Abdominoplasty in the Massive Weight Loss Patient: Are Aesthetic Goals and Safety Mutually Exclusive?

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The abstract of this manuscript has been accepted for presentation at The Aesthetic Meeting 2021, Miami.

Disclosures: The author declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Funding: The author received no financial support for the research, authorship, and publication of this article.

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ABSTRACT

Background: The goals of abdominoplasty in massive weight loss (MWL) patients are often functional, with a greater emphasis on safety than on aesthetic rejuvenation. As important as functional improvements and safety are, however, there may be room for increasing the aesthetic potential of abdominoplasties in these patients.

Objectives: To determine the safety of the pursuit of aesthetic goals for abdominoplasty in MWL patients.

Methods: This is a retrospective study examining 910 consecutive female patients consisting of three groups: postpartum (n=718), dietary MWL (n=65) and bariatric MWL (n=127). All patients were approached with a well-defined set of aesthetic goals which were pursued as needed and as feasible.

Results: The utilization of aesthetic abdominoplasty components was similar all groups, supporting the assertion that the groups were subjected to a similar aesthetic emphasis. Logistic regression showed that a history of bariatric MWL was an independent risk factor for multiple complications (OR 2.738, p=0.014), and that elevated BMI, smoking, diabetes and age were likewise independent risk factors for complications. Propensity score matched case-control pairs showed that bariatric MWL patients were more likely than dietary MWL patients to experience multiple complications (9.52% vs 0 percent, p=0.031).

Conclusions: Bariatric MWL patients but not dietary weight loss patients seem to have higher risk than postpartum patients. Other comorbidities (elevated BMI, smoking, diabetes, age) seem to be more important predictors of complications than MWL status. Select MWL patients can likely be approached with an emphasis on aesthetic goals, without increasing risks as compared to the postpartum population.
Abdominoplasty in the Massive Weight Loss (MWL) patient tends to be different from abdominoplasty in the typical postpartum patient. MWL patients are more likely to suffer from functional problems such as intertrigo and back pain and are more likely to be anemic or suffer from nutritional deficiencies. Even though they have lost a good deal of weight their BMI tends to remain higher, putting them at higher risk for surgical, anesthetic, and thromboembolic complications. The degree of abdominal soft tissue deformity tends to be greater. Psychological problems related to body image may be severe. There may be technical considerations such as preexisting abdominal scars or laparoscopic adjustable gastric band ports. It is fair to say that abdominoplasty in the MWL patient can present a series of challenges.

Although there is much written about enhancing the aesthetic outcome of abdominoplasty, most of the available literature on abdominoplasty in the MWL population focuses on the optimization of safety, minimization of complications, and functional or quality of life outcomes. There is relatively little written about strictly aesthetic issues in the MWL population. Clearly there are extreme cases of “panniculectomy” in which aesthetic outcomes are remote considerations. In less extreme cases it is important to consider the patient’s objectives: will the procedure be done for mainly aesthetic or mainly functional reasons? For many MWL patients the aesthetic result is very important, as they are often burdened by powerful body image issues. In a heavier patient it is more difficult to achieve a good aesthetic outcome, although the amount of aesthetic improvement tends to be greater, and this concept of maximal improvement would seem to apply especially to the MWL population. An important question is this: If one decides to strive for maximal aesthetic improvement in a patient that is so motivated, what are the specific goals? One can identify a series of key aesthetic elements in abdominoplasty and this represents a good conceptual starting point. It has been this current author’s practice to implement a similar series of objectives, an aspirational “aesthetic checklist,” to whatever extent is feasible in selected MWL patients (Appendix). These are the same objectives that are applied to postpartum abdominoplasties. Obviously not all of these will be needed or even possible in all MWL patients, yet they are part of a mindset that takes the patient’s aesthetic goals seriously. However, another important question is this: what are the consequences, in terms of complications, of pushing an aesthetic agenda in the MWL population?

This “safety versus aesthetics” question presents a bit of a conundrum, as these two goals may be at cross purposes. Indeed, the reason that aesthetics do not seem to be emphasized in the literature on MWL abdominoplasties may stem from a need to focus on safety, as there are many studies that support the notion that these patients have higher complication rates. Although these studies do not provide absolute clarity, in the aggregate they would certainly give a rational surgeon pause and would tend to temper enthusiasm for aesthetic goals when contemplating abdominoplasty in a MWL patient. This study represents an attempt to define the fraught relationship between aesthetic goals and safety in the MWL population. Since the focus of this study is on aesthetics it makes sense to compare complications in the MWL population to a “control” group of purely aesthetic
abdominoplasties, eg, the postpartum population that, aside from the fluctuations of pregnancy, has not lost a significant amount of weight. Thus for this study strictly postpartum versus MWL (many of which are also postpartum) women were compared. Since there is some speculation, as noted above, that the method of weight loss—either by bariatric surgery or through diet and exercise—may be an important factor for complication rates, this distinction was invoked and the MWL population was divided into the two types. This study aimed to compare complications among these groups and since the baseline characteristics of these three groups were not equal certain statistical analyses were undertaken in an attempt to control for preoperative differences in risk factors.

