OPEN FORUM

Body Contouring

Vertical Abdominoplasty Technique and the Impact of Preoperative Comorbidities on Outcomes

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Abstract

Background: As the number of patients requiring bariatric surgery has increased, so has the demand for body contouring after massive weight loss. Surgery involving the abdomen in these patients is particularly challenging as both vertical and horizontal laxity if often present, making traditional abdominoplasty techniques less effective.

Objectives: The aim of this study was to review the operative technique and evaluate the preoperative comorbidities and operative decisions that may impact patient outcomes in those undergoing vertical abdominoplasty.

Methods: A review of the authors' technique is described. A retrospective chart review of patients who underwent vertical abdominoplasty for significant vertical and horizontal laxity after massive weight loss by a single surgeon between June 2007 and July 2019 was performed. Preoperative parameters, operative factors, and minor and major complications were evaluated.

Results: Our complication rate was 81% (13/16), which were all minor. No major complications were encountered. Patients with a history of nicotine use had a 100% complication rate. There was a trend toward higher seroma formation in patients with coronary artery disease and those with a history of smoking. There was also a trend toward higher wound dehiscence in patients with renal disease. The authors found no statistically significant correlation between complications and older age, higher weight of tissue resected, higher body mass index, and medical comorbidities.

Conclusions: This small series helps to elucidate the role of vertical abdominoplasty in the care of patients following massive weight loss and its associated morbidity. Proper patient selection, appropriate preoperative patient counseling, and sound surgical technique help to mitigate the negative outcomes.

Level of Evidence: 4

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Obesity has become one of the most severe global public health problems over the last 20 years with over 2.1 billion adults worldwide affected.[1] It is associated with many comorbidities, such as heart disease, stroke, osteoarthritis, obstructive sleep apnea, type 2 diabetes mellitus, and certain types of cancer; these are some of the leading causes of preventable, premature death.[2] To address these concerns, there has been an increased prevalence

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of successful bariatric surgery procedures over the past 2 decades. This has resulted in a variety of body contour deformities in the massive weight loss patient that were not commonly seen by plastic surgeons in the past. When a patient loses >50% of his/her excess weight, he/she often sees loose, ptotic skin that has lost its elastic recoil in addition to unexpected folds and fat protuberances. These changes are not predictive of preoperative appearance, degree of weight loss, or patient age.[3] According to The Aesthetic Society for Aesthetic Plastic Surgery, abdominoplasty was the fourth most common procedure performed in 2018 with 157,492 cases. This represents an 11.8% increase from 2017 and a 31% increase from 2014.[4] With rising obesity rates, this number is only going to continue increasing. Unlike the typical abdominoplasty patients who have excess skin and fat in the vertical dimension with little redundancy in the transverse direction, massive weight loss patients often have redundancy in both. When not addressed, these patients are often left with epigastric fullness and laxity, poor waist contour, and unsightly dog ears. When a vertical component is included in the resection, the surgeon is able to directly excise this redundant epigastric tissue and improve the waist contour.

Although abdominal contouring procedures in the massive weight loss patient can be life-changing,[5] the overall complication rate is high at 48%[6] and varies greatly for vertical abdominoplasty (often referred to as fleur de lis) in the literature from 3% to 35.5%.[7-12] These complications are mostly in the form of minor wound complications such as dehiscence and delayed wound healing. Unfortunately, however, few studies focused on this patient population and their risk factors.

Our goal is to present our technique to address significant horizontal and vertical excess, highlighting the difference between our technique and a classic fleur de lis and our experience with the vertical abdominoplasty in massive weight loss patients. To better understand these patients, we also sought to evaluate whether patient factors (including demographic variables and comorbidities) or intraoperative factors had an impact on the incidence and type of complications. Patient selection, preoperative and postoperative care, complications, and results are discussed.

METHODS

This study was conducted in accordance with the Institutional Review Board (IRB). We carried out a retrospective review of all vertical abdominoplasty procedures done consecutively between June 2007 and July 2019 by the senior author at a single institution after massive weight loss. Inclusion criteria were as follows: weight stable for at least 6 months after achieving goal weight, vertical abdominoplasty as a primary procedure, nicotine free at the time of surgery, American Society of Anesthesiologist (ASA) status I, II, or III, medical comorbidities well controlled by primary care physician, no significant cardiac or pulmonary disease, absence of major psychiatric comorbidities, a preoperative medical clearance evaluation, and an understanding of the importance of weight maintenance long term. Massive weight loss was defined as the loss of greater than 50 lbs. Vertical abdominoplasty was done in patients with excess of redundant tissue over the entire torso that exceeded what could be excised using a single traditional, horizontal skin pattern excision. In other words, massive weight loss patients with a high degree of horizontal laxity that on a pinch test benefited from a horizontally oriented pull. Those patients were willing to accept a vertical scar to achieve a better epigastric contour. All patients who underwent vertical abdominoplasty procedure were included in the chart review. No patients were excluded. Waiver for informed consent was obtained, as per our IRB protocol, as all information collected was de-identified. All charts were reviewed in depth by single investigator for consistency.

