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Enhanced Abdominal Contouring

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Abstract

This chapter will discuss the various energy-based modalities that are available to optimize circumferential trunk liposuction to enhance patient results. We will discuss multimodal liposuction using power assisted liposuction, ultrasonic energy addition, as well as radiofrequency assisted modalities to achieve adipose reduction and concurrent skin and soft tissue contraction. An in-depth look at patient selection and intraoperative technique will be presented. The postoperative management for each modality will be discussed in detail, including expected results from each modality and potential complications and their ensuing management. We will also discuss the application of different modalities alone and in combination to achieve superior results.

Keywords: ultrasound-assisted liposuction, radiofrequency assisted lipolysis, helium plasma focused radiofrequency liposuction, abdominal liposuction, energy-based liposuction

1. Introduction

The use of liposuction to contour the abdomen and trunk has been employed for almost 40 years [1]. Since its widespread adoption, there has been a continual evolution in technique and the addition of various complementary technologic adjuncts. Energy-based devices have been created to enhance the results of traditional liposuction. The currently available energy-based devices include ultrasound, laser, and radiofrequency. The primary goal of the majority of energy-based devices is to create skin and fibroseptal contraction to improve postoperative skin laxity. Power-assisted liposuction is often utilized in combination with these energy-based technologies to aid in surgeon comfort and efficiency. Several techniques and modalities may be combined to improve patient results.

1.1 SAFE (separation, aspiration, and fat equalization) liposuction

We believe that incorporating the SAFE (Separation, Aspiration, and Fat Equalization) technique, as described by Simeon Wall, Jr., leads to superior liposuction results [2, 3]. As originally described, this technique involves three key steps: (1) separation of the fat using an exploded-tip or basket-tip cannula without suction, (2) aspiration of the fat, and (3) fat equalization again with an exploded-tip cannula off suction. Separation leads to mechanically emulsified fat while preserving vascular structures. Approximately 40% of the operative time is spent “separating” and the surgical endpoint is loss of resistance. Aspiration is then performed using less aggressive cannulas for 40% of the operative time. Finally, fat equalization is performed with a basket-tip cannula without suction. Any irregularities can

be smoothed out during this step and the fat is again emulsified resulting in a bed of “local” fat grafts. These “local” grafts prevent adherence of the dermis down to the underlying fascia. The surgical endpoint is a smooth rolling pinch test and a visibly smooth contour which translates to 20% of the total operative time.

1.2 Power-assisted liposuction (PAL)

Power-assisted liposuction (PAL) was introduced in 1998 by MicroAire Surgical Instruments (Charlottesville, VA, USA). The original handpiece utilized compressed air to power the device with later generations powered by electricity [4]. PAL is advantageous in fibrous areas and for secondary liposuction cases and has been noted to decrease surgeon fatigue with less plugging of the cannula and shorter operative times [5–7]. Some disadvantages of PAL are cost, learning curve, potential vibratory injury, and noise [4].

1.3 Ultrasound-assisted liposuction (UAL)

Ultrasound-assisted Liposuction (UAL) was first described by Zocchi nearly 30 years ago [8]. The ultrasonic probe transforms electrical energy into mechanical energy leading to cavitation and cellular disruption. The emulsified fat is then aspirated via traditional suction-assisted lipectomy (SAL). The third-generation UAL devices such as VASER™ (Solta Medical, Hayward, CA, USA), use pulsed rather than continuous energy allowing for greater fragmentation of adipocytes at a lower energy setting [9].

Proponents of UAL have found that the addition of UAL leads to decreased intraoperative blood loss, decreased postoperative ecchymoses and discomfort, decreased operative time, and enhanced skin contraction [9–15].

The drawbacks of UAL include increased expense, larger incisions, technical difficulty with a steep learning curve, and the risk of thermal burns [16–19].