METHODS

The author’s database of 955 consecutive abdominoplasties over a 12-year period from January 2008 to December 2019 was examined. The exclusion of men yielded 910 women who had abdominoplasty with and without simultaneous aesthetic procedures (for example, breast surgery or other body contouring). These patients were then considered as three groups, a “control” group of postpartum patients without significant weight loss (postpartum, n=718), a group with a history of greater than 50 pounds weight loss realized through diet and exercise (dietary MWL, n=65), and a group with a history of greater than 50 pounds weight loss following bariatric surgery (bariatric MWL, n=127). It is the author’s current practice to exclude abdominoplasties from all patients of any category until a goal of BMI < 35 is reached and until smoking cessation for three months is achieved. The database was queried for patient demographic and physical data as well as postoperative information regarding complications and operative reports were examined to gain information about technique. Preoperative photos were examined to determine deformity grade26 (Table 1). The study followed the guiding principles of the Belmont report, insofar as this study falls under the category of practice of “accepted therapy” which is “designed solely to enhance the well-being of an individual patient and that has a reasonable expectation of success.” Furthermore, all provisions of the Declaration of Helsinki were followed in the conduct of this study and written informed consent was obtained for all patients.

Operative Technique

Abdominoplasties in the postpartum group were performed in a fairly standard manner with flap undermining, fascial plication (repair of rectus diastasis plus paramedian fascial tightening as indicated), and flank liposuction and sub-Scarpa’s thinning as indicated.27 All operations were performed under general anesthesia. Sequential compression devices and were applied to the lower extremities of all patients and almost all patients had preoperative subcutaneous heparin. Postoperative chemoprophylaxis with either enoxaparin or rivaroxaban was administered for patients with a Caprini (2005) score of four or above. Progressive tension sutures were not used.
The operative approach in the MWL groups was somewhat different from that in the postpartum group. The MWL patients tended to have a greater degree of deformity (Table 2) with greater degrees of tissue laxity, including in the transverse direction, which underlies the utility of “fleur-de-lis” variants in the MWL patient population. However, in this series, the vertical scar was avoided by adherence to several principles (Figure 1), as follows:

1. The flap itself may need to be rehabilitated. Often, even after undermining, the flap will have multiple rolls, retractions and contour irregularities, which prevent its smooth redraping onto the abdominal wall. Resection of the sub-Scarpa’s fat pad will not only thin the flap but also release the flap and render it smoother and more pliable. There may also be a significant element of flap retraction and tightening through the thorough application of electrocautery to the undersurface of Scarpa’s fascia.

   Although this assertion of controlled thermal injury is unproven, conceptually it is analogous to skin shrinkage with laser and ultrasound-assisted lipoplasty, flap retraction with VASER lipoabdominoplasty (Solta Medical, Pleasanton, CA), thermal capsulorrhaphy for breast implant revision, and orbital septum shrinkage with electrocautery in blepharoplasty. It is important to note that the sub-Scarpa’s resection must be done in the appropriate plane to avoid devascularizing the flap.

2. Due to the increase in skin/tissue laxity, the downwards tension vector needs to be stronger than it does in the typical postpartum patient. This vector also has a lateral component. This means that the transverse cut delineating the lower edge of the flap may need to be higher than usual; almost always the umbilical donor site is removed with the resection specimen. There is little concern for excess tension on closure or vulvar distortion because, again, skin/tissue laxity is typically substantial and the mons ptosis that is the usual finding in these patients actually needs the upwards tension vector that is the complement of the stronger downwards tension vector. This approach results in removal of greater amounts of skin and tissue and since the
tension vector has a lateral component this alleviates some of the side-to-side laxity by distributing excess skin away from the midline.

3. The MWL patient typically needs an “extended” abdominoplasty with the incision extending back to the mid-axillary line or further; indeed some will have circumferential or near circumferential approaches. The lateral extent of this extended incision curves upwards. This extension achieves two advantages. Firstly there is a longer incision through which skin/tissue excess can be distributed laterally, and secondly the upwards curve facilitates a lateral tension vector which, again, can be used to help alleviate side-to-side tissue laxity by distributing excess skin away from the midline. This technique shares some of the concepts of the high-lateral-tension abdominoplasty, namely the recognition of side-to-side skin/tissue excess, an upwards curving lateral incision with significant lateral skin resection, an inferolateral tension vector, and superficial fascial system suspension.

4. The mons region deserves special attention in the MWL patient. Mons ptosis and tissue excess predisposes to a globular postoperative appearance of the mons. This tendency can be counteracted by placing the lower incision at a lower point, typically measured 6 or 7 cm from the apex of the introitus with the skin under maximal tension, trimming fat from the undersurface of the mons flap (or alternatively, mons liposuction), and applying upwards and lateral suturing of the mons to the fascia prior to skin closure.

This operative sequence is demonstrated in the Video. MWL patients will have a propensity towards seroma formation because BMI often remains high and because flank liposuction and sub-Scarpa’s lipectomies may be frequently utilized. Two and sometimes four Jackson-Pratt (JP) drains were placed. JP drains were removed once the effluent output dropped below 25cc per day.

For the purposes of this study, major flap necrosis was defined as full thickness loss of greater than 5 cm², minor flap necrosis as full thickness loss, epidermolysis or wound separation of less than 5cm², and fat necrosis as any palpable nodule present more than three
months postoperatively. Infection was defined as any cellulitis, wound infection, or cloudiness of Jackson-Pratt effluent.

