066*
Diabetes mellitus	0.83	0.41–1.71	0.61
Smoking			
Never smoker	Ref	Ref	Ref
Former smoker	0.86	0.43–1.72	0.67
Active smoker	3.79	1.18–12.1	0.0255*

*Statistically significant value.
Area under the ROC curve for this multivariable regression model is 0.66.
Ref, reference variable.

Table 6. Multivariable Analysis to Assess Predictors of Having a Length of Stay at the Hospital ≥3 Days

Predictors of Having an LOS ≥3 days	Adjusted OR	95% CI	*P*
BMI at the time of panniculectomy	1.07	1.03 – 1.12	0.0004*
History of VTE	2.33	1.07–5.1	0.0338*
Concomitant ventral hernia repair	2.36	1.31–4.28	0.0044*

Area under the ROC curve for this multivariable regression model is 0.71.
* Statistically significant value.

This study demonstrated that having a concomitant ventral hernia repair with panniculectomy did not significantly impact the odds of having a major wound complication, but it was significantly associated with having an LOS of 3 days or more. The effect of concomitant ventral hernia repair on wound healing remains controversial in the literature.[16,18,24] Zemlyak et al[24] reported a significant association between having a concomitant ventral hernia repair with panniculectomy and the odds of cellulitis when compared with panniculectomy alone, whereas Derickson et al[16] noted no significant association. On the other hand, a comparative study by Diaconu et al[25] in 2019 reported that performing these two operations simultaneously results in higher rates of surgical site occurrence, skin necrosis, and infection when compared with ventral hernia repair alone. However, there was no increase in the rate of surgical site occurrences that required an intervention.

Interestingly, patients with a BMI reduction rate of 30% or more in our cohort were significantly more likely to undergo an inverted-T panniculectomy to address both vertical and horizontal skin excess, hence allowing for more optimal body contouring.[14] Physical examination often determines the pattern of skin resection; however, this BMI reduction rate may offer surgeons additional parameters to plan body contouring procedures.

In our cohort of 238 patients, 151 (63.5%) patients had obesity at the time of panniculectomy, including 35 (14.7%) patients with WHO Class III obesity (BMI ≥ 40 kg/m^2) and 49 (20.6%) patients with WHO Class II obesity (35 kg/m^2 ≤ BMI < 40 kg/m^2). Other comorbidities included dyslipidemia, history of smoking, hypertension, and diabetes mellitus. The rate of postoperative complications is expected to be higher than the other types of body contouring procedures such as abdominoplasty, which is often performed in a younger patient population with less burden of comorbidities. This was previously documented in the study by Lesko et al,[18] in which the rates of complications were reported to be 9.7% and 21.2% after abdominoplasty and panniculectomy, respectively. Furthermore, the rate of postoperative SSI in our cohort was 11.3%, which is comparable to the case series of similar patient population in the literature, ranging from 4% to 22%.[16,18,20,21] The odds of developing SSI increased in patients with BMI of 40 kg/m^2 or greater compared with those with BMI less than 30 kg/m^2 in our cohort. Our routine practice does not include extended postoperative antimicrobial therapy unless a hernia repair was performed concomitantly with the panniculectomy. Some authors suggested an extended antibiotic prophylaxis until the removal of drains; however, studies addressing such practice showed contradictory results.[26,27] It is important to counsel patients about the association between high BMI, smoking cessation, and postoperative complications, as both obesity and smoking are modifiable risk factors before panniculectomy.[28]

Our study has some limitations, including its retrospective nature, which can introduce selection bias. Furthermore, patient-reported outcomes assessing the effect of panniculectomy on the quality of life and functional status of these patients could have been helpful. Further studies involving patient-reported outcomes collected before and after panniculectomy are helpful in illustrating the benefits of abdominal panniculectomy and postoperative recovery from a patient perspective.

CONCLUSIONS

Panniculectomy is generally safe to perform, with major postoperative wound complications of 22.3% in our cohort. Increase in BMI and active smoking were significantly associated with having a major wound complication. Patients with a BMI reduction rate of 30% or more were more likely to undergo inverted-T panniculectomy. Increase in BMI, concomitant hernia repair, and history of VTE were associated with an LOS of 3 days or more. Patients should be counseled about modifiable risk factors before panniculectomy to improve safety and help mitigate complications.

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