# Refinements in Abdominoplasty: A Critical Outcomes Analysis over a 20-Year Period

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**Background:** The use of liposuction combined with abdominoplasty has been controversial. The combination of techniques has been associated with an increased rate of venous thromboembolism and wound-healing complications. Through improvements in venous thromboembolism prophylaxis, refinements in liposuction techniques, and an understanding of anatomy, this cumulative risk has decreased, although the negative stigmata persist. This study describes the evolution of abdominal body contouring through a critical review of a single surgeon's 20-year experience with abdominoplasty. This clinical outcome analysis will highlight the significant contributions that have led to the improvement in the safety and efficacy of this technique.

**Methods:** A retrospective review of patients undergoing abdominoplasty procedures was performed. Patient demographics and procedural information, including postoperative course and complications, were recorded. Preoperative and postoperative photographs were scored by blinded evaluators for aesthetic result and scar quality.

**Results:** Two hundred fifty patients undergoing abdominoplasty from 1987 to 2007 were included in the study. The use of a "superwet" liposuction technique in combination with abdominoplasty significantly decreased intraoperative blood loss ($p < 0.04$) and length of hospital stay ($p < 0.05$). Liposuction volume and region had no significant effect on abdominoplasty outcome, although refinements in operative technique, including abdominal and flank ultrasound-assisted liposuction, high superior tension, and limited abdominal undermining, did improve the postoperative aesthetic score. Venous thromboembolic events significantly decreased with aggressive venous thromboembolism prophylaxis ($p < 0.001$).

**Conclusions:** The technical evolution of a single surgeon's 20-year experience demonstrates that liposuction can be safely and effectively combined with abdominoplasty. Preoperative trunk analysis, intraoperative surgical refinements including superwet technique and ultrasound-assisted liposuction, and perioperative venous thromboembolism prophylaxis significantly improve the outcome of abdominoplasty. (*Plast. Reconstr. Surg.* 126: 1063, 2010.)

Abdominoplasty has consistently ranked among the most popular cosmetic surgical procedures in the United States, with 147,392 such procedures being performed in 2008, which is a greater than 300 percent increase over the past 10 years according to the most recent American Society for Aesthetic Plastic Surgery data.[1] Since its inception, the technique of abdominoplasty has been refined from a simple horizontal incision for skin and fat excision, as described by Demars and Marx in 1880, to a multimodal approach that melds excisional tech-

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niques with liposuction for silhouette contouring.[2] Along the way, plastic surgeons have attempted to maximize aesthetic results through various skin incisions, planes of dissection, suture techniques, and concomitant use of liposuction; however, a technique accepted by all remains elusive.

The approach to liposuction combined with abdominoplasty, specifically, has been a point of contention. Some have advocated minor skin removal from the suprapubic area with extensive suction-assisted lipectomy of the abdominal wall.[3] Matarasso described in 1991 and 1995 the use of traditional abdominoplasty with suction-assisted lipectomy of the dorsum and flank only.[4] The limited aesthetic abdominoplasty presented by Wilkinson and Swartz includes a dissection just above the umbilicus and "fat sculpturing" of the panniculus.[5] In 1999, Shestak proposed his "marriage" abdominoplasty with limited undermining, no umbilical transposition, and aggressive suction-assisted liposuction of the entire abdominal wall.[6] This has evolved to the concept of lipoabdominoplasty, which relies on significant abdominal liposuction in the superficial and deep layers with or without umbilical transposition to achieve a well-contoured abdominal flap.[7] This technique differs from the classic techniques that rely on skin excision and significant wound tension. One critique of the lipoabdominoplasty technique is the theoretical devascularization of the central abdominal flap. It is possible that liposuction in these areas compromises perforator supply to the central skin flap. Dillerud and Hedén showed that pig buttock flap perfusion was compromised after traditional suction lipectomy.[8] Inceoglu et al. used duplex to examine the effects of traditional liposuction on the perforators in the thigh, and showed that approximately 50 percent of them were traumatized by the procedure.[9] Blondeel et al. demonstrated that conventional suction-assisted liposuction, ultrasound-assisted liposuction, and even subcutaneous infiltration damaged abdominal wall perforators.[10] However, gross cadaveric, endoscopic, and histologic evidence exists that liposuction preserves these perforator vessels.[11–13] Graf et al. showed preservation of 1-mm-diameter perforator vessels after liposuction and abdominoplasty using limited upper abdominal undermining.[14] With liposuction of the abdominal flap combined with limited undermining of the midline only, the perforator blood supply to the abdominal wall is preserved, maintaining perfusion of the abdominal flap.

