Comparison of Limited-Undermining Lipoabdominoplasty and Traditional Abdominoplasty Using Laser Fluorescence Imaging

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Abstract

Background: Body contouring that involves abdominoplasty and/or liposuction is a common cosmetic surgery procedure. Although single-staged lipoabdominoplasty has gained popularity, safety concerns remain.

Objectives: The authors compared abdominal flap perfusion and overall complication rates for traditional abdominoplasty and limited-undermining lipoabdominoplasty.

Methods: Eighteen abdominoplasty patients were evaluated in a prospective study. All patients were nonsmokers and lacked major comorbidities. The control group (n = 9) underwent traditional abdominoplasty with wide undermining. The study group (n = 9) underwent abdominoplasty with limited undermining as well as liposuction of the abdominal flap. The groups were similar with respect to age and body mass index. Patients received follow-up for an average of 97 days. Fluorescence imaging was utilized for perfusion studies. Results and complications were documented, and statistical significance was ascertained via the Student *t* test.

Results: Neither group had major complications or revisions. Minor complications included an exposed suture, resulting in delayed wound healing, in the control group. A patient in the study group had a small area of fat necrosis and a small seroma, neither of which required further treatment. No significant difference in abdominal flap perfusion was found between the control (57%) and study (50%) groups based on fluorescence levels relative to a designated baseline reference marker.

Conclusions: Results of the study indicate that no significant differences exist between the 2 operations with respect to the rates of abdominal flap perfusion or complications.

Level of Evidence: 3

Keywords

abdominoplasty, lipoabdominoplasty, laser fluorescence imaging, perfusion, SPY system

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Many studies have shown that, compared with traditional abdominoplasty alone, combining liposuction and abdominoplasty into a single procedure may improve aesthetic outcomes and reduce the indication of secondary procedures, without increasing complications.[1-10] Nevertheless, concerns about compromised abdominal flap vascularity, which may increase the incidence of wound dehiscence and skin necrosis, have prevented many surgeons from adopting the procedure.

Efforts have been directed at improving our understanding of the abdominal vasculature to minimize the potential

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for wound-healing problems and complications. Huger[11] described 3 vascular zones of the abdominal wall, and Matarasso[8] outlined safety areas for liposuction combined with abdominoplasty. Saldanha et al[6] later popularized lipoabdominoplasty by describing a selective undermining approach and recommended a perforator-sparing procedure with limited lateral undermining of the abdominal flap to improve perfusion. The rate of complications was low in their study, mitigating the stigmas associated with concurrent liposuction. The safety of lipoabdominoplasty was further corroborated by a large retrospective study by Stevens et al,[2] who found that the complication rate for the combined procedure was not higher than that of traditional abdominoplasty.

Successful clinical results have been reported for lipoabdominoplasty, but the literature lacks prospective analyses with objective outcomes. It is likely that the paucity of quantifiable data has contributed to the procedure's lack of overall acceptance in the plastic surgery community.

Our prospective observational study was designed to compare perfusion rates for lipoabdominoplasty and traditional abdominoplasty by means of the SPY Elite System (LifeCell Corp, Bridgewater, New Jersey), a fluorescent imaging device that quantifies tissue perfusion.

METHODS

Study Design

After obtaining approval from Institutional Review Board at the University of Texas Southwestern, a prospective, controlled trial was conducted on 18 patients who underwent abdominoplasty between October 2012 and June 2013. Patients satisfied at least 1 of the following inclusion criteria: abdominal wall laxity, excess skin or subcutaneous tissue, and/or striae at presentation. Each enrolled patient provided informed consent for the study, surgical procedure, and fluorescent imaging with iodinated contrast. Exclusion criteria included a history of smoking, significant comorbidities, and any known allergy to iodinated dye.

The control group (n = 9) underwent traditional abdominoplasty. The study group (n = 9) underwent limited-undermining lipoabdominoplasty. The choice of surgical procedure for each patient was based on the clinical judgment of the operating surgeon and was the primary factor in determining which patient would undergo lipoabdominoplasty. All operations were performed at the University of Texas Southwestern Outpatient Surgery Center (Dallas, Texas) by a senior author (J.R., F.E.B., or J.M.K). The average follow-up time was 97 days (range, 40-247 days). Medical records, including follow-up documentation, were examined to determine demographic data, body mass index (BMI), operating time, complications, and outcomes.

Surgical Techniques

The techniques for traditional abdominoplasty and lipoabdominoplasty in this study parallel those described elsewhere.[3,7,8] Wide undermining up to the costal margins was performed bilaterally on patients in the control group (traditional abdominoplasty) by a senior surgeon. Liposuction of the abdominal flap was performed on patients in the study group (lipoabdominoplasty) by another senior surgeon before the abdominoplasty, using a 1:1 superwet technique with infiltrate consisting of 1 mg of epinephrine in 1 L of Lactated Ringer's solution, administered as an injection. Suctioning of bilateral flanks was performed, with a consistent technique, in all patients in each group. Dissection was carried superiorly to the xiphoid process in all cases; however, lipoabdominoplasty patients underwent limited paramedian dissection to just beyond the medial border of the rectus. Vertical rectus plication was performed as needed.

Protocol for Fluorescent Imaging

The SPY Elite System was applied to every operation to track intraoperative abdominal perfusion. Imaging studies were conducted at 2 time points: (1) before local infiltration (before any incisions), to confirm lack of inherent abnormalities in abdominal perfusion, and (2) immediately after final closure, to generate data for comparison. Intravenous infusion of 3 mL of indocyanine green contrast dye followed by 10 mL of normal saline flush was administered by an anesthesiologist just before perfusion of the abdominal flap was recorded with the imaging device.