**Statistical Analysis**

Univariate comparisons for continuous variables were performed using unpaired t-tests and one-way ANOVA with post hoc analysis, and for categorical variables with $\chi^2$ tests. For multivariate comparisons binary logistic regression models were created for each dependent variable (each complication or combination of complications and the need for revision). The principle of parsimony was applied and the independent regression variables were taken from variables that on univariate analysis demonstrated a significance of 0.10. For case-control studies a propensity-score matching strategy was used to pair patients from the postpartum and weight loss groups that had similar baseline characteristics (the covariates of age, BMI, history of smoking, history of diabetes, fascial plication, flank liposuction, sub-Scarpa’s fat resection, and a simultaneous aesthetic procedure). Propensity scores were estimated by logistic regression followed by a nearest-neighbor matching algorithm seeking 1:1 matches with no replacement and a caliper of 0.2 of the standard deviation of the logit of the propensity score. Standardized mean differences for all covariates were calculated before and after matching to assess the adequacy of the matching process. After the matching process dichotomous dependent variables (ie, the presence or absence of each complication or combination of complications and the need for revision) were compared by McMemar’s test. The above analyses were performed in SPSS version 27 (IBM Corporation, Armonk, NY) with the PS Matching extension (developed by Felix Thoemmes at Cornell University, Ithaca, NY) and R (R Foundation for Statistical Computing, Vienna, Austria).

**RESULTS**

Follow-up ranged between 6 months and ten years (mean 17 months). The mean age of all patients was 43.27 years (Range 16.68 to 74.51 years). Baseline characteristics of the three groups and the utilization of cosmetic components is summarized in Tables 2 and 3. Statistical significance was reached for the amount of weight loss, BMI, age, deformity grade, flank liposuction and sub-Scarpa’s fat pad resection between dietary MWL and bariatric MWL. Statistical significance was reached for BMI, deformity grade, percentage of diabetic patients, sub-Scarpa’s fat pad resection, fascial plication and flank liposuction between postpartum and bariatric MWL. Statistical significance was reached for BMI, deformity grade, percentage with a simultaneous aesthetic procedure, sub-Scarpa’s fat pad resection, and fascial plication between postpartum and dietary MWL. Any Aesthetic Component, defined as either flank liposuction or sub-Scarpa’s lipectomy or fascial plication or a combination of these, was performed in 86.35% of the postpartum group, 80% of the dietary MWL group, and 80.31% of the bariatric MWL group; these differences were not statistically significant.
Univariate analysis of complications is presented in Table 4. Statistical significance was reached for the following comparisons: seroma formation: postpartum versus dietary MWL (p=0.038) and postpartum versus bariatric MWL (p=0.008); any complication: postpartum versus bariatric MWL (p=0.030); multiple complications, postpartum vs. bariatric MWL (p<.001) and dietary MWL vs. bariatric MWL (p=0.010). No other comparison reached statistical significance.

For multivariate analyses all the logistic regression models were statistically significant, indicating that each model was able to distinguish between patients with and without each complication. The models identified BMI as a predictor of major flap necrosis (Odds ratio 1.163, 95% CI 1.063-1.270, p=0.001), fat necrosis (Odds ratio 1.083, 95% CI 1.010-1.161, p=0.025), seroma formation (Odds ratio 1.049, 95% CI 1.008-1.092, p=0.020), any complication (Odds ratio 1.066, 95% CI 1.032-1.102, p<0.001), any ischemic complication (1.060, 95% CI 1.012-1.112, p=0.015) and multiple complications (Odds ratio 1.099, 95% CI 1.024-1.181, p=0.009). A history of smoking was identified as a predictor of major flap necrosis (Odds ratio 4.619, 95% CI 1.562-13.661, p=0.006), minor flap necrosis (Odds ratio 2.599, 95% CI 1.168-5.782, p=0.019), and any ischemic complication (Odds ratio 2.418, 95% CI 1.320-4.431, p=0.004). A history of diabetes was identified as a predictor of minor flap necrosis (Odds ratio 6.926, 95% CI 2.355-20.363, p<0.001) and any ischemic complication (Odds ratio 5.750, 95% CI 2.361-14.004, p<0.001). Age was identified as a predictor of infection (Odds ratio 1.061, 95% CI 1.024-1.100, p=0.001), venous thromboembolism (Odds ratio 1.054, 95% CI 1.003-1.108, p=0.038) and multiple complications (Odds ratio 1.039, 95% CI 1.002-1.078, p=0.041). A history of bariatric MWL was an independent predictor of multiple complications (Odds ratio 2.738, 95% CI 1.231-6.090, p=0.014) These results are summarized in Table 5.