Patient characteristics, comorbidities, and intraoperative parameters were captured, as displayed in Table 1. Comorbidities (Table 2) include history of smoking, hypertension, diabetes, coronary artery disease, anemia, renal disease, cancer, HIV, and history of deep vein thrombosis. Patient characteristics include age, gender, weight loss amount, type of bariatric procedure, preoperative body mass index (BMI), and ASA status. Intraoperative parameters include pain control type, concomitant procedures performed, weight of tissue excised, liposuction performed, operative time, use of nitropaste, and enoxaparin. Complications evaluated include hematoma, seroma, erythema, skin necrosis, dehiscence, infections, and revisions required. These are displayed in Table 3.

Statistical analysis was performed using R software (Vienna, Austria) by the Bioinformatics Core Facility (BICF). Supported by a grant from the Cancer Prevention and Research Institute of Texas (RP150596), BICF features a multidisciplinary team of personnel with expertise in bioinformatics, statistics, computer sciences, statistical genetics and genomics, database development, and data management. Patients' characteristics were summarized in both continuous and binary values. Simple matching coefficients (SMCs) were used to calculate correlations between preoperative risk factors and complications by evaluating the similarity and diversity of our sample sets. We performed comparisons between binary groups using the Chi-squared test. The minimum acceptable significance level was set to 5% ($P < 0.05$).

Table 1. Patient Characteristics

Variable	*N*	%
Gender		
Female	14	87.5
Male	2	12.5
Age		
<30	2	12.5
30-39	3	18.75
40-49	3	18.75
≥50	8	50
BMI		
Overweight (>25)	7	43.75
Obese (>30)	7	43.75
Severely obese (>35)	2	12.5
Morbidly obese (>40)	0	0
Weight loss method		
Roux-en-Y bypass	10	62.5
Gastric sleeve	4	25
Lap band	1	6.25
Diet and exercise	1	6.25
Amount of weight lost		
50-99	5	31
100-149	4	25
150199	3	19
200-249	1	6
>250	2	13
Concurrent procedure		
Brachiplasty	3	18.75
Mastopexy, thighplasty, and brachiplasty	2	12.5
Brachiplasty and chest excision	2	12.5
Breast reduction/mastopexy	1	6.25
Thighplasty	1	6.25
Blepharoplasty and facial fat grafting	1	6.25
Brachiplasty and mastopexy	1	6.25
Circumferential abdominoplasty	2	12.5
American Society of Anesthesiologist (ASA) status		
ASA 1	0	0
ASA 2	14	87.5
ASA 3	2	12.5
Pain control		
Pain pump	5	38
Exparel infiltration	3	23
TAP block with exparel	5	38
Weight tissue resected (kg)		
1-2.9	2	18
3-4.9	6	54
>5	3	27
Total operative time (min)		
100-199	5	31
200-299	5	31
300-399	6	37

BMI, body mass index; TAP, transversus abdominis plane.

Operative Technique and Postoperative Protocol

The techniques used by the senior author differ from the traditional fleur-de-lis abdominoplasty[13] and the corset trunkplasty[14] in both operative markings, sequence of maneuvers, and amount of undermining performed. In this technique, which is shown in Video 1, the patient is placed supine on the operating table and a vertical midline reference line is created from xiphoid to pubis. Lateral markings are made by grasping redundant horizontal skin extending from the lower chest to flanks, which is pulled to the midline, inverted, stapled, and marked. An ellipse is formed connecting these markings, ensuring equidistance from the midline. The lower transverse incision is marked at the level of the mons pubis, 5to 7 cm from vulvar commissure, and extended out laterally as one would normally mark a traditional abdominoplasty. The vertical elliptical skin removal is done before undermining the lower, transverse, abdominal skin flaps. Vertical skin is incised and dissection is taken straight down to fascia with limited undermining. Care is taken to preserve the umbilical stalk. Once the tissue is excised, the medial borders of the rectus muscles are approximated in the midline and the vertical incision is then loosely closed. The incision is advanced caudally with