The addition of VASER should be considered for patients undergoing large-volume liposuction or liposuction of fibrous areas such as the back and hip rolls (posterior flanks) where increased blood loss is expected [11]. VASER may also be considered in patients where additional skin tightening is desired [13].

We have combined the techniques of SAFE and ultrasound-assisted liposuction by utilizing the VASER to separate and emulsify the fat prior to suctioning. Fat equalization is still performed using the basket-tip cannula.

1.4 Laser-assisted liposuction (LAL)

Laser-assisted liposuction (LAL) relies on selective photothermolysis to target and lyse adipocytes [20] and interest in LAL began after studies conducted by Apfelberg [21] and Apfelberg et al. [22, 23] in 1992.

The wavelengths utilized in LAL target fat, collagen, vascular structures, hemoglobin, and water to varying degrees. Obliteration of these targets leads to photolysis of adipocytes, release of adipocyte lipases, dermal collagen contraction, and photocoagulation of small vessels [24–26].

The three main lasers utilized for LAL are the 1064 nm Nd:YAG, the 980 nm diode, and the 1064/1320 nm Nd:YAG lasers [27]. The most studied wavelength is 1064 nm Nd:YAG which has hemoglobin as its target [28]. Both SmartLipo™ (Cynosure Inc., Westford, MA, USA) and ProLipo PLUS™ (Sciton, Inc., Palo Alto, CA, USA) utilize 1064 nm wavelengths. ProLipo PLUS combines 1064 nm with 1319 nm in hopes of providing additional dermal contraction [29].

LAL can either be performed at the same procedure as SAL or in a two-stage procedure with SAL performed at the second stage.

Initial studies showed minimal cosmetic benefit with the addition of LAL to traditional SAL [22]. The disadvantages of LAL include increased cost, increased operative time, and potential for thermal burns [30].

1.5 Radiofrequency-assisted liposuction (RFAL)

Radiofrequency-Assisted Liposuction (RFAL) takes advantage of a high frequency oscillating electrical current to create a thermal effect which dissolves fat cells and causes dermal contraction. RF devices lead to contraction of the fibroseptal network (FSN) through immediate contraction of collagen fibers, subdermal remodeling, and neocollagen formation [31–34]. The devices that we currently use for the abdomen and trunk are BodyTite and Renuvion (formerly J-Plasma).

1.5.1 BodyTite radiofrequency (InMode)

The InMode devices (Invasix, Yokneam, Israel) are bipolar radiofrequency devices that contain both an internal and external temperature monitor. The tip of the handpiece delivers RF energy which travels to an external electrode that slides on the surface of the skin in line with the internal electrode. The RF energy creates a zone of thermal coagulative necrosis leading to adipocyte injury and FSN contraction [34]. BodyTite has been shown to lead to improved skin and soft tissue contraction when compared with traditional SAL (35% versus 8%) [35]. Complications after BodyTite include bruising, contour irregularities, pain, and thermal burns [36–38].

1.5.2 Renuvion helium plasma-driven radiofrequency (Apyx)

Renuvion was originally developed as a laparoscopic cautery device for general, gynecologic, and urologic surgeries [39]. Renuvion (Apyx Medical, Clearwater, FL, USA) combines radiofrequency energy and helium plasma to create subdermal tissue contraction. The device reaches the optimal temperature for subdermal tissue contraction (85°C) quickly with minimal thermal spread and cools to baseline temperatures in less than a second [40–45].

Helium plasma is created when helium gas is passed over the energized electrode at the tip of the handpiece. Heat is generated by the plasma beam itself and through the RF energy that passes from the handpiece to the patient's tissues [5].

The device is used after liposuction but can also be used alone to create skin tightening. The handpiece is passed through the subdermal plane and deeper subcutaneous tissues while slowly withdrawing the device. The amount of energy applied is recorded. In our experience, applying at least 10 kJ to the anterior abdomen is necessary.

Immediate results can be seen when using this device with visible improvement at 24 hours postoperatively and continued improvement for up to 12 months [5].