Aesthetic results are not the plastic surgeon's only concern—in body contouring procedures, venous thromboembolism and other patient safety issues are of great concern. Grazer and Goldwyn published the first survey discussing the complications associated with traditional abdominoplasty.[15] Nearly 1000 plastic surgeons reported on their performance of over 10,000 abdominoplasties, and there was an overall 14.6 percent complication rate and a 1.9 percent rate of venous thromboembolism, with 43 percent of the surgeons reporting having had a seroma or hematoma. Hester et al. showed that abdominoplasty is associated with venous thromboembolism in approximately 1 percent of patients and that this rate increases with more involved surgery.[16] More recently, Matarasso et al. published an updated national report on abdominoplasty, using data from a survey of members of the American Society of Plastic Surgeons.[17] Reported complications for full abdominoplasty revealed the following selected rates: skin necrosis, 5.4 percent; hematoma, 1.4 percent; wound dehiscence, 1 percent; blood transfusion requirement, 0.04 percent; deep venous thromboembolism, 0.04 percent; and pulmonary embolism, 0.02 percent. Kim and Stevenson examined the effect of liposuction on the incidence of seroma following abdominoplasty and found that there was no higher rate of seroma when liposuction was added to abdominoplasty.[18]

In this study, the authors review 250 patients over a 20-year period who underwent body contouring through a full abdominoplasty performed by the senior author (R.J.R). The surgical approach evolved over three phases (Table 1), which included changes in the approach to abdominoplasty and liposuction, including the use of ultrasonic liposuction. The goal of this study was to describe this evolution in abdominoplasty technique and to compare the clinical outcomes, including the aesthetic results and complication rates with each major refinement phase.

**Table 1. Generalized Summary of Technique Evolution from Phase I through Phase III**

| Phase | No. of Patients | Technical Points |
|---|---|---|
| I | 60 | Wide abdominal undermining<br>Wet technique liposuction of flanks |
| II | 111 | Wide abdominal undermining<br>Superwet liposuction of flanks<br>Ultrasound-assisted liposuction of flanks<br>Extended lower lateral dissection and excision |
| III | 79 | Limited central abdominal undermining<br>Maintenance of subscarpal tissue on the abdominal wall<br>Ultrasound-assisted liposuction of central abdomen and flanks<br>High superior tension |

## PATIENTS AND METHODS

From January of 1987 to August of 2006, 250 patients seeking body contouring surgery underwent full abdominoplasty performed by the senior author (R.J.R) at a single clinical location. These patients were selected by means of a retrospective review of the senior author's surgical database after institutional review board approval of the study (institutional review board no. 022007-018). Patients' charts were reviewed for preoperative, perioperative, and postoperative information.

The patients' preoperative demographic information, including age, sex, body mass index, and comorbidities, was recorded. The operative report was reviewed for operative technique, lipoaspirate volume, operative time, blood loss, concomitant procedures, and hospital stay. The patients' postoperative course was evaluated through review of the senior author's clinical notes and photographs.

Complications were identified in the medical record by clinical documentation and/or review of radiographic reports. These complications were categorized into the following: seroma, wound infection, skin edge necrosis/wound dehiscence, deep venous thrombosis, venous thromboembolism, and blood transfusion requirement. Preoperative and postoperative photographs were scored by two blinded evaluators for aesthetic result and scar quality. Statistical analysis was performed with analysis of variance evaluation and a *t* test.

### Operative Procedure

The senior author's current operative technique has evolved over time to the final phase III approach. The following steps are outlined below.