The matching algorithm was successful in that it yielded 61 case-control pairs comparing postpartum with dietary MWL, 120 case-control pairs comparing postpartum with bariatric MWL, and 63 case-control pairs comparing bariatric MWL with dietary MWL. These case-control pairs were all balanced with respect to the covariates of age, BMI, history of smoking, history of diabetes, fascial plication, flank liposuction, sub-Scarpa’s resection and a simultaneous aesthetic procedure as reflected by a standardized mean difference of less than 0.25 for all of these covariates. A comparison of complications in these matched and balanced pairs showed no statistically significant differences between the postpartum group and either the dietary MWL group or the bariatric MWL group on any complication/group of complications/need for revision (Tables 6-7). However, when the bariatric MWL and the dietary MWL were compared directly there was a statistically significant higher rate of multiple complications in the bariatric MWL group (Table 8).
DISCUSSION

In this study the bariatric MWL group but not the dietary MWL group had higher complication rates than the postpartum controls. This was true on univariate analysis where the bariatric MWL group had a statistically higher rate of seroma formation, any complication, and multiple complications (Table 4), on multivariate analysis where the bariatric MWL group had an increased risk of multiple complications (Table 5) and in case control pairs where the bariatric MWL group also had a higher rate of multiple complications (Table 8). The dietary MWL group did have a higher seroma rate than postpartum group but this was only true on univariate analysis. These findings agree with studies by Greco et al, Lievain et al, Staalesen, Breating, Vico and Constantine that implied that bariatric MWL patients have a higher risk than dietary MWL patients, as well as with Hasenbegovic’s meta-analysis of these studies that concluded that a history bariatric MWL presented a 60% greater risk than a history of dietary MWL. These findings are at odds, however, with those of De Kirviler and Gusenoff, who found no difference between these two MWL groups. If the increase in multiple complications in the bariatric MWL group in this current study is true one can hypothesize malnutrition as a possible cause. Bariatric MWL patients tend to have severe nutritional deficiencies (particularly hypoalbuminemia), even more so than dietary MWL patients, and in fact protein supplementation has been shown to ameliorate the risk of complications in bariatric MWL patients as well as in both bariatric and dietary MWL patients. This current study compared the MWL groups not only to each other but also to postpartum controls, because if we are to assess the safety of abdominoplasty in the MWL population, it seems that the postpartum, non-weight loss, “purely aesthetic” abdominoplasty is the low complication gold standard against which the MWL populations should be compared.

It is important to put these findings into the context of accompanying comorbidities. Any increased risk of the postbariatric population is not well defined and likely multifactorial; could there be other important risk factors besides the fact that the patient has lost a lot of weight? Probably the strongest candidate for an additional important risk factor is residual obesity, as the MWL groups had statistically significant higher BMIs in spite of the massive weight loss. For example, in this current study logistic regression gives an Odds Ratio of 1.163 for BMI and the complication of major flap necrosis, which suggests a 16.3% risk increase for each unit increase in the BMI. Since the mean BMI of the bariatric weight loss group was 3.38 units greater than the postpartum controls, this suggests a more than 60 percent increase in major flap necrosis due to BMI alone. A similar conclusion could be reached on the contribution of BMI to fat necrosis, seroma formation, any complication, any ischemic complication, or multiple complications in this current study (Table 5). Other authors have pointed to residual obesity as a principal culprit for the increased complication rate in the MWL population. For example, papers by Greco et al, Lievain et al, Coon et al, Vastine et al, and Winocour et al all concluded that elevated BMI at the time of abdominoplasty contributed, in various degrees, to an elevated complication rate. Au et al, in a study that examined postbariatric and dietary weight loss patients that had undergone a
variety of body contouring procedures, concluded that BMI (post weight loss) at the time of body contouring was a predictor of postoperative complications. The previously referenced Arthurs et al\textsuperscript{5} article, looking at postbariatric panniculectomies using logistic regression, found that elevated BMI was an independent predictor for developing a postoperative complication, with an odds ratio of 3.3. In a recent study also looking at just postbariatric abdominoplasties, Schlosshauer et al\textsuperscript{45} concluded that elevated BMI, age, and resection weights were risk factors for total complications. In addition to obesity the MWL population may have a greater incidence of other risk factors such as diabetes and smoking; this was the case in the previously referenced Greco study,\textsuperscript{20} and this would be expected to impact complication rates.\textsuperscript{46-48} In this current study the bariatric MWL group had a statistically significant higher rate of diabetes as well as a statistically insignificant trend towards a greater percentage of smokers as compared to postpartum controls (Table 2). Not surprisingly, and in general agreement with the literature, in this current study the other baseline risk factors of diabetes, smoking, age, as well as elevated BMI, were important, independent and statistically significant contributors to increased complications (Table 5). Along these lines Dutot et al.,\textsuperscript{49} in a recent large long-term study, concluded that the other risk factors of age, obesity and smoking were more important factors than a history of weight loss. The evidence in this current paper as well as the just cited evidence in the literature raises the possibility that although a history of bariatric MWL may present independent risk, there is a collinearity of risk factors that may contribute substantially to the increased complication rates, and these additional comorbidities should be included in the risk calculus.\textsuperscript{50}

What evidence is there that the MWL groups in this study were subject to the same “aesthetic emphasis” as the postpartum group? This is obviously highly subjective and difficult to quantify with anything even approaching scientific rigor. However, an overall sense can be obtained by looking at the rates of various “aesthetic components” of the abdominoplasties and the rates of performance of simultaneous aesthetic procedures. For example, in the author’s practice fascial plication is performed solely to effect a change in the shape of the abdominal wall and never for a functional reason (although there is some evidence that fascial plication can have a functional benefit\textsuperscript{51,52}). Thus for the purposes of this study plication can be considered as an aesthetic component to abdominoplasty. Likewise, a sub-Scarpa’s fat resection and flank liposuction are done only for aesthetic reasons. The addition of a separate, simultaneous aesthetic procedure (for example aesthetic breast surgery or other body contouring procedures) implies that an operation was done for at least partly aesthetic reasons. The percentages of patients in each group that had one or more of these aesthetic components (“Any Aesthetic Component”, Table 3) were very similar, and the percentage of patients having a simultaneous aesthetic procedure was actually higher in the dietary weight loss group (Table 3), suggesting that the three groups (postpartum, dietary MWL and bariatric MWL) were treated at least somewhat similarly with respect to aesthetic concerns.

