

Standards and Trends in Lipoabdominoplasty

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Background: Lipoabdominoplasty has evolved over the last 6 decades through contributions from numerous luminaries in plastic and reconstructive surgery.

Methods: The authors review historical perspective and provide a contemporary examination of trends in lipoabdominoplasty.

Results: In 1967, Pitanguy popularized abdominoplasty (without liposuction) as a technique for augmenting ventral hernias repairs and subsequently for aesthetic improvement of the abdomen. After the introduction of suction assisted lipectomy by Illouz in 1983, abdominoplasty became a central tool in a diverse armamentarium of anterior and lateral abdominal wall contouring procedures. Liposuction was initially utilized with mini-abdominoplasty in order to improve contour. Subsequently, Matarasso advanced the safe combination of liposuction with full abdominoplasty. Additionally, he systematized the variety of cutaneous undermining, excision, and liposuction procedures utilized in abdominal contouring as indicated by the degree of skin laxity and musculofascial diastasis. Lockwood advocated high lateral tension closure of the superficial fascial system of the abdomen to improve the contour of the hips and flanks. Saldanha advanced selective undermining and anterior abdominal wall perforator preservation to minimize wound healing and seroma complications associated with lipoabdominoplasty procedures.

Conclusion: In abdominal contour surgery, surgeons can rely on classic techniques and algorithms that have withstood the test of time while modifying their approaches with advances backed by compelling and rigorously obtained evidence. (*Plast Reconstr Surg Glob Open* 2020;8:e3144; doi: [10.1097/GOX.0000000000003144](https://doi.org/10.1097/GOX.0000000000003144); Published online 26 October 2020.)

INTRODUCTION

Lipoabdominoplasty has evolved over the last 6 decades through contributions from numerous luminaries in plastic and reconstructive surgery. In 1967, Pitanguy popularized abdominoplasty (without liposuction) as a technique for augmenting ventral hernia repairs and subsequently for aesthetic improvement of the abdomen.¹ After the introduction of suction-assisted lipectomy by Illouz in 1983, abdominoplasty became a central tool in a diverse armamentarium of anterior and lateral abdominal wall contouring procedures.² Liposuction was initially utilized with mini-abdominoplasty to improve contour. Subsequently, Matarasso advanced the safe combination of liposuction with full abdominoplasty, emphasizing vascular anatomy

of the abdominal wall (Fig. 1).³ Additionally, he systematized the variety of cutaneous undermining, excision, and liposuction procedures utilized in abdominal contouring, as indicated by the degree of skin laxity and musculofascial diastasis.³ Lockwood advocated high lateral tension closure of the superficial fascial system of the abdomen to improve the contour of the hips and flanks.⁴ Saldanha advanced selective undermining and anterior abdominal wall perforator preservation to minimize wound healing and seroma complications associated with lipoabdominoplasty procedures.⁵

These major advances among many others have helped advanced lipoabdominoplasty as a diverse set of procedures that produce a desirable appearance of the anterior and lateral abdomen with acceptable risk in appropriately selected patients. Current challenges include 1) improving aesthetic outcome and patient satisfaction, 2) risk stratifying and reducing incidence of venous thromboembolism and other complications, and 3) expanding indication for lipoabdominoplasty in

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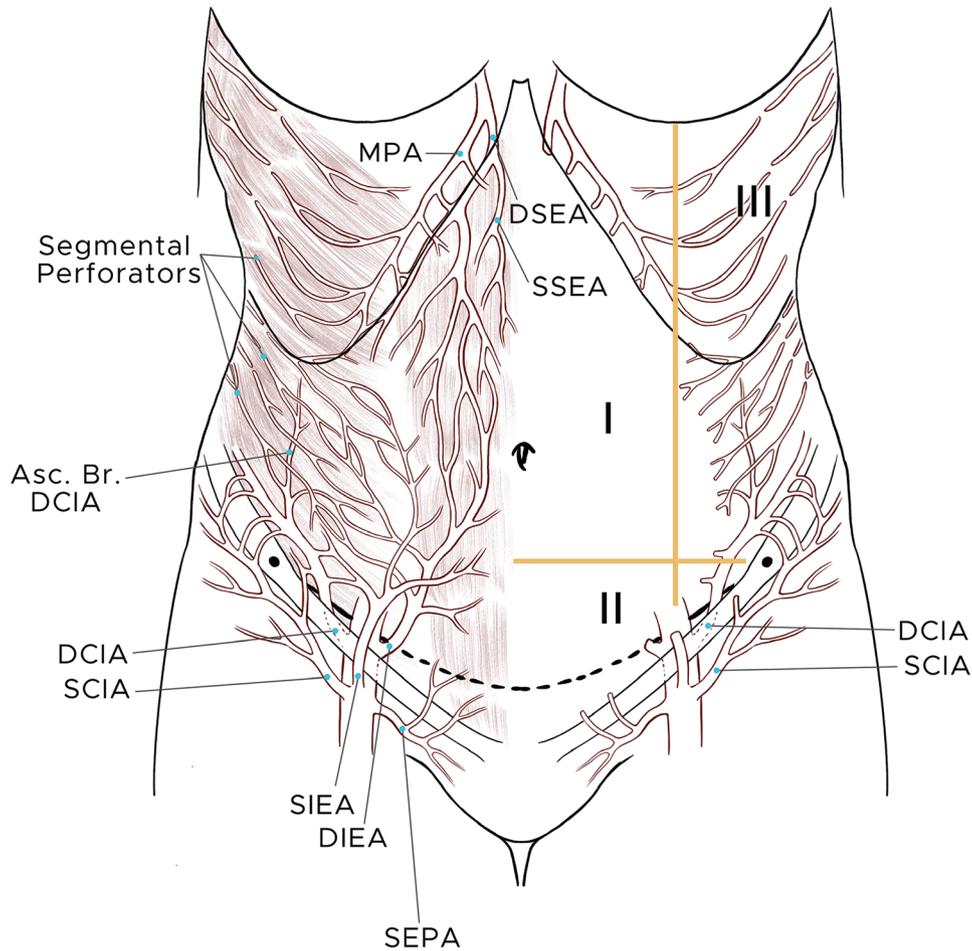


Fig. 1. Illustration of abdominal wall blood supply according to Huger zones (I, II, III). The right hemi-abdomen represents pre-operative anatomy. The left hemi-abdomen represents expected disruption of the perforating blood supply to the skin and subcutaneous tissue during abdominoplasty.

the context of the worldwide obesity epidemic. In this article, the authors discuss the key tenets and ongoing controversies in lipoabdominoplasty.