The patient is marked in both the standing and the recumbent positions. The pubis and anterior superior iliac spine are identified as reference points to mark the position of the final incision. The midline is marked in the standing position, as are the targets for liposuction. The lower incision should ideally be marked approximately 5 to 7 cm above the vaginal introitus (Fig. 1). In the recumbent position, the lower incision is marked to the anterior superior iliac spine, which should be the point of superiorly transposed soft tissue. The lower incision can be conformed to be symmetric through measurement of the lateral limbs of the proposed incisions and vertical height of the incisions. The procedure is started in the supine position if no back or flank liposuction is needed, although typically, flank and back liposuction are required for optimal contouring (Fig. 2). The anterior areas of liposuction

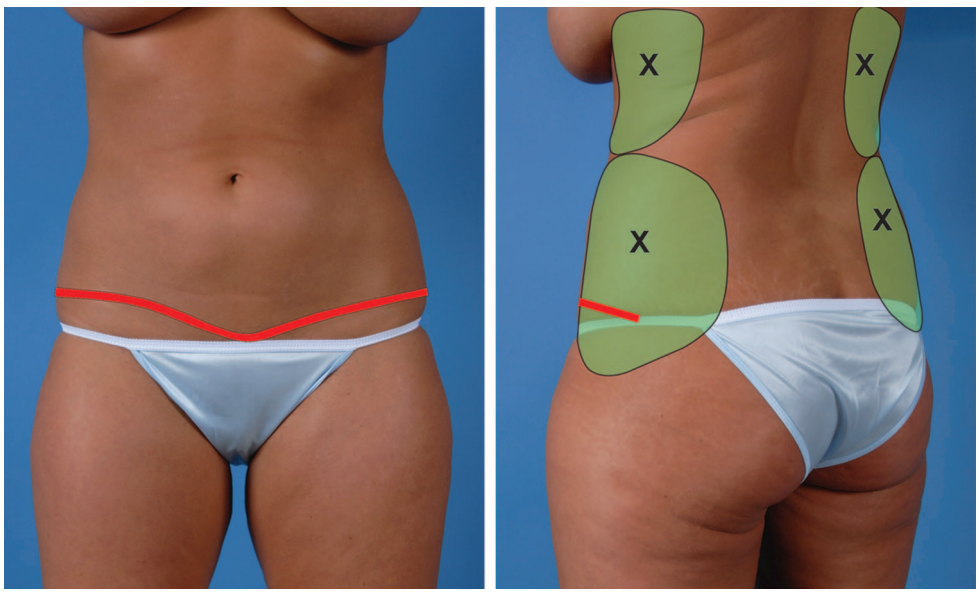


**Fig. 1.** Preoperative markings for abdominoplasty with liposuction. (*Left*) Schematic of lower incision markings with lateral flank zones of ultrasound-assisted liposuction. Clinical example of markings including a lower incision placed at 5 cm above the vaginal introitus. The estimated upper margin of skin excision is marked in the semirecumbent position. (*Right*) The areas of lateral ultrasound-assisted liposuction are marked preoperatively and include upper and lower flanks; this is combined with central ultrasound-assisted liposuction (not marked) for improved abdominal contouring.