The advantages of the Renuvion system are decreased procedure times, decreased pain, and decreased risk of complications [39, 45–49]. The measured skin temperature rarely exceeds 38°C, leading to its increased safety profile. The risks associated with this device include helium embolism, thermal burns, pneumothorax, transient or permanent nerve injury, and helium gas buildup and crepitus.

1.6 Cannula selection

1.6.1 Cannula size

The larger the diameter of the cannula, the more rapidly the fat is removed. Larger diameter cannulas may be prone to creating contour irregularities from oversuctioning. Therefore, a balance exists between efficiency and postoperative complications. For abdominal and trunk contouring, we typically utilize 4 mm cannulas. The exception is for patients with extreme adiposity or minimal adiposity. A 5 mm cannula may be used during the initial debulking of the deeper fat compartments in patients with large adipose stores. In contrast, 3 mm cannulas may be appropriate for patients who are extremely thin to help prevent postoperative contour irregularities.

1.6.2 Cannula type

Caution has been placed on using basket cannulas for suctioning [2, 3], but we have not noted any untoward effects. On the contrary, we have found that suctioning with a 4 mm basket-tip cannula is more efficient than suctioning with the same diameter Mercedes-tip cannula. We utilize basket-tip cannulas for fat separation and fat equalization. Multi-holed cannulas are used for abdominal etching to remove all the fat between the fascia and dermis.

2. Evolution of technique

We have gone through multiple iterations to arrive at our current method of abdominal contouring.

Regardless of the technology used, liposuction technique is of paramount importance. The end point of liposuction should not be viewed as what has been taken away, but what remains. While it is important to note the total volume of fat aspirated from each site, the resulting contour is of greater importance.

Our current method of abdominal contouring combines the SAFE (Separation, Aspiration, and Fat Equalization) technique with VASER for fibrotic areas and Renuvion or BodyTite to assist in skin contraction in patients with more significant skin laxity. In our experience, VASER leads to mild skin contraction, but its main advantage is easier fat removal by facilitating adipose disaggregation in fibrotic areas. We use vaser in almost every liposuction case with the exception of cases where the aspirated fat would be used for fat grafting the breasts and when we are elevating an abdominoplasty flap.

When more profound skin contraction is required, we turn to the Renuvion or InMode devices. The decision for using Renuvion over the InMode devices is based on the surgical area treated. The design and ease of use of the Renuvion device makes it better suited for larger treatment areas. Bodytite can typically target more superficial soft tissue contraction needs while Renuvion can be helpful for large surface area fibroseptal contraction. There are instances where we will combine both Renuvion and Bodytite to achieve maximal contractions. In addition we will often add percutaneous treatment using RF microneedling treatments to improve skin quality and further increase contraction. We prefer the Morpheus 8 device by InMode. We will typically perform 3 serial treatments separated by 4–6 weeks. We no longer utilize laser-assisted liposuction as we have had superior results with radiofrequency-assisted liposuction.

3. Patient evaluation and marking

Ideal candidates for abdominal and trunk liposuction are patients who present with localized areas of adiposity with minimal to moderate skin laxity. Patients with significant skin excess or those with minimal adiposity are better suited to excisional procedures. A pinch test should be performed to delineate subcutaneous versus intraabdominal fat. Patients should be counseled that intraabdominal fat will not be addressed or improved by liposuction. A history of any intraabdominal procedures should be elicited and the patient should be examined for any abdominal scars or hernias. Imaging is typically reserved for patients with questionable abdominal wall defects or hernias. In these cases, a computed tomographic scan of the abdomen and pelvis with oral contrast should be performed prior to surgical intervention.