STANDARDS IN LIPOABDOMINOPLASTY

Board-certified plastic surgeons performed over 130,000 abdominoplasties in 2018.⁶ Given the enormous popularity of this procedure, we first discuss the generally accepted tenets of modern lipoabdominoplasty, including patient selection, aesthetic planning, and surgical technique.

Patient Selection

Abdominoplasty is a system for classifying treatments that represent a collection of procedures, with the common goal of improving and restoring a youthful and lean aesthetic contour to the anterior abdomen and flanks. Lipoabdominoplasty is the application of liposuction to a full (type IV) abdominoplasty. Abdominoplasty procedures are designed to correct laxity of the musculofascial wall of the anterior abdomen and refine the contour and appearance of the overlying cutaneous tissues. The ideal

lipoabdominoplasty patient has traditionally been a post-partum woman who would benefit from repair of rectus diastasis and excision of cutaneous striae and redundancy, and suction aspiration or excision of mild to moderate excess subcutaneous fat.⁷

It is worth noting that active nicotine use, significant ventral hernia burden or abdominal wall defects, active malignancy, or previous radiation remain contraindications for lipoabdominoplasty due to increased risk of wound healing and other complications. In child-bearing women, the desire for future pregnancy should guide timing of abdominoplasty, as recurrence of rectus diastasis and skin laxity may occur.

Aesthetic Ideals of the Abdomen

Achieving a desirable abdominoplasty result requires consideration of the position of the transverse scar, position and shape of the umbilicus, waist-to-hip (WHR) ratio, and definition of the underlying abdominal wall musculature. These considerations differ in female and male patients and must be taken into account because an ever-increasing range of patients seek abdominal contouring procedures. Finally, these standards have evolved over

time, and this discussion will strive to highlight both classic and recent viewpoints.

The transverse abdominoplasty scar should be well hidden by undergarments and swim wear. The popularity of swimwear and clothing that sits lower on the hips and abdomen dictates placing this incision approximately 5–9 cm above the introitus in women and below prior scars. However, excessively low and tight closure of the incision can lead to cicatricial upward pull on the introitus and discomfort during sexual intercourse. Furthermore, low placement of the lateral aspect of the incision may increase the risk of injury to the lateral femoral cutaneous nerve and cause paresthesias of the anterior and lateral thigh. In men, the transverse incision may sit higher on the abdomen as the inseam of male swimwear and clothing are typically longer and better able to conceal higher scars.

Yu et al. objectively described the appearance of umbilicus in youthful, normal BMI patients of diverse racial groups and genders.⁸ The ideal umbilicus was round and depressed, with a height and width of approximately 2 cm. It is typically found within 1 cm of a horizontal line made between both iliac crests. Deviation from the midline was less than 1 cm. Importantly, there was a minimal variation between white, African American, Asian, and Hispanic patients. The distance between the xiphoid to umbilicus was 17.1 versus 18.0 in women versus men ($P < 0.05$), which may give the appearance of a higher umbilicus position in women. Other studies generally confirm these findings, with the suggestion that a vertically ovoid (height modestly greater than width) shape may also be desirable.^{9,10}

Analysis of media depictions of female torsos suggest an ideal WHR of 0.75 in antiquity.¹¹ Over the last 2 centuries, the ideal WHR has decreased to approximately 0.7.¹¹ However, there is now a greater variance in depiction of WHR, though it is unclear whether this stems from decreasing waist circumferences or rising popularity in hip- and buttock-augmentation procedures. With the introduction of flank liposuction, high lateral tensioning of the abdominoplasty flap, and adjunctive buttock and hip lipografting, surgeons now have a multitude of tools to help patients achieve their desired WHR. Importantly, the aesthetically appealing male WHR is greater than that of the female WHR, though there have been limited studies on this subject. Thus, surgeons should avoid excessively cinching the waist in male abdominoplasty patients. Rectus muscle plication or imbrication can contribute to this appearance and is thus uncommon in male patients.

Matarasso et al. described aesthetic subunits of the abdomen to define the role of liposuction in treating cutaneous contour concerns of the anterior and posterior abdomen.^{7,12} They also reported that an hourglass silhouette, and midline and periumbilical concavity as ideal in the female abdomen. In the male abdomen, a triangular silhouette, midline depression, and definition of the paired rectus abdominis muscles and inscriptions are desired. In both groups, a flat, un-projected mons pubis is an often overlooked but also essential aesthetic goal.

Hoyos has advocated the use of extensive VASER-assisted liposuction to further define the abdominal musculature in both genders,¹³ though “high definition” of the abdominal wall musculature is not universally accepted as the aesthetic ideal.

Surgical Technique

Numerous modifications of abdominal skin excision, undermining, and redraping have been described for abdominal contouring indications. In 1991, Matarasso first classified abdominal contour problems based on cutaneous laxity, subcutaneous adiposity, and musculofascial diastasis and laxity to create a standardized treatment algorithm using these techniques³:

Type 1: minimal skin laxity and minimal musculofascial laxity treated with liposuction alone;

Type 2: mild skin laxity and infraumbilical musculofascial laxity treated with skin excision and fascial plication of the infraumbilical abdomen (mini-abdominoplasty);

Type 3: moderate skin laxity and musculofascial laxity above the umbilicus treated with abdominoplasty with or without umbilical transposition (modified abdominoplasty);

Type 4: significant skin laxity and musculofascial laxity treated with standard abdominoplasty with or without liposuction.

This classic algorithm endures as a guide to surgical treatment of many abdominal contouring indications.¹⁴ However, the techniques referenced in it have evolved over the last 3 decades. (See **Video [online]**, which displays the abdominoplasty technique.) Earlier efforts focused on the excision of vertical excess in the central abdominoplasty flap with lateral extensions to avoid dog-ears. This principle yielded improvements in the central abdomen but failed to address laxity in the lateral abdomen. Lockwood advocated greater excision of excess tissue in the lateral abdomen and closure of the dermis and Scarpa's fascia under tension to create an evenly distributed cutaneous tensioning and redraping. Discontinuous undermining of the lateral flap with a liposuction cannula or scissors would facilitate flap advancement under tension while avoiding seroma and wound healing complications thought to be associated with wide sharp undermining^{4,15,16} (**Fig. 2**).