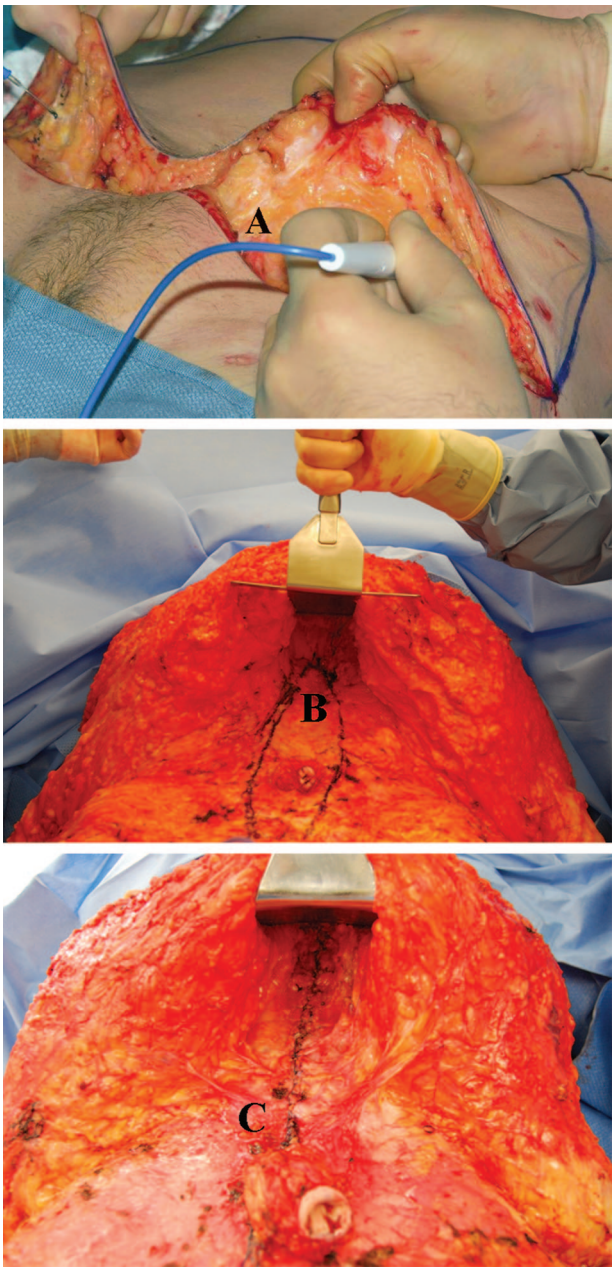


**Fig. 2.** Intraoperative photographs of lower abdominal dissection plane, which maintains the deep abdominal fat (*above*) on the anterior abdominal fascia and preserves the upper inguinal lymphatic tissue. (*Center*) Photograph showing limited central undermining of the upper abdomen, which preserves the lateral abdominal perforating neurovascular bundles and improves the vascularity of the abdominal flap, enabling central liposuction for improved upper abdominal contouring. (*Below*) Photograph showing maintenance of upper abdominal perforating neurovascular bundles after two-layer midline fascial plication.

are first infiltrated with the wetting solution, which contains 30 ml of 1% lidocaine and 1 cc of 1:1000 epinephrine. The flank and upper abdomen are then liposuctioned with ultrasound-assisted liposuction followed by standard liposuction evacuation. The umbilicus is dissected circumferentially to the anterior abdominal wall. The lower markings are incised and undermined in a subscarpal plane maintaining the lateral groin lymphatics. The lower abdomen is then undermined, maintaining the areolar tissue and a thin, subscarpal fat layer on the abdominal fascia. Next, the dissection is directed centrally to clear the area for facial plication, with particular care taken to preserve the upper lateral abdominal perforating vessels (Fig. 3). A lighted retractor or Saldanha retractor can be used for this central upper tunnel dissection. A two-layer midline plication is performed with 0 Mersilene suture (Ethicon, Inc., Somerville, N.J.) (Fig. 4). The abdominal flap can then be liposuctioned with suction-assisted lipectomy for additional contouring and discontinuous undermining. The bed is then placed in the flexed position. The superior markings can be first confirmed for accuracy and symmetry and then incised with excess skin removed. Central progressive tension sutures are placed superior to the umbilicus. High superior tension is then applied centrally to the abdominal flap with a superiorly placed suture just above the umbilicus transposition site that is brought down 2 cm to the umbilical stalk. The umbilical stalk should be shortened, if necessary, and then secured to the anterior abdominal wall with lateral stay sutures. The abdominal incision is approximated with staples and then excess skin is excised with lateral extensions to prevent any standing lateral soft-tissue deformities. The abdominal

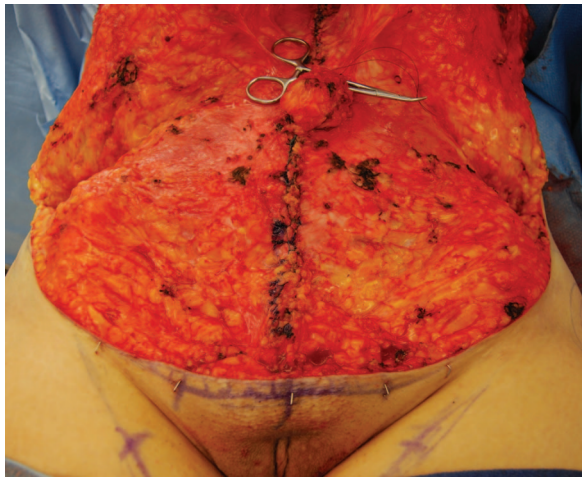

**Fig. 3.** Intraoperative photograph of two-layer midline fascial plication that includes a deep layer of interrupted 0-gauge figure-of-eight Mersilene sutures, and a superficial layer of a running and locking 0-gauge Mersilene suture.