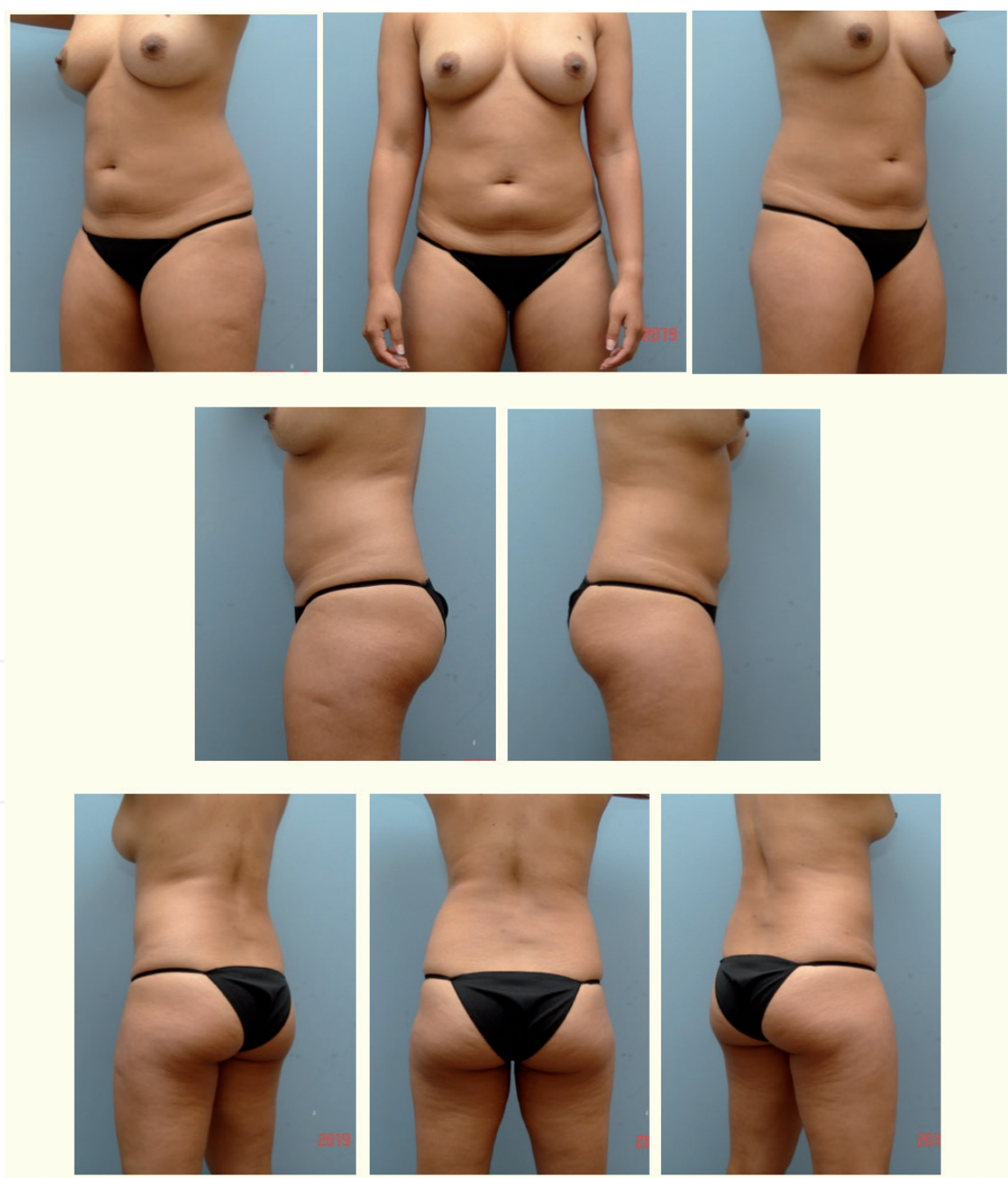


Figure 1.
Standard abdominal series. Includes anterior and posterior trunk.



Figure 2.
Example of topographic marking for circumferential trunk liposuction. Thin areas are marked in red.

A standard series of photographs are taken prior to marking the patient (**Figure 1**).