Saldanha later proposed an abdominoplasty with selective undermining between the medial borders of the rectus and discontinuous undermining with liposuction in the lateral abdomen to facilitate flap redraping while preserving the perforating blood supply from the deep epigastric vessels⁵ (**Fig. 3**). These cumulative advances have formed the basis of safer modern abdominoplasty techniques. As indications for abdominoplasty have expanded to overweight and massive-weight-loss patients, further modifications of the technique have been made. Fleur-de-lis or corset abdominoplasty may offer superior results in patients with significant horizontal abdominal laxity, 270-degree abdominoplasty may offer improvement in patients with flank laxity, and circumferential procedures may be best for patients with laxity extending to the posterior trunk.

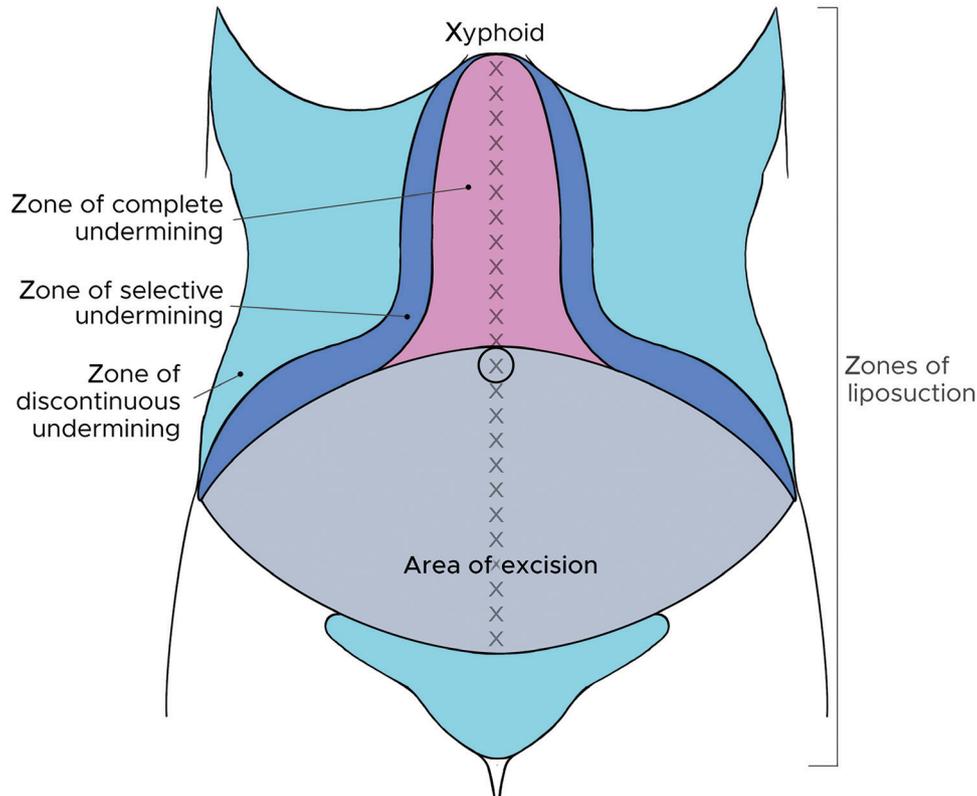


Fig. 2. Modern abdominoplasty techniques advocate narrow undermining of the central flap (Huger Zone I) to facilitate abdominal wall plication, and selective undermining of the lateral flap (Huger Zone III) to facilitate flap advancement and reduce seroma and wound healing complications.

NOVEL TRENDS IN LIPOABDOMINOPLASTY

The latest trends in abdominoplasty are centered on efforts to improve patient satisfaction, increase safety, and expand indications for abdominoplasty.

Liposuction and Flap Thinning

Though Saldanha, Matarasso, and others have described the aesthetic benefits and verified the safety of concurrent liposuction and abdominoplasty, some surgeons still hesitate to perform immediate liposuction of the central abdomen or elevated abdominoplasty flap due to concerns about vascular compromise (Fig. 2).

Any time liposuction is performed if the provider should adhere to American Society of Plastic Surgeons Practice Advisory on Liposuction.¹⁷ The maximum dose of lidocaine included in anesthetic infiltrate should be 35 mg/kg. The senior author prefers the superwet technique with 1 L of Ringer's lactate with 20 mL of 1% lidocaine and 1 mL of 1:1000 epinephrine.¹⁴ Adhering to these guidelines is important for patient safety whether performing traditional abdominoplasty with liposuction of adjunctive treatment areas or performing lipoabdominoplasty with liposuction of the abdominal flap.

Vierira et al. retrospectively reviewed 9637 lipoabdominoplasty versus 1553 abdominoplasty cases and found that lipoabdominoplasty had a significantly lower overall complication rate (10.5% versus 13%; $P = 0.046$) and

significantly a lower seroma rate ($P = 0.03$).¹⁸ Lipoaspirate volume was not associated with the increased risk of complications. However, their study did not delineate which regions of the abdomen underwent liposuction. Sozer et al. reported circumferential liposuction and abdominoplasty flap undermining without skin necrosis in a series of 1000 patients.¹⁹ Other authors have also found that concurrently performing liposuction and abdominoplasty is not associated with the increased risk of complications.^{20–22}

Surgeons have also recently challenged the importance of preserving thickness of the abdominoplasty flap. In 2015, Swanson used laser perfusion imaging to show no change in abdominoplasty flap perfusion after excision of sub-Scarpa tissue in 22 consecutive cases.²³ Tourani et al. found that lymphatic drainage of the lower abdomen also lies superficial to Scarpa's fascia in 8 hemi-abdomen specimens from 4 cadavers.²⁴ However, a systematic review of 4 studies (including 630 patients) found that preservation of the Scarpa's fascia (and cutaneous tissues deep to this layer) was associated with significantly decreased seroma rate, time to drain removal, drain output, and hospital stay.²⁵ These data suggest a trade-off in aesthetic improvement from thinning the abdominoplasty flap and the risk of surgical site complications. Surgeons should be selective in debulking abdominoplasty flaps. In an effort to safely combine unrestricted flap thinning with liposuction to a thickness of 2–3 cm with abdominal wall tightening,