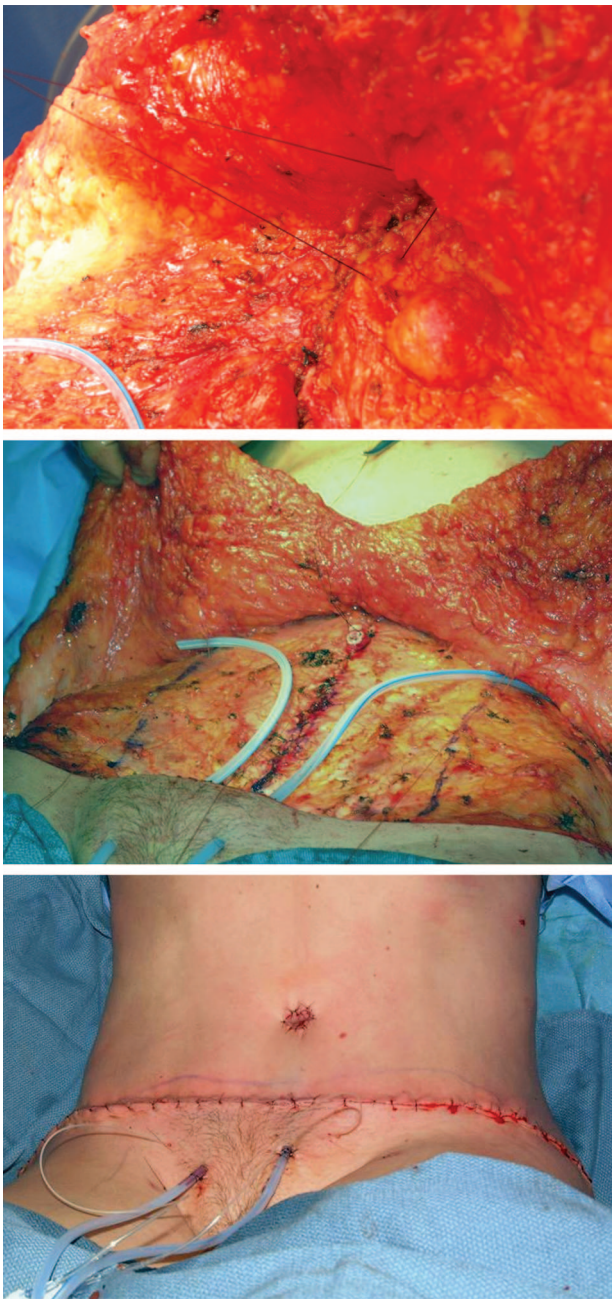

**Fig. 4.** Intraoperative photographs demonstrating (*above*) an upper abdominal progressive tension suture for high central tension and improved upper abdominal contouring, (*center*) abdominal flap closed over two drains, and (*below*) final incision in the recumbent position with closure of the lower incision and umbilical transposition.

incision is closed in layers; specifically, the tension on the skin is unloaded onto the superficial fascial system with the dermis and skin closed in separate layers. A 3-0 Vicryl suture (Ethicon) is used in the superficial fascial system, and a 4-0 Vicryl suture is used in the dermis; however, if a barbed suture is used, an 0 and 3-0 polydioxanone Quill suture (Angiotech Pharmaceuticals, Inc., Vancouver, British Columbia, Canada) is used, respectively. In all cases, Dermabond (Ethicon) is used to seal the skin. Two 19-mm drains are placed in the lower abdomen and left in place for an average of 5 to 7 days. All patients considered high risk by the modified Davison-Caprini risk assessment model are placed on 30 mg of daily subcutaneous enoxaparin.[19,20] Lastly, the patient is placed in an abdominal binder for 3 weeks.

## RESULTS

### General

Two hundred fifty patients were included in the study. Ninety-nine percent were women (99.2 percent), with an average age of 47.4 years. All patients underwent a full abdominoplasty, with 22 patients (8.8 percent) undergoing secondary abdominoplasty procedures. The average preoperative body mass index was 26.4. The most common comorbidity was obesity. The average follow-up for all patients was 10 months. Sixty patients underwent abdominal contouring during phase I; 111 patients underwent abdominal contouring in phase II; and 79 patients were reviewed in phase III (Table 1).