The areas for liposuction are then marked topographically with care to delineate zones of adherence and other areas where liposuction should be minimized. The areas where fat removal should be avoided are typically marked in red (**Figure 2**). For patients undergoing abdominal etching, the muscular anatomy of the rectus abdominis muscle and external obliques are palpated with the patient flexing his or her abdominal muscles. The linea alba, linea semilunaris, and transverse rectus abdominis muscle inscriptions are marked. The rectus abdominis muscle inscriptions typically begin at the level of the umbilicus and continue with two or more inscriptions superiorly. Any excessive flank adiposity is marked topographically as well.

4. Operative technique

Following preoperative photographs and markings, the patient is brought to the operating room and placed in the supine position. Sequential compression devices are placed and activated prior to induction of general anesthesia. A warming blanket is used throughout the procedure to maintain optimal body temperature. For moderate to large volume liposuction, 1 gram of tranexamic acid (TXA) is administered intravenously at the start of the procedure.

The areas to be liposuction are infiltrated with tumescent solution prior to formal prepping and draping. The liposuction entry sites are cleansed with Betadine prior to incision and the cannula is frequently wiped with Betadine. In moderate to large volume liposuction, lower concentrations of lidocaine are used and 1 gram of TXA is added to each 1 liter bag of tumescent solution. The tumescent formula typically utilized is 12.5 mL 1% lidocaine, 1 mL 1:1000 epinephrine, and 1 gram TXA in 1,000 mL of warm Lactated Ringer's solution. The total amount of tumescent solution used depends on the planned amount of aspirate. The ideal ratio of infiltration fluid to aspirate volume is 1:1 for moderate and large-volume liposuction. A higher ratio of tumescent solution is typically utilized for small volume liposuction.

Small Volume Liposuction: <2,000 mL.

Moderate Volume Liposuction: 2,000 mL to 5,000 mL.

Large Volume Liposuction: >5,000 mL.

The patient is then fully prepped and draped. Skin protector ports are then placed at the access sites. Ultrasound-assisted liposuction (UAL) with VASER™ (Solta Medical, Hayward, CA, USA) is then performed to all areas of planned liposuction unless concomitant abdominoplasty is being performed. For these patients, VASER is only utilized posteriorly on the trunk. For the abdomen and posterior trunk, the VASER is set to 80% power. End hits of the cannula are avoided to prevent thermal injury to the dermis. Treatment is performed in both the deep and superficial fat layers until resistance is lost. Special attention is paid to zones of adherence to break up the dense fibrous attachments in these areas.

The typical treatment time is 5–10 minutes for the anterior trunk and 5–15 minutes for the posterior trunk.

The SAFE technique (Separation, Aspiration, Fat Equalization) described by Simeon Wall, Jr. [2, 3] is utilized for all trunk liposuction cases, but is avoided when performing liposuction to the anterior portion of the abdominoplasty flap.

Power-assisted liposuction (PAL) using MicroAire (Charlottesville, VA, USA) handpiece with 4 mm Mercedes tip and Basket tip cannulas is performed until even contour is achieved. The majority of the liposuction is focused on the deeper fat layers, leaving a thin, even blanket of fat in the superficial layer to prevent contour irregularities.

Fat equalization with a 4 mm basket tip cannula on the PAL handpiece is then performed. This equalization should be performed outside the areas of liposuction to blend and feather the liposuctioned area into the non-liposuctioned area.

4.1 Circumferential trunk liposuction

Patient positioning for circumferential trunk liposuction can be performed in the supine, prone and lateral positions. Our preferred technique for circumferential trunk liposuction positions the patient prone and then supine. We do not routinely utilize lateral positioning. When the patient arrives in the operating room, they are initially placed supine on a stretcher and tumescent fluid is infiltrated anteriorly. The patient is then placed prone on the operating room table and the posterior trunk is similarly infiltrated. The patient is then prepped and draped in the usual sterile fashion and suctioning begins in the prone position. The patient is transferred back to the stretcher in the supine fashion and placed on the operating room table in the supine position. The patient is again prepped and draped and suctioning is performed to the anterior abdomen.