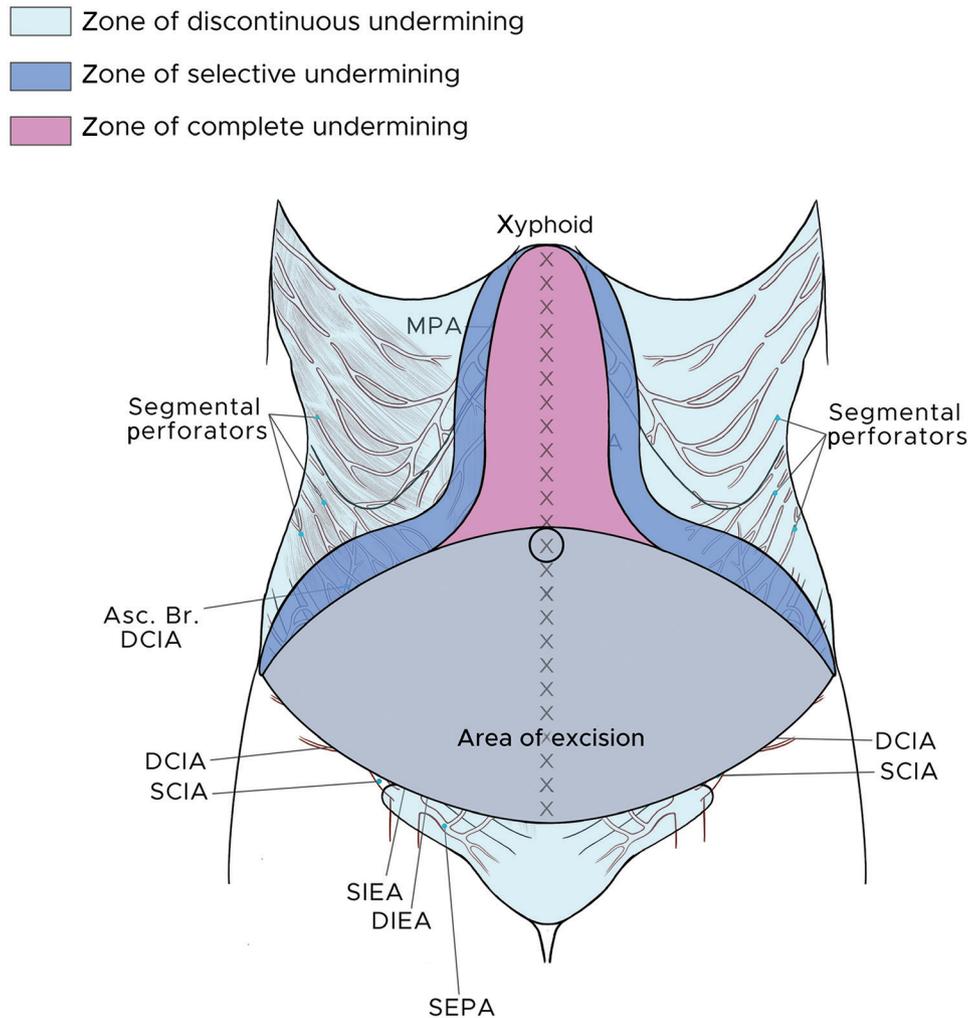


Fig. 3. Undermining should be tailored to aesthetic goals while limiting disruption of blood supply from the underlying abdominal wall.

Villegas Alzate shares his TULUA lipoabdominoplasty technique, which he has been performing since 2005.²⁶ The technique significantly modifies traditional lipoabdominoplasty technique by including no flap elevation above the umbilicus, routine umbilical amputation, concurrent neoumbilicoplasty, and transverse elliptical plication of the infraumbilical abdomen to advance the external obliques inferomedially to cinch in the waist and shorten the excursion of the paired rectus abdominis muscles. He will only include elevation of a midline vertical tunnel to the xiphoid in cases of rectus diastasis of >5 cm. In his review, he notes that patients had significantly decreased postoperative waist circumference compared with preoperative waist circumference and decreased tension on skin closure after transverse plication.

Innovations in liposuction devices must also be considered in the context of combining liposuction with abdominoplasty. Radiofrequency-assisted, laser-assisted, and vibration-assisted liposuction combined with abdominoplasty may increase the risk of tissue injury and lead to seroma, hypertrophic scarring, and wound healing complications.²⁷⁻²⁹ However, further studies must be

performed to determine the safety and efficacy of using these modalities in combination with or in close proximity to abdominoplasty.

Approaches to Reduce Dead Space and Prevent Fluid Collection

Seroma is cited as the most common complication of lipoabdominoplasty. Closed suction drains are the most frequently used device to prevent fluid accumulation. Janis et al. reviewed the plastic surgery literature and found that maintaining drains until output decreased to 25-50mL per day while the patient was ambulatory was associated with significantly fewer seroma complications than maintaining drains for a set duration, irrespective of output.³⁰ However, these data were derived from several breast reconstruction series as opposed to abdominoplasty cohorts, and thus may only be valid as a rough guideline for drain removal. Khansa et al. performed a detailed study of drain physics and found that large caliber (15 and 19 French), flat, perforated drains were superior to small caliber (10 French), round, fluted drains in fluid evacuation rate.³¹ Additionally, intra-cavitary drain length did not

significantly affect flow rate, while longer extra-cavitary tubing decreased flow rate.

Beer and Wallner reported that immobilizing patients for 48 hours versus 24 hours after surgery reduced the incidence of seroma from 13% to 0% in a series of 60 patients.³² However, lengthy periods of immobilization may increase venous thromboembolic risk and decondition patients. Hunstad et al. advocated the use of tissue adhesive between the abdominoplasty flap and the abdominal wall to reduce dead space, shearing, and resultant seroma.³³ In their randomized, controlled trial of 130 patients, the treatment group received tissue adhesive and no drains during abdominoplasty, while the control group had drains that were maintained for approximately 7 post-operative days. However, 27.3% of the treatment group required a total of 112 needle aspirations versus 12.5% of control group requiring a total of 24 needle aspirations to manage fluid accumulation. Mabrouk et al. compared the incidence of seroma in obese (BMI >30) patients undergoing lipoabdominoplasty randomizing 60 patients between a treatment group fibrin tissue adhesive in combination with drains versus a control group with drains alone. Utilizing ultrasound evaluation at post-operative appointments, they found a significantly lower incidence of seroma (3%) in the treatment group than in the control group (37%).³⁴ Nasr et al. performed a meta-analysis of 5 RCTs including Mabrouk et al., the pooled analysis did not find a statistically significant difference in seroma rates between patients who received tissue adhesives versus those who did not, however there was significantly lower output from the drains while they were in place in patients who received tissue adhesives.³⁵ Interestingly, the among the other RCTs included, only Pilone et al. focused on tissue adhesives in obese, post-bariatric patients undergoing circular abdominoplasty.³⁶ The authors noted a significant decrease in seroma in patients treated with tissue adhesive (6.6%) than in patients not treated with tissue adhesive (53.3%). Together, these data suggest that tissue adhesives may offer increased benefits in seroma prevention in obese patients undergoing abdominoplasty or lipoabdominoplasty. Future studies with larger patient cohorts are needed to clarify this issue.