Table 2. Comorbidities

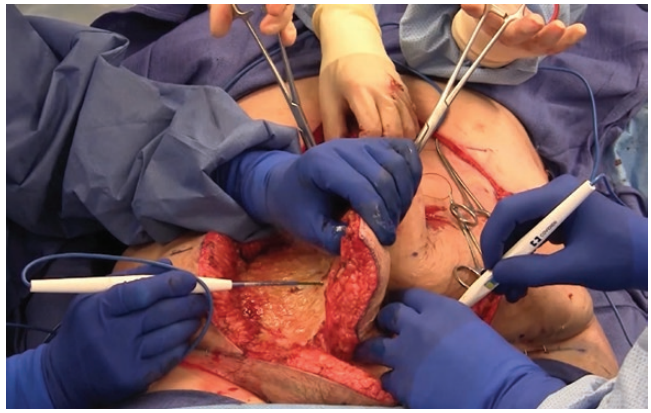
Associated diseases	*N* (%)
Hypertension	5 (31)
Diabetes	1 (6.25)
Coronary artery disease	2 (12.5)
Anemia	4 (25)
Renal disease	1 (6.25)
Cancer	0
History of Deep Vein Thrombosis/ Pulmonary Embolism	0

Table 3. Outcomes

Complication	*N* (%)
Wound breakdown	11 (68.75)
Revisions	7 (43.75)
Erythema	6 (37.5)
Infection	5 (31.25)
Seroma	2 (12.5)
Hematoma	0

3-point sutures in an attempt to eliminate the redundancy in the epigastrium, displacing it caudally. After ensuring 10 to 12 cm from the umbilicus to lower transverse incision, vertical redundancy is created inferiorly and taken out laterally with horizontal excisions bilaterally. Care is taken to limit undermining transversely in an attempt to maximize perfusion to the T point. Routine subcutaneous drain placement is not done, as there is little dead space using this technique. The skin is closed in layers and a compressive surgical dressing is placed.

All patients received preoperative prophylactic antibiotics. Calf pneumatic compression devices were worn during the operation and postoperatively until fully ambulatory. A foley catheter, a warming blanket, and a core temperature monitor were all placed. All patients were admitted overnight and ambulated on the day of their operation. Weight-based dosing of enoxaparin was administered into the thigh 8 hours following the completion of the procedure and continued daily, while the patient was in the overnight facility. All patients were ambulated on the day of their procedure, a minimum of 3 times a day. Compression garments were continuously worn in the immediate postoperative period. Local pain control evolved over time based on the surgeon's preference: from pain pump to bupivacaine liposome injectable suspension local injection



Video 1. Watch now at http://academic.oup.com/asjof/article-lookup/doi/10.1093/asjof/ojaa043

to ultrasound-guided transversus abdominis plane (TAP) block with bupivacaine liposome injectable suspension. A foley catheter is kept for 24 hours postoperatively. While this practice is not done by all, we feel that it is important to monitor fluid status and maximize patient comfort in the immediate postoperative period, particularly while the patient is mobilizing fluids. Protein supplementation and vitamins are begun on the first postoperative day; 1.5 to 2 × daily recommended protein supplementation continues for 4 to -6 weeks to help facilitate the healing process. Case examples are shown in Figures 1-3.

RESULTS

The study included a total of 16 patients. Patient characteristics are displayed in Table 1. There were 2 males and 14 females. The average patient age was 45 (range 25-65) who had an average weight loss of 145 lbs (range 50-400). The average BMI at the time of the plastic surgical procedure was 30.5 (range 25.8-37.1), with the majority of patients being categorized as either overweight or obese. Gastric bypass was the most common method of weight loss, followed by gastric sleeve, laparoscopic band, and finally diet and exercise. Five patients had a lifetime history of smoking. Eleven patients had additional body contouring procedures performed at the time of their abdominoplasty (69%). Two patients underwent circumferential lower body lifts incorporating vertical principles anteriorly. The average operative time was 252 minutes (range 145-388 min), and the average weight of resection was 4.4 kg (range 1.3-8.1 kg). Abdominal liposuction was performed in 2 patients and a wetting solution infiltrated in 6 patients. Patient comorbidities are displayed in Table 2, the most common one being hypertension. The average follow-up was 17 months (range 3-49 months).

Figure 1. A 30-year-old female underwent a lower body lift with vertical abdominoplasty. Frontal (A) and lateral (C) photographs taken preoperatively. Frontal (B) and lateral (D) photographs taken at 6 month posteroperatively.

Figure 2. A 53-year-old female underwent a lower body lift with vertical abdominoplasty. Frontal (A) and lateral (C) photographs taken preoperatively. Frontal (B) and lateral (D) photographs taken at 6 months postoperatively.