4.2 Abdominoplasty with liposuction

A majority of our patients undergoing full abdominoplasty also receive abdominal liposuction to improve postoperative abdominal contour. Liposuction is performed prior to resection of the abdominal skin flaps. Access incisions are created within the area of planned resection and at the superior umbilicus.

A 4 mm Mercedes tip cannula is used with the Microaire PAL system to perform liposuction to the entire abdominal flap. The use of basket cannulas and fat equalization is minimized to prevent trauma to the vessels supplying the abdominoplasty skin flap. After the abdominal skin and fat is resected, the subscarpal fat is further trimmed to improve the contour and match the thickness of the mons.

4.3 Abdominal etching

Candidates for abdominal etching include patients who desire muscular definition in addition to fat reduction.

Patients with poorly defined muscular anatomy are candidates for modified abdominal etching, while patients with well-defined muscular anatomy are candidates for full abdominal etching [50].

Modified abdominal etching involves moderate fat preservation over the rectus abdominis muscles with thinning of the subcutaneous fat layer over the external obliques. Increased definition is performed at the linea alba and linea semilunaris.

Full abdominal etching adds liposuction of the rectus muscle inscriptions to the areas of liposuction performed in modified abdominal etching.

4.4 Drain vs. No drain

Incisions are either left open for drainage or closed with simple interrupted sutures when small volume liposuction is performed. Drain placement is considered for larger areas of liposuction. A 7 mm flat JP drain is placed to facilitate fluid egress and seroma prevention when larger volume liposuction is performed. The lumbar (hip roll) area is often drained especially in the setting of concomitant abdominoplasty. In these cases, the liposuction cannula can be advanced through the subcutaneous tissue from one liposuction entry site to another, the external portion of the drain is placed over the cannula and the drain is pulled through the entry site. When Renuvion is performed, the access sites are left open to allow for helium gas and fluid escape.

5. Outcomes and results

With the combination of sound liposuction technique and energy-based technologies we have seen excellent results with improvement in skin laxity. Whenever possible, we treat the trunk circumferentially. Below we demonstrate our abdominal contouring results with and without energy-based technologies, with the addition of an abdominoplasty, and with the addition of abdominal etching.

5.1 Case 1: circumferential trunk liposuction with SAFE technique

This is a 33-year-old female who desired circumferential trunk contouring. We performed circumferential trunk liposuction with the SAFE technique using the MicroAire PAL handle and 4 mm Mercedes tip and basket tip cannulas. In addition, she received breast and buttock fat grafting to enhance her result. Each buttocks was grafted with 250 cc and the breasts were grafted with 250 cc and 200 cc. A total of 1660 cc of excess fat was removed (**Figure 3**).

5.2 Case 2: circumferential trunk liposuction with VASER and Renuvion

Case 2 is a 36-year-old female who desired trunk contouring. Circumferential trunk liposuction with VASER and Renuvion was performed. She also received fat grafting to her breasts. The total VASER time was 5 minutes and 53 seconds to the posterior trunk. Renuvion was performed in 4–5 passes per treatment area. The total excess fat removed was 1360 cc (**Figure 4**).

5.3 Case 3: full abdominoplasty with circumferential trunk liposuction

This 42-year-old patient desired trunk contouring. She presented with rectus diastasis, excess abdominal skin, and abdominal striae; necessitating skin removal



Figure 3.
Preoperative photographs. Patient is shown 3 months postoperatively with significant improvement in abdominal contour.

and repair of her diastasis. She underwent circumferential trunk liposuction and full abdominoplasty with rectus muscle plication. VASER was used to treat the posterior trunk (**Figure 5**).

5.4 Case 4: abdominal etching with VASER

Case 4 is an example of full abdominal etching on a 44-year-old male. He also underwent chest contouring with VASER liposuction and gynecomastia gland excision. A total of 950 cc of fat was removed from the abdomen and chest (**Figure 6**).