### Operative Time and Hospital Stay

No statistical significance was found when comparing the average operative times for the three different phases ($p < 0.5$): phase I, 237.2 minutes; phase II, 219.5 minutes; and phase III, 224.7 minutes. The mean length of stay in either hospital or overnight stay facility for phase I patients was found to be 2.29 ± 1.58 days versus phase II and III patients, who had a mean length of stay of 1.33 ± 0.66 days. This was statistically significant ($p < 0.0001$) (Table 2).

### Wound Infections

In our total series, the rate of wound infection for the full abdominal contouring procedure was found to be 1.6 percent ($n = 4$). This is slightly lower when comparing our combined approach with the individual wound-healing complication

**Table 2. Operative Means for Abdominal Contouring during Each Phase**

| Phase | Mean Length of Operation (min) | Postoperative Stay (days) | Mean Lipoaspirate (cc) | Mean Estimated Blood Loss (cc) |
|---|---|---|---|---|
| I | 237.2 | 2.12 | 1200 | 182 |
| II | 219.5 | 1.52 | 2054 | 123 |
| III | 224.7 | 1.04 | 1100 | 131 |

**Fig. 5.** Preoperative (*left*) and 2-year postoperative (*right*) patient photographs demonstrating phase I (anterior, posterior, and lateral). Results of the early technique that included wide undermining and only a wet technique of liposuction applied to the flank with limited improvement of abdominal silhouette are shown.

**Table 3. Complications Seen after Abdominal Contouring during Each Phase**

| Phase | Wound Infection Rate (%) | Wound-Healing Complication Rate (%) | Seroma Rate (%) | Hematoma Rate | VTE Rate (%) | Return to OR |
|---|---|---|---|---|---|---|
| I | 1.8 | 11.6 | 15 | N/A | 0 | N/A |
| II | 1.6 | 3.5 | 11 | N/A | 1.6 | N/A |
| III | 1.1 | 3.2 | 3 | N/A | 0 | N/A |

VTE, venous thromboembolism; OR, operating room; N/A, not applicable.

**Fig. 6.** Preoperative (*left*) and 2-year postoperative (*right*) lateral views of the patient shown in Figure 5.

rates of liposuction and abdominoplasty at 1 percent and 1.1 percent, respectively. Our analysis of patients in phase III revealed a wound infection rate of 1 percent compared with the rate of 1.7 percent for those from phase I and phase II who did not undergo inferior superficial dissection. These differences were not statistically significant.

### Wound-Healing Complications and Seromas

Six patients in this series suffered from wound-healing complications (2.4 percent). Four of these patients were from phase I (6.7 percent) and one each were found in phases II (0.9 percent) and III (1.3 percent). Chi-square goodness-of-fit test demonstrates a value of $p < 0.05$, with the wound-healing complication rate in phase I patients being higher than that seen in the latter two groups (Table 2).

The rate of seroma formation was found to be statistically decreased in phase III patients when compared with the other two groups ($p < 0.04$). Two patients in the phase III group experienced seroma formation (2.5 percent) compared with 17 phase I and phase II patients (10.2 percent) (Table 3).

### Blood Loss

The comparison of phase I patients undergoing wet infiltrative technique for liposuction revealed that these patients had a higher intraoperative estimated blood loss when compared with phase II and III patients who received superwet infiltration. Phase I patients had a mean estimated blood loss of $182.8 \pm 138.1$ cc compared with a mean estimated blood loss of $131.13 \pm 93.1$ cc for phase II and III patients. The $t$ test comparison of means revealed that this difference was statistically significant with a value of $p < 0.002$ (Table 3).

Phase I patients were also found to require blood transfusions more frequently when compared with their phase II and III counterparts to a statistically significant degree ($p < 0.003$). Five patients (8.3 percent) in the former group required transfusions after their abdominal contouring procedure. Two patients receiving superwet infiltration in phases II and III required blood transfusions (1.1 percent) (Table 3).

### Aesthetic Outcomes

Aesthetic outcomes were determined by two blinded evaluators with a scoring system ranging from 1 to 5 to assess total abdominal contour and scar quality. The average score increased progressively with each phase in technique (Figs. 5 through 10). The greatest improvement in aesthetic result was observed in the transition from phase I to phase II, where the average aesthetic outcome increased from 3.5 to 4.2. The increase from phase II to phase III was less dramatic, from 4.2 to 4.5. The more significant increase in aesthetic score from phase I to phase II correlates with the addition of ultrasound-assisted liposuction.