No intraoperative or major complications occurred. The overall complication rate was 81.25% (13/16), which were all minor and most commonly wound healing problems (Table 3). Our threshold for counting complications was low, likely driving this rate higher than previously published. The cause of these wound problems is hard to

Figure 3. A 34-year-old male underwent staged vertical abdominoplasty. Photographs taken preoperatively (A, D), 6 months after panniculectomy (B), and one-and-a-half year postoperatively (C, E).

determine but is likely multifactorial and largely related to patient physiology. Seven patients required revisional surgery—most commonly, scar revision following wound healing complications (Table 4).

Table 4. Patient Outcome Details

Patient age	Gender	Weight lost (lb)	BMI	Follow-up (mo)	Outcome
53	F	150	34.6	49	Wound breakdown and cellulitis at 10 days postoperatively requiring wound vac and secondary revision
34	M	277	29.7	13	Small wound at 2.5 mo postoperatively, resolved with local wound care. Continued weight loss resulting in further laxity
30	F	123	25.8	16	Lateral dehiscence at 2 mo requiring revision
57	F	114	26.7	20	Periumbilical wound immediately postoperatively, resolved. Mild incisional dehiscence at 5 mo at vertical and transverse incision treated with local wound care
50	F	180	31.1	7	Healed well
26	F	95	29.2	23	Small T junction dehiscence at 2 weeks postoperatively. Underwent secondary scar revision
57	M	100	30.5	4	Lower abdominal *Staphylococcus* infection at 2 weeks postoperatively, resolved with antibiotics
45	F	410	30.0	5	Small T junction dehiscence postoperatively. Underwent flank revision
45	F	85	28.5	30	Dehiscence of T junction requiring wound vac placement. On post operative day 10 seroma drained; 5 days later infected seroma reaccumulated, was drained, and resolved on antibiotics
53	F	50	31.1	34	Epigastrium revision 3 mo later; scar revision 1 year later
37	F	100	26.0	33	Healed well, flank fullness requiring excision
51	F	50	30.3	12	Healed well, mild epigastric fullness
56	F	75	31.4	7	Healed well
65	F	100	31.1	8	High volume seroma and infection requiring prolonged wound care and eventual scar revision
40	F	150	36.0	7	Mild wound dehiscence healed with local wound care
25	F	220	37.1	3	Small wound requiring debridement and scar revision

BMI, body mass index.

Table 5. Risk Factors and Complications

Risk factor (*n*)	Number of cases with complications (%)
Hypertension (5)	4 (80)
Coronary artery disease (2)	2 (100)
Concomitant procedure performed (11)	9 (82)
Anemia (4)	3 (75)
Smoking history (5)	5 (100)
No smoking history (11)	5 (45)
Smoking within 1 month (2)	2 (100)
Liposuction performed (2)	2 (100)

Possible association between complications and patients' risk factors was analyzed using Chi-squared Test. All factors listed in Table 5 were not statistically significantly correlated with a higher complication rate. However, based on the sorted mean SMC score, we did find a few remarkable correlations between comorbidities and outcomes (displayed in the heat map, Figure 4). In particular, the development of a postoperative seroma was highly correlated with coronary artery disease and smoking within 1 month. The need to use nitropaste was highly correlated with smoking within 1 month. Not surprisingly, tissue necrosis was also highly correlated with the need to use nitropaste. And lastly, tissue necrosis was highly correlated with renal disease.

DISCUSSION

Recent Center for Disease Control data shows an increased prevalence of obesity in the United States of almost 30% over the last 8 years[2]. With the rising obesity rate, plastic surgeons will likely see a steady increase in the number of patients desiring body contouring procedures. Friedman