5.5 Postoperative care

All patients are placed in compression garments at the conclusion of the procedure. When combined with abdominoplasty, an abdominal binder is placed for ease of evaluating the abdominal flap postoperatively. For circumferential trunk liposuction, either an abdominal binder or compression garment is placed. A layer of foam is placed beneath the garment to ensure even compression and reduce indentations from the garment.

If the patient is staying overnight for monitoring, the drains are hooked up to wall suction to allow for rapid fluid egress and removal of residual tumescent fluid. The drains are placed back to bulb suction when the drainage slows down.

Patients are prescribed oral antibiotics, pain medication, and vitamins. Patients are instructed to drink plenty of fluids with a goal of 1 gallon per day. The abdominal binder or compression garment is worn at all times, except when



Figure 4.
Preoperative photographs and markings. Patient shown 5 months postoperatively with excellent contour and skin contraction.

showering, which is permitted on postoperative day 2. It is recommended that patients wear some form of compression for at least 6 weeks postoperatively. Drains are removed once the output is less than 25 cc per day for at least two consecutive days.

Three Endermologie® (LPG Endermologie USA, Fort Lauderdale, FL) treatments are recommended to all patients to improve postoperative edema, with the option to add further treatments for continued areas of swelling or firmness. The Endermologie machine employs a suction-assisted massage technique that improves lymphatic drainage [51].

5.6 Management of postoperative complications

Seromas are a known complication of liposuction and may occur even in the setting of drain use. When patients present with a seroma, they are treated aggressively with repeated aspirations every day or every other day until the collection resolves.



Figure 5.
Preoperative photographs demonstrating skin excess and abdominal striae. Postoperative result at 6 months with improved contour.

Contour irregularities may be treated with manual lymphatic drainage (MLD) or Endermologie when mild. Endermologie and MLD help reduce postoperative edema and soften areas of firmness. More significant irregularities may be addressed with Kybella or touch up liposuction.

When patients present postoperatively with residual skin laxity that is minimal, external percutaneous radiofrequency microneedling devices (InMode Morpheus) may be used to aid in further skin contraction.

Potential complications from energy-based devices include thermal injury. Areas of full-thickness burns are treated conservatively with local wound care. Once healed, these small areas are often amenable to scar revisions.



Figure 6.
Preoperative photographs and 3 month postoperative photographs are shown.

6. Future directions

Continual improvement of energy-based technologies has led to enhanced patient outcomes for body contouring. The currently available technologies are suitable for minimal to moderate skin laxity, but no device is able to provide surgical results for patients with severe excess skin and laxity. Furthermore, few therapies have proved useful for the treatment of skin rippling and dimpling associated with cellulite. Future directions should focus on maximizing fibroseptal network and skin contraction, addressing rippling cellulite, and preventing postoperative liposuction deformities.

Furthermore, our patients yearn for less invasive options as well as less stigmata of having had a surgical procedure. Technology will continue to evolve to achieve further skin and soft tissue contraction in combination with fat reduction. Eventual advances will ideally allow these changes to occur percutaneously without the need for any incisions or downtime.

7. Conclusion

Enhanced abdominal contouring involves the addition of energy-based devices to traditional abdominal liposuction. We recommend performing SAFE liposuction in all patients (excluding abdominoplasty flaps). VASER can be utilized as the initial step in SAFE liposuction instead of separation by basket tip cannulas. VASER may also assist in some skin contraction and is helpful for fibrous areas. Power-assisted liposuction allows for decreased surgeon fatigue and increased efficiency. Radiofrequency devices (BodyTite and Renuvion) are considered for patients with more severe skin laxity. These treatments can be safely combined to provide optimal patient results.

Conflict of interest

Dr. Bharti and Dr. Kortesis are consultants for Allergan, Apyx Medical, and InMode. Dr. Kleban has no conflicts of interest to disclose.

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