There were four patients in the bariatric MWL group that had a thromboembolic event, and although this rate of 3.15% was not statistically different from postpartum controls or the
dietary MWL group in any of the statistical analyses, this rate does seem high and is worthy of comment. There were no deaths in this series, but venous thromboembolism certainly carries that risk. Many MWL patients undergo simultaneous procedures (69.8% of the patients in this series) and this adds to the time under anesthesia, adding to the thromboembolic risk presented by the higher BMI in these patients. Although the data presented in this paper cannot provide recommendations for abatement of this risk, it does seem that chemoprophylaxis and/or staging\textsuperscript{53} of multiple procedures should be contemplated and weighed in many of these cases, and numerous studies offer recommendations for risk stratification and prophylaxis against the serious issue of thromboembolism in the abdominoplasty patient population.\textsuperscript{54-58}

The zero implementation rate of a “fleur-de-lis” technique in this study is at odds with much of the literature on abdominoplasty in MWL patients and is also worthy of comment. Other authors\textsuperscript{22,26,41,54,59,60} report performing a substantial percentage of abdominoplasties in the MWL patient population as combined horizontal and vertical excisions and offer the rationale of correction of side-to-side skin/tissue laxity as an acceptable tradeoff for the increased scar burden and potentially higher wound complication rate. However, the author of this current study has found it difficult to convince patients to accept the vertical scar component as many of them have the lofty aspiration to wear two-piece bathing suits, and this patient reluctance regarding the vertical midline scar has been experienced by other authors.\textsuperscript{61} This provides the impetus for avoidance, but in which patients is it possible to avoid the vertical scar and still obtain acceptable side-to-side skin tightening? Patients with a Pittsburgh deformity rating\textsuperscript{26} of 2 or less will not likely need the additional skin excision but this represents only a small percentage of this current study in which the average deformity rating was 3.17 for dietary MWL and 3.52 for bariatric MWL patients. In spite of these high deformity ratings, a “fleur-de-lis” approach was not deemed to be necessary for any patient in this study. There are several possible reasons for this. Firstly, 11 percent of the massive weight loss patients in this current study were circumferential “belt” lipectomies and virtually all of the others were “extended” abdominoplasties where the posterior scar extended past the midaxillary line, providing greater latitude in reconciling the transverse skin excess. Other authors have likewise stated that “extended” or circumferential/near circumferential abdominoplasties can avoid the vertical skin excision by virtue of the greater incisional length to distribute the side-to-side skin laxity,\textsuperscript{61-63} even papers that frequently employ a fleur-de-lis approach state that circumferential lipectomies can avoid it.\textsuperscript{26,63} Secondly, other factors in this current author’s technique, namely the flap thinning,\textsuperscript{27,61} flap redraping, and possible flap tightening principles as outlined above (Methods and Figure 1), may allow for avoidance of the vertical excision even in some cases where preoperatively it might seem to be appropriate (Figures 2 and 3). Although the “fleur-de-lis” is a well-established technique with equivalent complication rates reported in some centers,\textsuperscript{64} other authors find the complication rates to be higher.\textsuperscript{49,54,65} It is the author’s opinion that in many cases the aesthetics are better (Figures 2 and 3) without the vertical midline scar, even if some minor side-to-side laxity remains. One center concurs with this assessment and has largely ceased the performance of the fleur-de-lis due to concerns
regarding the aesthetics of the “hard to disguise” vertical scar as well as, in their experience, a higher complication rate.⁴⁹

The strengths of this study are that it is a large, consecutive, single-surgeon study, so that relative uniformity of technique and assessment can be assumed. One weakness is that it is a retrospective study that relies on chart/EMR review which could miss or misclassify information. Another weakness is that the ability to record or even define “aesthetic intent” is by nature very subjective, as noted above. A third weakness is that there is no consideration given to the nutritional status of the patients, which may be a factor in wound healing in the MWL population. ³, ³⁸-⁴⁰ This study contributes to the knowledge base and differs from the majority of the literature in that it compares the MWL groups to postpartum patients and also attempts to introduce rarely mentioned aesthetic concepts in the MWL population.