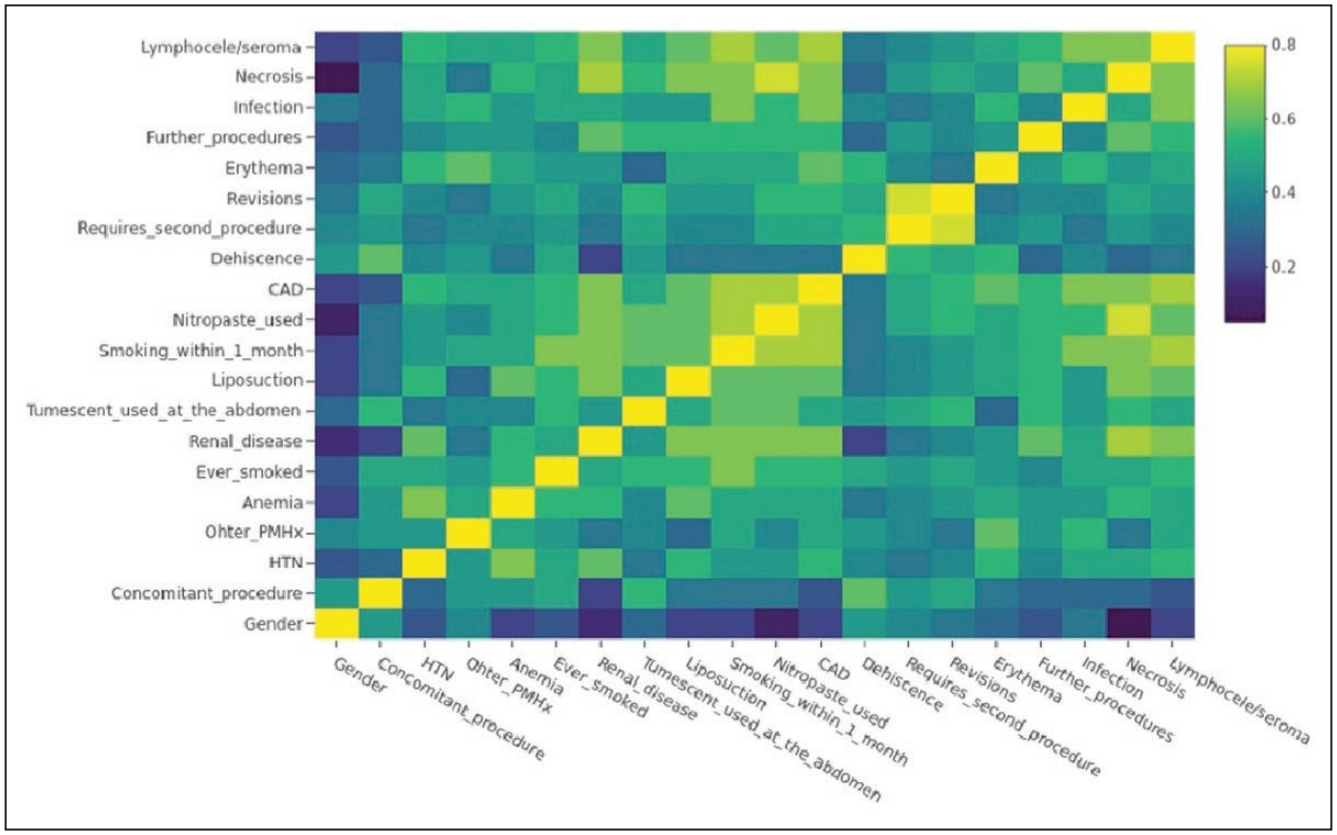


Figure 4. Heat Map based on simple matching coefficients (SMC) score. X and Y axes with comorbidities and outcomes. The value of one (yellow) represents a high correlation when each figure correlates with itself, and the value of zero (dark blue) represents no correlation. For example, gender highly correlates to itself, as depicted in bright yellow. Similarly, necrosis highly correlates with nitropaste used. This is seen as a bright green color, corresponding to 0.8 score.

et al[15] showed that of all massive weight loss patients desiring an abdominoplasty, one-third have horizontal laxity that requires a vertical incision. This represents a significant cohort of patients that plastic surgeons need to be comfortable managing.

The vertical abdominoplasty technique that we use differs from the traditional fleur-de-lis technique described by Dellon[13] in 1985. In his original description of 16 patients, 2 had major complications (umbilical necrosis and hematoma) and 5 had minor wound complications. Since that original description, abdominal contouring techniques have evolved to minimize major complications and make this a safe and reliable procedure. The high lateral tension abdominoplasty, reverse abdominoplasty, and modified fleur-de-lis abdominoplasty have all attempted to address the truncal contour in this patient population. Moya and Sharma[9] describe a modified approach to the vertical abdominoplasty in conjunction with extended high lateral incisions. In their series of 16 patients undergoing this procedure, they report 2 minor complications, related to wound healing (total complication rate of 12.5%). Similar to our technique, serious wound complications were avoided by limited undermining. Costa et al[7] describes a modified vertical technique to address this bidirectional laxity. Like our technique, the epigastric fullness is addressed by grasping tissue and bringing to the midline, creating an ellipse of tissue to be removed without widely undermining. In his series of 48 massive weight loss patients using this technique, 2 developed seromas, 4 had minor epidermolysis, and 1 required a blood transfusion. He reported no major complications. Unlike these techniques that employ “en bloc” resections, ours is done sequentially. First, the horizontal laxity is addressed with the vertical ellipse of tissue excised. Once this is caudally translocated, the amount of lower abdominal resection is determined. We believe that by addressing this horizontal laxity first, we can minimize tissue trauma, achieve a tension-free closure, and improve truncal contour. More importantly, the horizontal vectors applied to the abdomen result in a greater change than a vertical advancement flap and are the focus of the procedure. Ziegler et al[16] describe a modified fleur-de-lis abdominoplasty technique in which the upper abdominal skin flaps have deepithelialized mediocaudal edges. In their series of 76 patients, half underwent traditional fleur-de-lis abdominoplasties, and the other half this modified