In summary, when comparing phase I and phase II, we observed lower wound infection rates, fewer wound-healing complications, lower blood loss, and

**Fig. 7.** Preoperative (*left*) and 9-month postoperative (*right*) patient photographs demonstrating phase II (anterior, posterior, and lateral). Results of the interval technique that included wide undermining with flank liposuction using a superwet ultrasound-assisted liposuction technique with improved flank contour but limited upper abdominal contour correction are shown.

shorter hospital stays in the latter patients. Phase III patients experienced a lower wound infection rate and lower seroma rate in comparison with the phase II patients. Aesthetic score improved from phase I to phase II and then again to phase III.

## DISCUSSION

This study is an analysis of the evolution in abdominal contouring surgery performed by the senior author (R.J.R.). The addition of each aforementioned technique has led to the senior author's current approach, which is analyzed through comparison of complication rates and aesthetic outcomes. Specifically, patients were categorized into three major phases in abdominoplasty technique. Phase I patients underwent a widely undermined abdominal flap with limited flank suction-assisted liposuction conducted using

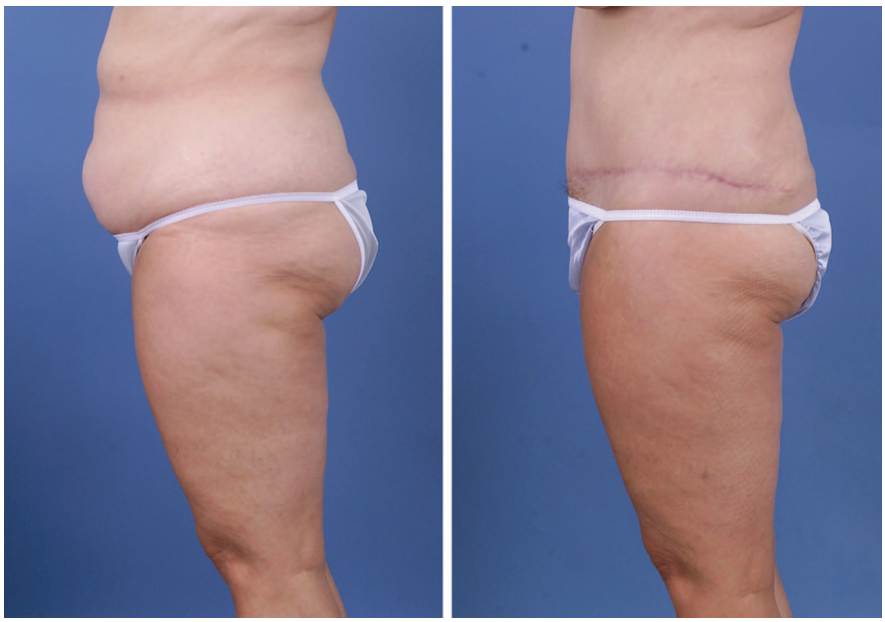

**Fig. 8.** Preoperative (*left*) and 9-month postoperative (*right*) lateral views of the patient shown in Figure 7.

the wet technique. In phase II, patients underwent abdominoplasty, more extensive suction-assisted liposuction, and ultrasound-assisted liposuction of the flanks with a superwet tumescent solution rather than wet technique, and wide abdominal undermining. Most recently, the phase III patients underwent placement of progressive tension sutures, and an abdominal flap dissection in a limited central pattern with maintenance of a subscarpal fat plane on the entire abdominal wall. The goal of this study was to compare the overall complication rates and aesthetic outcomes of each phase in technique and the total group of patients over 20 years.

Huger[21] described clearly that traditional wide undermining eliminated the major preoperative blood supply to the abdominoplasty flap, specifically, the superior and inferior epigastric systems (zone 1). Although it is accepted that liposuction of the abdominoplasty flap risks devascularization of any skin dependent only on the subdermal plexus, more recent studies indicate that perforator vessels are largely unharmed after liposuction.[11–14] This is clinically manifested in a number of reports showing that liposuction can be safely combined with abdominoplasty.[8–11] The marked improvement in wound-healing complication rate from phase I to phase III (11.6 percent to 1.1 percent) can most likely be attributed to the transition to a more limited central dissection of the abdominoplasty flap. With the less central dissection used in phase III, the critical superior epigastric perforators can be preserved and thus improve wound-healing outcomes.