CONCLUSIONS

The MWL abdominoplasty candidate often presents a challenge in risk mitigation as well as achievement of aesthetic goals. The risks may be higher due to co-morbidities (chiefly residual obesity) which makes an argument for consideration of all risk factors as opposed to a focus merely on the history of weight loss. In addition the data herein suggest that a history of bariatric MWL may be an independent risk factor for complications whereas a history of dietary MWL seems not to be. Thus postbariatric patients should be approached with greater caution. In both MWL groups the deformities are greater so the path to a good aesthetic outcome is longer (and potentially more perilous). However, select MWL candidates (lower BMI, nonsmoking, nondiabetic, dietary MWL) can probably be approached with a mindset to optimize aesthetics, as in this study the prioritization of aesthetic goals in these patients did not increase the risk of major complications as compared to postpartum controls. This mindset might include attention to aesthetic details as previously delineated, as well as careful reconsideration as to whether concessions to safety such as sacrifice of the umbilicus,⁶³,⁶⁶ or unnatural skin patterns such as the W-plasty⁶¹,⁶⁷-⁶⁹ are actually necessary. In the author’s opinion the common fleur-de-lis pattern may sometimes, perhaps often, be avoided as well. In this day and age of ubiquitous self-publication by patients of results on the internet there is a better general awareness of plastic surgical techniques and outcomes; patients know what they want and especially what they don’t want. For this reason it seems that aesthetic standards have been raised, thus we are in a sense forced to reassess some of our old habits. “So, we should not be ashamed to change our methods; rather we should be ashamed not to do so.”⁷⁰ MWL patients have high expectations, just like postpartum patients, and so long as we can do it safely we should strive to meet those expectations.
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Table 1. Pittsburgh Rating Scale for Abdominal Deformity

| Appearance                                    | Classification | Numerical Score |
|-----------------------------------------------|----------------|-----------------|
| Normal                                        | 0              | 0               |
| Moderate adiposity without overhang           | 1              | 1               |
| Overhanging pannus                            | 2              | 2               |
| Double roll confined to panty/girdle line     | 3a             | 3               |
| Double roll extending to midaxillary line     | 3b             | 4               |
| Double roll extending to back                 | 3c             | 5               |
| Triple roll                                   | 3d             | 6               |
Table 2. Baseline Characteristics of Abdominoplasty Patients: Postpartum Versus Dietary MWL Versus Bariatric MWL

|                          | Postpartum | Dietary Massive Weight Loss | Bariatric Massive Weight Loss | $p^a$       |
|--------------------------|------------|-----------------------------|-------------------------------|-------------|
| No. of patients          | 718        | 65                          | 127                           |             |
| Weight Loss (pounds)     | NA         | 85.49                       | 107.74                        | Dietary vs. bariatric $<0.001^b$ |
| BMI (at abdominoplasty)  | 26.74      | 28.28                       | 30.12                         | Postpartum vs. dietary $0.039^b$         |
|                          |            |                             |                               | Postpartum vs. bariatric $<0.005^b$       |
|                          |            |                             |                               | Dietary vs. bariatric $0.032^b$           |
| Deformity Grade          | 2.56       | 3.17                        | 3.52                          | Postpartum vs. dietary $<0.001^b$        |
|                          |            |                             |                               | Postpartum vs. bariatric $<0.001^b$       |
|                          |            |                             |                               | Dietary vs. bariatric $0.039^b$           |
| Age (mean)               | 43.27      | 41.12                       | 44.75                         | Postpartum vs. dietary $0.212$           |
|                          |            |                             |                               | Postpartum vs. bariatric $0.268$         |
|                          |            |                             |                               | Dietary vs. bariatric $0.043^b$          |
| % Smokers                | 11.84(85)  | 12.31(8)                    | 16.54(21)                     | Postpartum vs. dietary $0.911$          |
|                          |            |                             |                               | Postpartum vs. bariatric $0.141$         |
|                          |            |                             |                               | Dietary vs. bariatric $0.439$            |
| % Diabetic               | 2.23(16)   | 3.08(2)                     | 7.09(9)                       | Postpartum vs. dietary $0.662$          |
|                          |            |                             |                               | Postpartum vs. bariatric $0.003^b$       |
|                          |            |                             |                               | Dietary vs. bariatric $0.258$            |

$^a$Calculated using ANOVA with posthoc analysis, unpaired t-test and $\chi^2$ test.

$^b$Statistically significant difference between groups.
Table 3. Utilization of Aesthetic Components and Concomitant Aesthetic Procedures:
Postpartum vs. Dietary MWL vs. Bariatric MWL

| %Simultaneous Aesthetic Procedure | Postpartum | Dietary Massive Weight Loss | Bariatric Massive Weight Loss | p<sup>a</sup> |
|----------------------------------|------------|----------------------------|----------------------------|-------------|
| % Flank Liposuction              | 21.87(157) | 16.92(11)                  | 4.72(6)                    |             |
| % Sub-Scarpa’s Fat Resection     | 33.84(243) | 46.15(30)                  | 48.82(62)                  |             |
| % Fascial Plication             | 83.28(598) | 61.54(40)                  | 64.57(82)                  |             |
| Any Aesthetic Component<sup>c</sup> | 86.35(620) | 80.00(52)                  | 80.31(102)                 |             |

<sup>a</sup>Calculated using χ² test.

<sup>b</sup>Statistically significant difference between groups.