technique. They found a decreased rate of seroma formation and full-thickness wounds in the patients who had undergone the modified approach. This suggests that limited undermining at the T-point decreases complications.

Risk Analysis

One of the goals of this study was to understand the role that preoperative comorbidities and intraoperative details play on outcomes in this unique patient population. Although we were limited by a small sample size in this study, we are able to draw some significant conclusions from our analysis. First, and most surprisingly, the BMI and amount of weight loss achieved did not contribute to a higher complication rate in this cohort. These findings are in conflict with previous studies. One study shows that a BMI greater than 25 at the time of abdominal contour surgery results in a 3-fold increase in wound complications.[10] Borud and Warren[17] found that a BMI above 35 trended toward more T-point wounds. And in a study by Duff and Griffiths in 2003, higher complication rates were correlated to older patients, higher BMIs, and a greater amount of tissue resected.[12]

With regard to the method of weight loss, previous studies have shown there to be no difference in complication rates following abdominal body contouring procedures attributable to the method of weight loss. Chetta et al[18] found that weight loss through bariatric surgery vs diet and exercise showed no worse outcomes in their body contouring patients. In our small series, we also found this to be the case. There were no significant differences in outcomes based on the method of weight loss.

The American Society of Anesthesiologists (ASA) classification is an established predictor of anesthetic overall perioperative risk. A study of 3678 patients undergoing abdominoplasty found that complication rates increased significantly with increasing ASA class.[19] However, we found no difference in outcomes between patients in a lower ASA class and higher ASA class.

Wound breakdown is often one of the most common complications seen in this population. It is usually a minor complication that can be treated as an outpatient. The rate of wound problems in the literature varies from 3% to 35% depending on the series.[7-13] In our small series, we had 11 out of 16 (68.8%) patients with some form of wound breakdown. Any wound breakdown, regardless of size, was considered a complication, which is what likely drives our complication rate higher than the previous series. Etiology of these wounds is likely multifactorial, with patient physiology playing a large role. Wound dehiscence (an opening down to the level of the underlying muscle fascia) was not seen. We also recognize that performing multiple procedures is highly associated with higher rates of complications. Winocour et al[20] performed an analysis of 25,478 abdominoplasties identified through the CosmetAssure database and concluded that combining procedures increased the risk of complications. In fact, they found that when abdominoplasty was combined with procedures on other body regions, the complication rate increased with the number of body regions operated on, up to 4.8%. Additionally, they found that BMI > 25 was associated with increased complications. We believe, however, that these complications can be minimized by limited undermining, preserving perforating vessels, and achieving a tension-free closure.

Some favor creating a neo-umbilicus as a second procedure. Mendes et al[21] advocate a secondary umbilicoplasty in order to achieve predictable umbilical scarring and to decrease umbilical-related complications. If the umbilical stalk is not excessively long in length and has maintained perfusion, we attempt to preserve the native umbilicus. We prefer to inset it along our vertical incision and incorporate 3-point sutures in a similar manner performed during a standard abdominoplasty.

We did not operate on any active smokers but did find a 100% complication rate in patients with a lifetime history of smoking vs a 45% complication rate in nonsmokers. This was not a statistically significant difference but does show an interesting trend. Even patients who have quit smoking in the past should be counseled that they could potentially be at risk for minor complications postoperatively. Shestak et al[22] conducted an evidence-based update for plastic surgeons performing abdominoplasty and recommend preoperative smoking cessation for at least 4 weeks before surgery. A urine cotinine test can also be considered.[22]