The use of sutures to minimize dead space and shear between the abdominoplasty flap and abdominal wall has gained increasing attention over the last decade. Pollock and Pollock first described the use of progressive tension sutures (PTS) that secured the Scarpa's fascia to the underlying abdominal fascia to reduce seroma risk while avoiding drain placement.³⁷ In their review of 597 consecutive cases using PTS, the seroma rate was 0.8% without the use of drains. They hypothesized that PTS reduced dead space and shear forces between the cutaneous flap and fascia. Interestingly, they also noted greater abdominal flap advancement afforded by PTS.³⁸ Similar experiences were reported by Antonetti and Antonetti in 516 consecutive cases from 1981 to 2008.³⁹ After the adoption of PTS, their seroma rate dropped from 24% to 1.7%. Trussler et al. examined outcomes from abdominoplasties performed over a 20-year period and found a statistically significant reduction in seroma rate to 3% after adopting

the use of PTS with drains.⁴⁰ Gould et al. found a significantly lower seroma rate in patients undergoing drainless lipoabdominoplasty with PTS compared with those with those undergoing lipoabdominoplasty with drains.⁴²⁻⁴⁴ Finally, Jabbour et al.'s systematic review of 3 RCTs and 4 retrospective studies found that abdominoplasty with PTS had significantly lower seroma rate than abdominoplasty with drains.⁴⁵

Critics of the technique argue that it adds unnecessary and potentially risky operative time. Several modifications of the technique have been offered to help reduce the additional operative time. Bromley et al. performed a randomized control trial to analyze the number of progressive tension sutures necessary to prevent seroma.⁴⁶ They report that 11 progressive tension sutures were as efficient at preventing seroma as the usage of 22 progressive tension sutures and that the time cost was an additional 13 versus 30 minutes. Rosen et al. reported the effective use of running barbed PTS without drains in their abdominoplasties over a 10-year period in over 400 cases.⁴⁷ They found significantly lower seroma incidence than abdominoplasty performed with drains over the same period. Interestingly no studies reported increased wound healing delay, hematoma, or permanent contour irregularities with the use of PTS.

Risk Stratification of Venous Thromboembolism

Venous thromboembolism is a potentially fatal complication of abdominoplasty. The Caprini score is frequently used to guide preoperative risk stratification for venous thromboembolism (VTE), but may underestimate the risk of VTE in abdominoplasty due to increased intra-abdominal pressure with musculofascial plication, post-operative protocols requiring patient immobilization and binder use, and patient positioning.^{48,49} Mittal et al. reviewed 25 studies of cosmetic surgery outcomes and found that abdominoplasty accounts for the majority of VTEs from cosmetic procedures.⁵⁰ Obesity, circumferential procedures, and hormone replacement therapy were independent risk factors for VTE in abdominoplasty patients. Hafez et al. performed a systematic review of outcomes in abdominal contouring procedures and found that circumferential abdominoplasty had the highest risk of VTE (3.4%) followed by abdominoplasty combined with intra-abdominal procedures (2.17%).⁵¹ Abdominoplasty alone had a significantly lower thromboembolism rate (0.35%), which was approximately doubled when abdominoplasty was combined with other plastic surgery procedures (0.79%)

Given the VTE risk inherent to abdominoplasty, adequate consideration should be given to prophylaxis on the basis of patient characteristics, procedure duration and type, and *Caprini* score. Mechanical sequential compression of the legs and early ambulation are almost universally considered appropriate. *Caprini* score greater than 7 or 8 has been validated as one of the several criteria for chemoprophylaxis by Pannucci et al.⁴⁸ Swanson has argued against the routine use of anticoagulation pharmacologic agents and mechanical sequential compression

devices, and instead favors the use of pre- and post-operative ultrasonography to detect VTEs before treatment.^{52–55}

Historically, some have avoided chemical prophylaxis due to concerns of increasing the risk of hematoma and need for blood transfusion. In 2012, Dini et al. halted a double-blinded randomized control trial after administration of rivaroxaban 10 mg for 10 days after surgery led to a 29.6% incidence of large hematoma.⁵⁶ However, Hunstad et al. found only 2.3% rate of hematoma in a series of 132 patients treated with 10 mg rivaroxaban for 7–14 days based on VTE risk factors.⁵⁷ Similarly, Reish et al. reported only 1 hematoma and no thromboembolic events in 105 consecutive patients who underwent abdominoplasty with or without adjunctive procedures and received post-operative subcutaneous unfractionated heparin or low molecular weight heparin for up to 7 days.⁵⁸ Finally, Sarhaddi et al. published a single-center retrospective review of 233 patients who received no chemoprophylaxis and 252 who received fondaparinux for 7 days after surgery.⁵⁹ They noted that a significantly fewer VTE in the group received chemoprophylaxis (2.1% versus 0%); no significant difference in hematoma requiring reoperation (2.3% versus 1.7%); and no significant increase in blood loss requiring transfusion (0% versus 0.8%). Based on these and other recent reports,⁶⁰ it appears that VTE chemoprophylaxis achieves the goal of reducing VTE risk without increasing the incidence of hematoma or the need for transfusion. Surgeons should choose VTE prophylaxis with patient and operative risk factors in consideration.