In addition, it is worth noting that the lower wound-healing complication rate from phase I to phase II also highlights that the addition of ultrasound-assisted liposuction did not, at least, overwhelm the benefits of limited lateral dissection. These findings support the conclusions of Blondeel's Doppler studies regarding the equivalence between ultrasound-assisted liposuction and suction-assisted lipectomy in their propensity to violate the perforating vessels.[11]

Previous studies have estimated the blood loss associated with the *wet* technique to be 20 to 25 percent of the total aspirate and the blood loss associated with the *superwet* technique to be in the range of 1 to 4 percent.[22–27] Our data support this finding, with the superwet technique resulting in a lower total estimated blood loss (181 ml versus 123 ml). This difference proved to be clinically significant, with five patients requiring blood transfusions after undergoing the wet technique compared with no patients with the superwet approach. Although it is no longer an area of great debate, our data confirm the consensus that the superwet technique improves the safety of liposuction.

The wound infection rate for all of the combined abdominoplasty and liposuction techniques outlined in this study totaled 1.5 percent, which is at least comparable to the aforementioned survey

**Fig. 9.** Preoperative (*left*) and 5-month postoperative (*right*) patient photographs demonstrating phase III (anterior, posterior, and lateral). The evolution of abdominoplasty that includes limited central undermining combined with central and flank ultrasound-assisted liposuction and high superior tension with improved flank and upper abdominal contour is shown.

data when one extrapolates the individual complication rates for abdominoplasty and liposuction alone. The lower wound infection rate observed in the phase III patients compared with the phase II patients may be attributed to the more superficial and limited abdominal dissection, which serves to improve the vascularity of the abdominal flap and to respect the deep lymphatic trunks.[22] These preserved lymphatic trunks likely allow for proper lymphatic drainage of the abdominal flap and thus minimize factors that contribute to infection. Central progressive tension sutures also improve the vascularity of the abdominal flap by unloading the tension on the lower incision by translating to above the umbilicus.

Seroma rates decreased from 11 percent in phase II to 3 percent in phase III. This can be attributed, again, to the superficial inferior dis-

**Fig. 10.** Preoperative (*left*) and 5-month postoperative (*right*) lateral views of the patient shown in Figure 9.

section to prevent injury to the deep lymphatic trunks. Also, it is likely that the placement of progressive tension sutures contributes significantly to the limitation of serous fluid collection. This is accomplished because progressive tension sutures not only help minimize dead space but also secure the abdominoplasty flap to the underlying abdominal wall to prevent interruption of early wound healing. This has been described previously by Pollock and Pollock, who reported no seromas in a 20-year experience with this technique.[28,29]

Evaluation of the aesthetic outcomes revealed a progressive improvement from phase I through phase III. The most noticeable improvement in cosmetic result was observed between phase I and phase II. Although there were multiple modifications, it is most likely that the addition of more extensive liposuction and the addition of ultrasound-assisted liposuction helped to achieve a superior abdominal contour. The smaller increase in aesthetic score from phase II to phase III is not surprising because the evolution in technique was more focused on prevention of complications rather than achieving superior aesthetic results. Progressive tension sutures, however, may contribute to the cosmetic outcome by improving the final scar position through limitation of upward tension on the inferior suture line. It is worth noting that improvement in the aesthetic score from phase I through phase III is undoubtedly affected by the senior surgeon's experience and subsequent refinement in technical execution of the actual operation.

Limitations of the study are first and foremost the retrospective nature of the study. Prospective randomized studies give the highest quality data, and so the data revealed in this investigation are second order. Another weakness is the inability to isolate each technical refinement because multiple changes in technique were made in concert. Also, evaluation of cosmetic outcome was not delineated between abdominal contour and final scar, which would have helped better isolate which technique contributed to each increase in aesthetic score.

## SUMMARY

The technical evolution of a single surgeon's 20-year experience demonstrates that liposuction can be safely and effectively combined with abdominoplasty. Preoperative trunk analysis, intraoperative surgical refinements including superwet technique and ultrasound-assisted liposuction, and perioperative venous thromboembolism prophylaxis significantly improve the outcome of abdominoplasty.

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