These massive weight loss patients often desire other contouring procedures that address tissue laxity of their arms, lower body, and breasts. Due to financial restraints, time off from work, and consolidated recovery time, performing multiple procedures at once is appealing to many patients. There is no doubt, however, that performing concomitant procedures increases case complexity and operative time. In our series, the average operative time for multiple procedures was 284 minutes, compared with 179 minutes for the vertical abdominoplasty alone. Hardy et al[23] found in their series of 1753 plastic surgery cases that each hour increase in surgery duration was associated with a 21% increase in odds of morbidity and that complications significantly increase above 3 hours. In our series, 82% of patients who had multiple procedures performed developed complications. This is higher than those who underwent abdominal contouring procedures alone (complication rate 60%). Although there is concern about increased risks when combining body contouring procedures, literature says this can be done safely. Coon et al[24] reported their experience with 609 massive weight

loss patients and concluded that there was no significant increase in complications on a per-procedure basis. Additionally, there is a reason to suggest that patients who address multiple concerns do better in the long term. Wiser et al[25] found that contouring procedures performed on more than 3 anatomic areas leads to better outcomes and weight control in the long term. Ultimately, massive weight loss patients must understand the pros and cons of performing multiple body contouring procedures at once. They should be counseled that they may be at a higher risk of wound healing complications. But ultimately the decision of what and when procedures should be performed should be a patient-centric decision that considers the patient's medical comorbidities, operative time, patient's motivation, surgeon's experience, and opposing vectors of pull between adjacent tissue.

Lastly, the approach to these patients should be multidisciplinary. Preoperative evaluation and clearance by the bariatric medical provider or the appropriate caregiver based on comorbidities should always be considered. Some advocate waiting as little as 3 months for weight to be stable before embarking on body contouring surgery,[25] but we feel that the patient's weight should be stable for at least 6 months. This usually represents at least 12 to 18 months from the time of their original bariatric procedure. This is done for multiple reasons: to minimize complications, allows time to correct any metabolic abnormalities and control medical comorbidities, gives time to allow for smoking cessation if present, allows tissue laxity to reach an equilibrium, and optimizes aesthetic outcomes.

CONCLUSIONS

The traditional abdominoplasty techniques fail to address epigastric fullness and waist contour. When these areas are neglected not only does it lead to patient dissatisfaction but also may result in the need for further surgeries. This can lead to increased risk of complications, associated costs and healthcare utilization, a higher scar burden, and ultimately patient frustration. Plastic surgeons, therefore, should consider this technique when evaluating massive weight loss patients with a large amount of abdominal laxity that will have suboptimal results if a vertical component is not included in the tissue excision.

Lockwood[26] emphasized the treatment of lateral lower abdominal skin laxity using a high lateral tension approach, with significant lateral resection and highest-tension wound closure placed laterally. In this patient population, however, placing a high degree of tension at any area of closure increases the risk of complications. This procedure is designed to help flatten the anterior abdominal wall. Lockwood's operation does not adequately address the epigastric horizontal laxity. Laterally is best addressed by a circumferential procedure, not placing high tension. Additionally, body shape depends on several things: the width of the thoracic cage, the width of the abdomen/soft tissue, and pelvic width. These set the transition from convex to concave to convex. We do not think that in patients with more significant weight loss you can see as much contour change anteriorly as we see with a vertical abdominoplasty.

Previous studies have shown that this is a safe procedure[5,6,16] and our data confirm that finding. Although we did have a high complication rate, all were minimal in the form of minor infections and wound healing problems. It is vital, therefore, that during the preoperative evaluation, the patient must be counseled about the large scar burden and a high likelihood of wound healing complications.

Although there have been concerns for potential necrosis of abdominal flaps at the T closure, we believe that with proper patient selection, preoperative planning, and sound surgical technique, this can be done with little to no patient comorbidity. This small series lets us better understand the risk profile of our patients undergoing body contouring procedures and how to use these data to counsel patients preoperatively. This series highlights pearls that the plastic surgeon can use to maximize patient safety and minimize complications. However, this is a small case series and more research on this topic needs to be undertaken in future research.

Disclosures

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REFERENCES

1. González-Muniesa P, Mártinez-González MA, Hu FB, et al. Obesity. *Nat Rev Dis Primers*. 2017;3:17034.
2. Centers for Disease Control and Prevention. Adult obesity facts. https://www.cdc.gov/obesity/data/adult.html. Published February 27, 2020. Accessed March 27, 2020.
3. Fotopoulos L, Kehagias I, Kalfarentzos F. Dermolipectomies following weight loss after surgery for morbid obesity. *Obes Surg.* 2000;10(5):451-459.
4. Cosmetic Surgery National Data Bank Statistics. *Aesthet Surg J*. 2018;38(Suppl 3):1-24.
5. Cai A, Maringa L, Hauck T, et al. Body contouring surgery improves physical activity in patients after massive weight loss–a retrospective study. *Obes Surg.* 2020;30(1):146-153.