Expanding Indications for Abdominoplasty

The ideal candidate for classic abdominoplasty with or without liposuction is a post-partum woman with no significant comorbidities, normal body mass index, and rectus diastasis, and/or skin laxity secondary to pregnancy. However, with the ever-growing global obesity epidemic, a significant segment of patients seeking improved abdominal contour fall within the overweight or obese range and possess significant adiposity of the central abdomen and flanks. Furthermore, some portion of patients seeking abdominoplasty present after massive weight loss (MWL) with or without a bariatric surgery, which presents unique considerations for surgical planning and management.

Batac et al. recently described their experience with abdominoplasty in the obese versus non-obese.⁶¹ They found similar rates of seroma (22.5% versus 14.2%), wound dehiscence (11.3% versus 9.5%), infection (8.0% versus 9.5%), and hematoma (1.6% versus 4.7%). Notably, they did not observe any clinically significant venous thromboembolism in their series of 62 non-obese and 21 obese patients. Hammond et al. found 8% rate of major complications requiring return to the OR and 39.1% risk of minor complications that were managed conservatively in a series of 46 overweight and obese patients (mean BMI = 32 kg/m).⁶² Patients reported high satisfaction with the overall appearance of their abdomen post-operatively. Although both studies were significantly limited by small statistical power, they suggest that the growing trend of lipoabdominoplasty procedures in overweight and obese populations can be performed safely and with satisfactory results.

Bossert and Rubin provide a comprehensive algorithm for evaluating MWL patients presenting for body contouring.⁶³ Of note, plastic surgeons ideally should wait at least 1 year after a bariatric surgery to intervene. Patients should be able to maintain a BMI < 30 and a stable weight for 3 months before opting for a body contouring surgery. Oftentimes, multiple areas of the body will be affected by redundant skin and subcutaneous tissue, which necessitates contouring surgery in multiple stages. Plastic surgeons should work with patients to identify and prioritize treatment of areas that will provide the most functional and psychological improvement while limiting the risk of complications.

Many surgeons will obtain nutritional and medical consultation to optimize cardiovascular, pulmonary, and endocrine comorbidities and reduce the risk of wound healing complications. Albino et al. suggest a 31%–66% incidence of wound healing complications following body contouring surgery in massive weight loss patients.⁶⁴ They argue that dysregulation of inflammatory cytokines and matrix metalloproteinases may contribute to this phenomenon. Others have hypothesized that protein and micronutrient deficiencies are associated with delayed wound healing in MWL patients. Austin et al. found decreased wound healing complications in MWL patients who were supplemented with protein before body contouring surgery.⁶⁵ However, Barbour et al. were unable to link albumin or other micronutrient deficiencies to delayed wound healing in an analysis of 161 MWL patients undergoing panniculectomy.⁶⁶ However, they do note that BMI at the time of surgery and volume of excised tissue were associated with wound healing complications. Other studies confirm this finding.^{63,67,68} Katzel et al. found persistent abnormal microvascular architecture and histology in abdominoplasty flaps of MWL patients.⁶⁹ They hypothesize that this may also contribute to the delayed wound healing observed in MWL patients.

Song et al. proposed the Pittsburgh Rating Scale to classify contour abnormality of the abdomen following massive weight loss⁷⁰ based on the amount of overhanging pannus and rolls. Zammerilla et al. modified the scale to address the diverse range of deformities in patients with multiple rolls.⁷¹ In particular, they grade the lateral extension of rolls toward the flank and back. In severe cases, patients may be best served with fleur-de-lis abdominoplasty, corset abdominoplasty, or circumferential body lift procedures, which are powerful techniques that fall outside the purview of standard lipoabdominoplasty discussion and require additional operative and post-operative considerations.^{72–74} For MWL patients with moderate deformities, abdominoplasty has been shown to provide significant psychosocial and functional improvement.^{67,68,75} Importantly, excision of redundant skin provides the greatest utility for patients in this population, while rectus plication may not be critical to achieving a satisfactory result.⁷⁵

CONCLUSIONS

A diverse array of surgical techniques is available to treat contour deformities of the abdomen. Surgeons can

rely on classic techniques and algorithms that have withstood the test of time while modifying their approaches with advances backed by compelling and rigorously obtained evidence. An ever-expanding patient population seeking abdominal contouring must be carefully counseled and treated with the appropriately selected techniques to limit the risk of complications and achieve optimal outcomes.