<sup>c</sup>Flank liposuction, sub-Scarpa’s fat resection, plication, or combination.
Table 4. Univariate Analysis of Complications

|                               | Total | Post-partum | Dietary Massive Weight Loss | Bariatric Massive Weight Loss | \( p^a \)               |
|--------------------------------|-------|-------------|-----------------------------|------------------------------|----------------------------|
| No. of patients                | 910   | 718         | 65                          | 127                          |                           |
| Major Flap Necrosis (%)        | 1.65(15) | 1.39(10)    | 1.54(1)                     | 3.15(4)                      | Postpartum vs dietary 0.924 |
|                                |       |             |                             |                              | Postpartum vs bariatric 0.153 |
|                                |       |             |                             |                              | Dietary vs bariatric 0.507  |
| Minor Flap Necrosis (%)        | 3.96(36) | 4.04(29)    | 1.54(1)                     | 4.72(6)                      | Postpartum vs dietary 0.315 |
|                                |       |             |                             |                              | Postpartum vs bariatric 0.721 |
|                                |       |             |                             |                              | Dietary vs bariatric 0.265  |
| Fat Necrosis (%)               | 3.29(30) | 2.92(21)    | 3.08(2)                     | 5.51(7)                      | Postpartum vs dietary 0.945 |
|                                |       |             |                             |                              | Postpartum vs bariatric 0.133 |
|                                |       |             |                             |                              | Dietary vs bariatric 0.450  |
| Seroma (%)                     | 13.08(119) | 11.28(81)   | 20.00(13)                   | 19.68(25)                    | Postpartum vs dietary 0.038⁸⁰ |
|                                |       |             |                             |                              | Postpartum vs bariatric 0.008⁸⁰ |
|                                |       |             |                             |                              | Dietary vs bariatric 0.959  |
| Infection (%)                  | 3.52(32) | 3.76(27)    | 0                           | 3.93(5)                      | Postpartum vs dietary 0.112 |
|                                |       |             |                             |                              | Postpartum vs bariatric 0.923 |
|                                |       |             |                             |                              | Dietary vs bariatric 0.105  |
| Hematoma (%)                   | 0.88(8) | 0.84(6)     | 0                           | 1.57(2)                      | Postpartum vs dietary 0.459 |
|                                |       |             |                             |                              | Postpartum vs bariatric 0.428 |
|                                |       |             |                             |                              | Dietary vs bariatric 0.309  |
| Venous Thromboembolism (%)     | 1.54(14) | 1.25(9)     | 1.54(1)                     | 3.15(4)                      | Postpartum vs dietary 0.845 |
|                                |       |             |                             |                              | Postpartum vs bariatric 0.110 |
|                                |       |             |                             |                              | Dietary vs bariatric 0.507  |
| Any Complication (%)           | 24.28(221) | 22.70(163) | 27.69(18)                   | 31.49(40)                    | Postpartum vs dietary 0.361 |
|                                |       |             |                             |                              | Postpartum vs bariatric 0.030⁸⁰ |
|                                |       |             |                             |                              | Dietary vs. bariatric       |
|                          | Postpartum vs dietary | Postpartum vs bariatric | Dietary vs. bariatric |
|-------------------------|-----------------------|-------------------------|----------------------|
| Ischemic Complication$^c$ (%) | 8.24(75)              | 7.79(56)                | 6.15(4)              | 11.81(15)            |
| Multiple Complications (%) | 3.19(29)              | 2.36(17)                | 0                    | 9.45(12)             |
| Revision (%)             | 4.51(41)              | 4.59(33)                | 3.08(2)              | 4.72(6)              |

$^a$ Calculated by $\chi^2$ test,

$^b$ Statistically significant difference between groups.

$^c$ Any flap necrosis or fat necrosis.
Table 5. Predictors of Complications via Binary Logistic Regression

| Complication                  | Predictor          | Odds Ratio | 95% Confidence Interval | P value |
|-------------------------------|--------------------|------------|-------------------------|---------|
| Major Flap Necrosis (>5cm²)  | BMI                | 1.163      | 1.063-1.270             | 0.001<sup>a</sup> |
|                               | Smoking            | 4.619      | 1.562-13.661            | 0.006<sup>a</sup> |
| Minor Flap Necrosis (<5cm²)   | Diabetes Mellitus  | 6.926      | 2.355-20.363            | <0.001<sup>a</sup> |
|                               | Smoking            | 2.599      | 1.168-5.782             | 0.019<sup>a</sup> |
| Fat Necrosis                  | BMI                | 1.083      | 1.010-1.161             | 0.025<sup>a</sup> |
| Seroma                        | BMI                | 1.049      | 1.008-1.092             | 0.020<sup>a</sup> |
| Infection                     | Age                | 1.061      | 1.024-1.100             | 0.001<sup>a</sup> |
| Venous Thromboembolism        | Age                | 1.054      | 1.003-1.108             | 0.038<sup>a</sup> |
| Any Complication              | BMI                | 1.066      | 1.032-1.102             | <0.001<sup>a</sup> |
| Ischemic Complication<sup>b</sup> | BMI              | 1.060      | 1.012-1.112             | 0.015<sup>a</sup> |
|                               | Smoking            | 2.418      | 1.320-4.431             | 0.004<sup>a</sup> |
|                               | Diabetes Mellitus  | 5.750      | 2.361-14.004            | <0.001<sup>a</sup> |
| Multiple Complications        | Age                | 1.039      | 1.002-1.078             | 0.041<sup>a</sup> |
|                               | BMI                | 1.099      | 1.024-1.181             | 0.009<sup>a</sup> |
|                               | Bariatric MWL      | 2.738      | 1.231-6.090             | 0.014<sup>a</sup> |

<sup>a</sup>Statistically significant.