6. Hammond DC, Chandler AR, Baca ME, Li YK, Lynn JV. Abdominoplasty in the overweight and obese population: outcomes and patient satisfaction. *Plast Reconstr Surg.* 2019;144(4):847-853.
7. Costa LF, Landecker A, Manta AM. Optimizing body contour in massive weight loss patients: the modified vertical abdominoplasty. *Plast Reconstr Surg.* 2004;114(7):1917-1923; discussion 1924.
8. Chaouat M, Levan P, Lalanne B, Buisson T, Nicolau P, Mimoun M. Abdominal dermolipectomies: early postoperative complications and long-term unfavorable results. *Plast Reconstr Surg.* 2000;106(7):1614-1618; discussion 1619.
9. Moya AP, Sharma D. A modified technique combining vertical and high lateral incisions for abdominal-to-hip contouring following massive weight loss in persistently obese patients. *J Plast Reconstr Aesthet Surg.* 2009;62(1):56-64.
10. Greco JA 3rd, Castaldo ET, Nanney LB, et al. The effect of weight loss surgery and body mass index on wound complications after abdominal contouring operations. *Ann Plast Surg.* 2008;61(3):235-242.
11. Fraccalvieri M, Datta G, Bogetti P, et al. Abdominoplasty after weight loss in morbidly obese patients: a 4-year clinical experience. *Obes Surg.* 2007;17(10):1319-1324.
12. Duff CG, Aslam S, Griffiths RW. Fleur-de-Lys abdominoplasty—a consecutive case series. *Br J Plast Surg.* 2003;56(6):557-566.
13. Dellon AL. Fleur-de-lis abdominoplasty. *Aesthetic Plast Surg.* 1985;9(1):27-32.
14. Acevedo E, Nadhan KS, Everett M, Moya A, Bradley JP. Corset trunkplasty: recommended with abdominal skin laxity and open cholecystectomy scar. *Plast Reconstr Surg.* 2018;141(1):60-69.
15. Friedman T, O'Brien Coon D, Michaels J, et al. Fleur-de-Lis abdominoplasty: a safe alternative to traditional abdominoplasty for the massive weight loss patient. *Plast Reconstr Surg*. 2010;125(5):1525-1535.
16. Ziegler UE, Ziegler SN, Zeplin PH. Modified fleur-de-lis abdominoplasty for massive weight loss patients. *Ann Plast Surg.* 2017;79(2):130-134.
17. Borud LJ, Warren AG. Modified vertical abdominoplasty in the massive weight loss patient. *Plast Reconstr Surg.* 2007;119(6):1911-1921; discussion 1922.
18. Chetta MD, Aliu O, Tran BA, Abdulghani M, Kidwell KM, Momoh AO. Complications in body contouring stratified according to weight loss method. *Plast Surg (Oakv).* 2016;24(2):103-106.
19. Familusi OT, Doscher M, Manrique OJ, Shin J, Benacquista T. Abdominal contouring: can the American Society of Anesthesiologists classification system help determine when to say no? *Plast Reconstr Surg.* 2016;138(6):1211-1220.
20. Winocour J, Gupta V, Ramirez JR, Shack RB, Grotting JC, Higdon KK. Abdominoplasty: risk factors, complication rates, and safety of combined procedures. *Plast Reconstr Surg.* 2015;136(5):597e-606e.
21. Mendes FH, Donnabella A, Fagotti Moreira AR. Fleur-de-lis abdominoplasty and neo-umbilicus. *Clin Plast Surg.* 2019;46(1):49-60.
22. Shestak KC, Rios L, Pollock TA, Aly A. Evidenced-based approach to abdominoplasty update. *Aesthet Surg J.* 2019;39(6):628-642.
23. Hardy KL, Davis KE, Constantine RS, et al. The impact of operative time on complications after plastic surgery: a multivariate regression analysis of 1753 cases. *Aesthet Surg J.* 2014;34(4):614-622.
24. Coon D, Michaels J 5th, Gusenoff JA, Purnell C, Friedman T, Rubin JP. Multiple procedures and staging in the massive weight loss population. *Plast Reconstr Surg.* 2010;125(2):691-698.
25. Wiser I, Heller L, Spector C, Fliss E, Friedman T. Body contouring procedures in three or more anatomical areas are associated with long-term body mass index decrease in massive weight loss patients: a retrospective cohort study. *J Plast Reconstr Aesthet Surg.* 2017;70(9):1181-1185.
26. Lockwood T. High-lateral-tension abdominoplasty with superficial fascial system suspension. *Plast Reconstr Surg*. 1995;96(3):603-615.