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REFERENCES

- Pitanguy I. Abdominal lipectomy: an approach to it through an analysis of 300 consecutive cases. *Plast Reconstr Surg.* 1967;40:384–391.
- Illouz YG. Body contouring by lipolysis: a 5-year experience with over 3000 cases. *Plast Reconstr Surg.* 1983;72:591–597.
- Matarasso A. Abdominoplasty. In: *Clinics in Plastic Surgery*. Philadelphia, Pa.: W.B. Saunders and Company; 1989;16:2.
- Lockwood T. High-lateral-tension abdominoplasty with superficial fascial system suspension. *Plast Reconstr Surg.* 1995;96:603–615.
- Saldanha OR, Pinto EB, Matos WN Jr, et al. Lipoabdominoplasty without undermining. *Aesthet Surg J.* 2001;21:518–526.
- The American Society of Plastic Surgeons. Plastic Surgery Statistics Report. <https://www.plasticsurgery.org/documents/News/Statistics/2018/plastic-surgery-statistics-full-report-2018.pdf>.
- Matarasso A, Smith DM. Strategies for aesthetic reshaping of the postpartum patient. *Plast Reconstr Surg.* 2015;136:245–257.
- Yu D, Novicoff WM, Gampper TJ. The average size and position of the umbilicus in young men and women. *Ann Plast Surg.* 2016;76:346–348.
- Correia N, Jayyosi L, Chiriac S, et al. Morphometric analysis of the umbilicus according to age. *Aesthet Surg J.* 2018;38:627–634.
- Lee SJ, Garg S, Lee HP. Computer-aided analysis of the “beautiful” umbilicus. *Aesthet Surg J.* 2014;34:748–756.
- Bovet J, Raymond M. Preferred women’s waist-to-hip ratio variation over the last 2,500 years. *PLoS One.* 2015;10:e0123284.
- Matarasso A, Wallach SG. Abdominal contour surgery: treating all aesthetic units, including the mons pubis. *Aesthet Surg J.* 2001;21:111–119.
- Hoyos AE, Millard JA. VASER-assisted high-definition liposculpture. *Aesthet Surg J.* 2007;27:594–604.
- Matarasso A, Matarasso DM, Matarasso EJ. Abdominoplasty: classic principles and technique. *Clin Plast Surg.* 2014;41:655–672.
- Lockwood T. Lower body lift with superficial fascial system suspension. *Plast Reconstr Surg.* 1993;92:1112–1122; discussion 1123.
- Lockwood T. The role of excisional lifting in body contour surgery. *Clin Plast Surg.* 1996;23:695–712.
- The American Society of Plastic Surgeons. Practice Advisory on Liposuction: Executive Summary. <https://www.plasticsurgery.org/documents/medical-professionals/health-policy/key-issues/Executive-Summary-on-Liposuction.pdf>.
- Vieira BL, Chow I, Sinno S, et al. Is there a limit? A risk assessment model of liposuction and lipoaspirate volume on complications in abdominoplasty. *Plast Reconstr Surg.* 2018;141:892–901.
- Sozer SO, Basaran K, Alim H. Abdominoplasty with circumferential liposuction: a review of 1000 consecutive cases. *Plast Reconstr Surg.* 2018;142:891–901.
- Swanson E. Prospective clinical study of 551 cases of liposuction and abdominoplasty performed individually and in combination. *Plast Reconstr Surg Glob Open.* 2013;1:e32.
- Xia Y, Zhao J, Cao DS. Safety of lipoabdominoplasty versus abdominoplasty: a systematic review and meta-analysis. *Aesthetic Plast Surg.* 2019;43:167–174.
- Smith LF, Smith LF Jr. Safely combining abdominoplasty with aggressive abdominal liposuction based on perforator vessels: technique and a review of 300 consecutive cases. *Plast Reconstr Surg.* 2015;135:1357–1366.
- Swanson E. Comparison of limited and full dissection abdominoplasty using laser fluorescence imaging to evaluate perfusion of the abdominal skin. *Plast Reconstr Surg.* 2015;136:31e–43e.
- Tourani SS, Taylor GI, Ashton MW. Scarpa fascia preservation in abdominoplasty: does it preserve the lymphatics? *Plast Reconstr Surg.* 2015;136:258–262.
- Xiao X, Ye L. Efficacy and safety of Scarpa fascia preservation during abdominoplasty: a systematic review and meta-analysis. *Aesthetic Plast Surg.* 2017;41:585–590.
- Villegas Alzate FJ. TULUA: transverse plication lipoabdominoplasty without supra-umbilical flap detachment. A series of 176 patients. *Cir Plást Iberolatinoam.* 2020;46:7–21.
- Sasaki GH. Quantification of human abdominal tissue tightening and contraction after component treatments with 1064-nm/1320-nm laser-assisted lipolysis: clinical implications. *Aesthet Surg J.* 2010;30:239–245.
- Gorgu M, Gökkaya A, Karabekmez FE, et al. Effects of device variables to radiofrequency (RF) applications. *J Cosmet Laser Ther.* 2019;21:364–371.
- Abuelatta YA, Abdelaal MM, Bersy NA. The effectiveness and safety of combining laser-assisted liposuction and abdominoplasty. *Aesthetic Plast Surg.* 2014;38:49–56.
- Janis JE, Khansa L, Khansa I. Strategies for postoperative seroma prevention: a systematic review. *Plast Reconstr Surg.* 2016;138:240–252.
- Khansa I, Khansa L, Meyerson J, et al. Optimal use of surgical drains: evidence-based strategies. *Plast Reconstr Surg.* 2018;141:1542–1549.
- Beer GM, Wallner H. Prevention of seroma after abdominoplasty. *Aesthet Surg J.* 2010;30:414–417.
- Hunstad JP, Michaels J, Burns AJ, et al. A prospective, randomized, multicenter trial assessing a novel lysine-derived urethane adhesive in a large flap surgical procedure without drains. *Aesthet Surg J.* 2015;39:616–624.
- Mabrouk AA, Helal HA, Al Mekkawy SF, et al. Fibrin sealant and lipoabdominoplasty in obese grade 1 and 2 patients. *Arch Plast Surg.* 2013;40:621–626.
- Nasr MW, Jabbour SF, Mhaweji RI, et al. Effect of tissue adhesives on seroma incidence after abdominoplasty: a systematic review and meta-analysis. *Aesthet Surg J.* 2016;36:450–458.
- Pilone V, Vitiello A, Borriello C, et al. The use of a fibrin glue with a low concentration of thrombin decreases seroma formation in postbariatric patients undergoing circular abdominoplasty. *Obes Surg.* 2015;25:354–359.
- Pollock H, Pollock T. Progressive tension sutures: a technique to reduce local complications in abdominoplasty. *Plast Reconstr Surg.* 2000;105:2583–2586; discussion 2587.
- Pollock TA, Pollock H. Progressive tension sutures in abdominoplasty: a review of 597 consecutive cases [published correction appears in *Aesthet Surg J.* 2012 Sep;32(7):910]. *Aesthet Surg J.* 2012;32:729–742.
- Antonetti JW, Antonetti AR. Reducing seroma in outpatient abdominoplasty: analysis of 516 consecutive cases. *Aesthet Surg J.* 2010;30:418–425.
- Trussler AP, Kurkjian TJ, Hatfield DA, et al. Refinements in abdominoplasty: a critical outcomes analysis over a 20-year period. *Plast Reconstr Surg.* 2010;126:1063–1074.