<sup>b</sup>Any flap necrosis or fat necrosis
### Table 6. Comparison of Complications in Propensity Score Matched Pairs: Postpartum Versus Dietary Massive Weight Loss

|                          | Postpartum | Dietary Massive Weight Loss | \( p^a \) |
|--------------------------|------------|-----------------------------|----------|
| No. of patients          | 61         | 61                          |          |
| % Major Flap Necrosis    | 1.7(1)     | 1.7(1)                      | 1.0      |
| % Minor Flap Necrosis    | 3.3(2)     | 1.7(1)                      | 1.0      |
| % Fat Necrosis           | 3.3(2)     | 3.3(2)                      | 1.0      |
| % Seroma                 | 14.8(9)    | 16.4(10)                    | 1.0      |
| % Infection              | 0          | 0                           | NS       |
| % Hematoma               | 0          | 0                           | NS       |
| % VTE                    | 0          | 0                           | NS       |
| % Any Complication       | 18.0(11)   | 19.7(12)                    | 1.0      |
| % Ischemic Complication\(^b\) | 8.19(5)   | 6.56(4)                      | 1.0      |
| % Multiple Complications | 1.64(1)    | 0(0)                        | 1.0      |
| % Revision               | 8.2(5)     | 3.3(2)                      | .453     |

\(^a\)Calculated using McNemar’s test.

\(^b\) Any flap necrosis or fat necrosis.
Table 7. Comparison of Complications in Propensity Score Matched Pairs: Postpartum Versus Bariatric Massive Weight Loss

|                      | Postpartum | Bariatric Massive Weight Loss | $p^a$ |
|----------------------|------------|------------------------------|-------|
| No. of patients      | 120        | 120                          |       |
| % Major Flap Necrosis| 2.50(3)    | 3.33(4)                      | 1.00  |
| % Minor Flap Necrosis| 5.00(6)    | 4.17(5)                      | 1.00  |
| % Fat Necrosis       | 5.00(6)    | 5.00(6)                      | 1.00  |
| % Seroma             | 12.5(15)   | 19.16(23)                    | 0.229 |
| % Infection          | 5.83(7)    | 4.17(5)                      | 0.758 |
| % Hematoma           | 0.83(1)    | 1.66(2)                      | 1.0   |
| % VTE                | 5.00(6)    | 4.17(5)                      | 1.0   |
| % Any Complication   | 26.67(32)  | 30.83(37)                    | 0.567 |
| % Ischemic Complication$^b$ | 10.83(13)  | 11.67(14)                    | 1.0   |
| % Multiple Complications | 5.83(7)    | 8.33(10)                     | 0.629 |
| % Revision           | 5.00(6)    | 4.17(5)                      | 1.0   |

$^a$Calculated using McNemar’s test.

$^b$Any flap necrosis or fat necrosis.
Table 8. Comparison of Complications in Propensity Score Matched Pairs: Dietary Weight Loss vs Bariatric Weight Loss

|                                | Dietary Weight Loss | Bariatric Weight Loss | $p^a$ |
|--------------------------------|---------------------|-----------------------|-------|
| No. of patients                | 63                  | 63                    |       |
| % Major Flap Necrosis          | 1.59(1)             | 1.59(1)               | 1.0   |
| % Minor Flap Necrosis          | 1.59(1)             | 4.76(3)               | 0.617 |
| % Fat Necrosis                 | 3.17(2)             | 6.35(4)               | 0.683 |
| % Seroma                       | 20.65(13)           | 20.65(13)             | 1.0   |
| % Infection                    | 0                   | 3.17(2)               | NS    |
| %Hematoma                      | 0                   | 0                     | NS    |
| %VTE                           | 0                   | 1.59(1)               | NS    |
| %Any Complication              | 26.70(17)           | 30.16(19)             | 0.851 |
| %Ischemic Complication$^c$     | 6.35(4)             | 14.29(9)              | 0.267 |
| %Multiple Complications        | 0(0)                | 9.52(6)               | 0.031$^b$ |
| %Revision                      | 3.17(2)             | 7.94(5)               | 0.450 |

$^a$Calculated using McNemar’s test.

$^b$Statistically significant difference between groups.

$^c$Any flap necrosis or fat necrosis.
FIGURE LEGEND

Figure 1. Principles of abdominoplasty flap contouring in the MWL population. 1. Flap itself may need improvement (thinning, release, possible tightening) which can be achieved by sub-Scarpa’s resection with electrosurgery. 2. Higher upper incision results in strong downwards/lateral tension vector. 3. Extended, upwards curving lower incision provides lateral tension vector. 4. Mons rejuvenation via a lower incision placement (approximately 6-7 cm from introitus) with upwards/lateral tension vector as well as mons thinning and fascial suspension.

Figure 2. A 31-year-old nonsmoking, nondiabetic woman with BMI of 30.84 and a deformity rating of 3(b) had lost 140 pounds following gastric bypass then underwent abdominoplasty with “belt” lipectomy and breast reduction. Anterior abdominal specimen weighed 4038 grams. Photos at three years postop. A. Frontal preoperative view. B. Frontal postoperative view. C. Lateral preoperative view. D. Lateral postoperative view. E. Oblique preoperative view. F. Oblique postoperative view.

Figure 3. A 43-year-old nonsmoking, nondiabetic woman with a BMI of 32.89 and a deformity rating of 3(c) had lost 120 pounds by a program of diet and exercise then underwent abdominoplasty and brachioplasty. Photos at one year postop. A. Frontal preoperative view. B. Frontal postoperative view. C. Lateral preoperative view. D. Lateral postoperative view. E. Oblique preoperative view. F. Oblique postoperative view.