41. Gould DJ, Macias LH, Saeg F, et al. Seroma rates are not increased when combining liposuction with progressive tension suture abdominoplasty: a retrospective cohort study of 619 patients. *Aesthet Surg J*. 2018;38:763–769.
42. Macias LH, Kwon E, Gould DJ, et al. Decrease in seroma rate after adopting progressive tension sutures without drains: a single surgery center experience of 451 abdominoplasties over 7 years. *Aesthet Surg J*. 2016;36:1029–1035.
43. Sforza M, Husein R, Andjelkov K, et al. Use of quilting sutures during abdominoplasty to prevent seroma formation: are they really effective? *Aesthet Surg J*. 2015;35:574–580.
44. Vera Cucchiaro J, Lostia H, Velazquez P, et al. Lipoabdominoplasty with progressive traction sutures. *Plast Reconstr Surg Glob Open*. 2017;5:e1338.
45. Jabbour S, Awaida C, Mhaweji R, et al. Does the addition of progressive tension sutures to drains reduce seroma incidence after abdominoplasty? A systematic review and meta-analysis. *Aesthet Surg J*. 2017;37:440–447.
46. Bromley M, Marrou W, Charles-de-Sa L. Evaluation of the number of progressive tension sutures needed to prevent seroma in abdominoplasty with drains: a single-blind, prospective, comparative, randomized clinical trial. *Aesthetic Plast Surg*. 2018;42:1600–1608.
47. Rosen AD, Gutowski KA, Hartman T. Reduced seroma risk in drainless abdominoplasty using running barbed sutures: a 10-year, multicenter retrospective analysis. *Aesthet Surg J*. 2020;40:531–537.
48. Pannucci CJ, Bailey SH, Dreszer G, et al. Validation of the Caprini risk assessment model in plastic and reconstructive surgery patients. *J Am Coll Surg*. 2011;212:105–112.
49. Hsu P, Basu CB, Venturi M, et al. Venous thromboembolism prophylaxis. *Semin Plast Surg*. 2006;20:225–232.
50. Mittal P, Heuft T, Richter DF, et al. Venous Thromboembolism (VTE) prophylaxis after abdominoplasty and liposuction: a review of the literature. *Aesthetic Plast Surg*. 2020;44:473–482.
51. Hatef DA, Trussler AP, Kenkel JM. Procedural risk for venous thromboembolism in abdominal contouring surgery: a systematic review of the literature. *Plast Reconstr Surg*. 2010;125:352–362.
52. Swanson E. The case against chemoprophylaxis for venous thromboembolism prevention and the rationale for SAFE anesthesia. *Plast Reconstr Surg Glob Open*. 2014;2:e160.
53. Swanson E. Venous thromboembolism risk stratification and chemoprophylaxis: a meta-analysis finds no benefit, more risk. *Plast Reconstr Surg Glob Open*. 2017;5:e1356.
54. Swanson E. The effect of sequential compression devices on fibrinolysis in plastic surgery outpatients: a randomized trial. *Plast Reconstr Surg*. 2020;145:392–401.
55. Swanson E. Prospective study of Doppler ultrasound surveillance for deep venous thromboses in 1000 plastic surgery outpatients. *Plast Reconstr Surg*. 2020;145:85–96.
56. Dini GM, Ferreira MC, Albuquerque LG, et al. How safe is thromboprophylaxis in abdominoplasty? *Plast Reconstr Surg*. 2012;130:851e–857e.
57. Hunstad JP, Krochmal DJ, Flugstad NA, et al. Rivaroxaban for venous thromboembolism prophylaxis in abdominoplasty: a multicenter experience. *Aesthet Surg J*. 2016;36:60–66.
58. Reish RG, Danjanovic B, Colwell AS. Deep venous thrombosis prophylaxis in body contouring: 105 consecutive patients. *Ann Plast Surg*. 2012;69:412–414.
59. Sarhaddi D, Xu K, Wisbeck A, et al. Fondaparinux significantly reduces postoperative venous thromboembolism after body contouring procedures without an increase in bleeding complications. *Aesthet Surg J*. 2019;39:1214–1221.
60. Vasilakis V, Klein GM, Trostler M, et al. Postoperative venous thromboembolism prophylaxis utilizing enoxaparin does not increase bleeding complications after abdominal body contouring surgery. *Aesthet Surg J*. 2020;40:989–995.
61. Batac J, Hamade M, Hamade H, et al. Abdominoplasty in the obese patient: risk versus reward. *Plast Reconstr Surg*. 2019;143:721e–726e.
62. Hammond DC, Chandler AR, Baca ME, et al. Abdominoplasty in the overweight and obese population: outcomes and patient satisfaction. *Plast Reconstr Surg*. 2019;144:847–853.
63. Bossert RP, Rubin JP. Evaluation of the weight loss patient presenting for plastic surgery consultation. *Plast Reconstr Surg*. 2012;130:1361–1369.
64. Albino FP, Koltz PF, Gusenoff JA. A comparative analysis and systematic review of the wound-healing milieu: implications for body contouring after massive weight loss. *Plast Reconstr Surg*. 2009;124:1675–1682.
65. Austin RE, Lista F, Khan A, et al. The impact of protein nutritional supplementation for massive weight loss patients undergoing abdominoplasty. *Aesthet Surg J*. 2016;36:204–210.
66. Barbour JR, Iorio ML, Oh C, et al. Predictive value of nutritional markers for wound healing complications in bariatric patients undergoing panniculectomy. *Ann Plast Surg*. 2015;75:435–438.
67. Rosa SC, Macedo JLS, Canedo LR, et al. Quality of life and predictive factors for complications in patients undergoing abdominoplasty after gastric bypass: a retrospective cohort. *Surg Obes Relat Dis*. 2019;15:447–455.
68. Krauss S, Medesan R, Black J, et al. Outcome of body-contouring procedures after massive weight loss. *Obes Surg*. 2019;29:1832–1840.
69. Katzel EB, Shakir S, Kostereva N, et al. Abnormal vessel architecture persists in the microvasculature of the massive weight loss patient. *Plast Reconstr Surg*. 2016;137:24e–30e.
70. Song AY, Jean RD, Hurwitz DJ, et al. A classification of contour deformities after bariatric weight loss: the Pittsburgh Rating Scale. *Plast Reconstr Surg*. 2005;116:1535–1544; discussion 1545.
71. Zammerilla LL, Zou RH, Dong ZM, et al. Classifying severity of abdominal contour deformities after weight loss to aid in patient counseling: a review of 1006 cases. *Plast Reconstr Surg*. 2014;134:888e–894e.
72. Ziegler UE, Ziegler SN, Zeplin PH. Modified fleur-de-lis abdominoplasty for massive weight loss patients. *Ann Plast Surg*. 2017;79:130–134.
73. Acevedo E, Nadhan KS, Everett M, et al. Corset trunkplasty: recommended with abdominal skin laxity and open cholecystectomy scar. *Plast Reconstr Surg*. 2018;141:60–69.
74. Carloni R, De Runz A, Chaput B, et al. Circumferential contouring of the lower trunk: indications, operative techniques, and outcomes—a systematic review. *Aesthetic Plast Surg*. 2016;40:652–668.
75. Staalesen T, Olsén MF, Elander A. The effect of abdominoplasty and outcome of rectus fascia plication on health-related quality of life in post-bariatric surgery patients. *Plast Reconstr Surg*. 2015;136:750e–761e.