This technology utilizes an infrared laser to excite the dye and a camera to record fluorescence emanating from the tissue. The level of fluorescence reflects the degree of perfusion, which is then quantifiable based on regional differences. As soon as the camera was able to capture a fluorescent blush from the dye (typically 5-10 seconds after infusion), video recording was initiated, and images of the entire abdominal wall were recorded over a 30- to 60-second period following infusion.

All perfusion reports were stored on the SPY computer, from which color-coded perfusion gradients were extracted, quantified, and analyzed. Quantification was based on a marker placed at the maximally perfused focus, below the incision, near the midline. This reference point served as the baseline measurement of abdominal perfusion. Three additional markers were placed just above the incision to determine respective perfusion levels as a percentage of the reference point. Their locations—left and right inguinal creases and midline—remained constant to enable consistent, accurate comparison among patients and procedures (Figure 1).

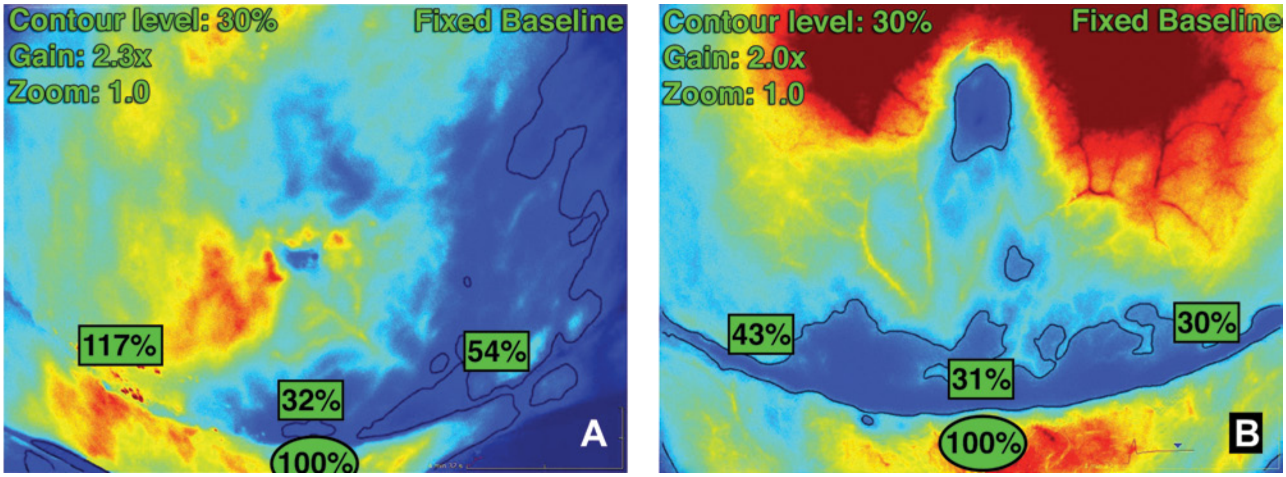

Figure 1. Intraoperative fluorescent imaging performed immediately after final closure. (A) This 39-year-old woman underwent traditional abdominoplasty, and (B) this 60-year-old woman underwent lipoabdominoplasty. On each angiography image, note the horizontal incision, the midline reference marker below it, and the 3 study markers above it at the inguinal creases, bilaterally and midline. Also note that the perfusion of the upper aspect of the abdominal flap was greater in the lipoabdominoplasty patient (B) than in the traditional abdominoplasty patient (A), likely denoting greater preservation of the superior perforators. Red indicates well-perfused areas; blue indicates poorly perfused areas.

Table 1. Operating Time, Tumescent Infiltration Volume, Suction Volume, and Perfusion Data

		Tumescent Infiltration, mL		Lipoaspirate, mL		Perfusion Data, %			
	Operating Time, min	Abdominal	Total	Abdominal	Total	Left Inguinal	Midline	Right Inguinal	Mean
Traditional abdominoplasty									
Minimum	96	0	550	0	335	30	10	42	36
Maximum	189	0	1510	0	1640	95	100	100	94
Mean	136	0	862	0	792	61	57	67	62
Lipoabdominoplasty									
Minimum	101	250	423	100	300	30	30	35	35
Maximum	172	1182	2626	780	3350	100	100	89	96
Mean	139	609	1163	474	1028	62	50	55	56
P value	.883	NA	NA	NA	NA	.885	.571	.205	.550

NA, not applicable.

Statistical Analysis

Statistical analysis was performed with Microsoft Excel for Mac 2011 (Microsoft Corp, Redmond, Washington). The Student *t* test was applied to compare mean values for age and BMI between the groups, as well as perfusion means at each abdominal flap location. Statistical significance was defined as $P < .05$.

RESULTS

Seventeen of the 18 patients (94.4%) were women. The average age was 41 years (range, 28-65 years) for the control group and 51 years (range, 32-60 years) for the study group ($P = .065$). The average BMI was 26.1 kg/m^2 (range, 21.1-33.7 kg/m^2) for the control group and 25.3 kg/m^2 (range, 21.9-31.3 kg/m^2) for the study group ($P = .650$). Mean age and BMI did not differ significantly between the 2 groups (Table 1).

The mean operating times for the control and study groups, respectively, were 136 minutes (range, 96-189 minutes) and 139 minutes (range, 101-172 minutes) ($P = .883$). In the control group, the mean abdominal infiltrate, total infiltrate, abdominal lipoaspirate, and total aspirate volumes were 0 mL, 862 mL, 0 mL, and 792 mL, respectively. The

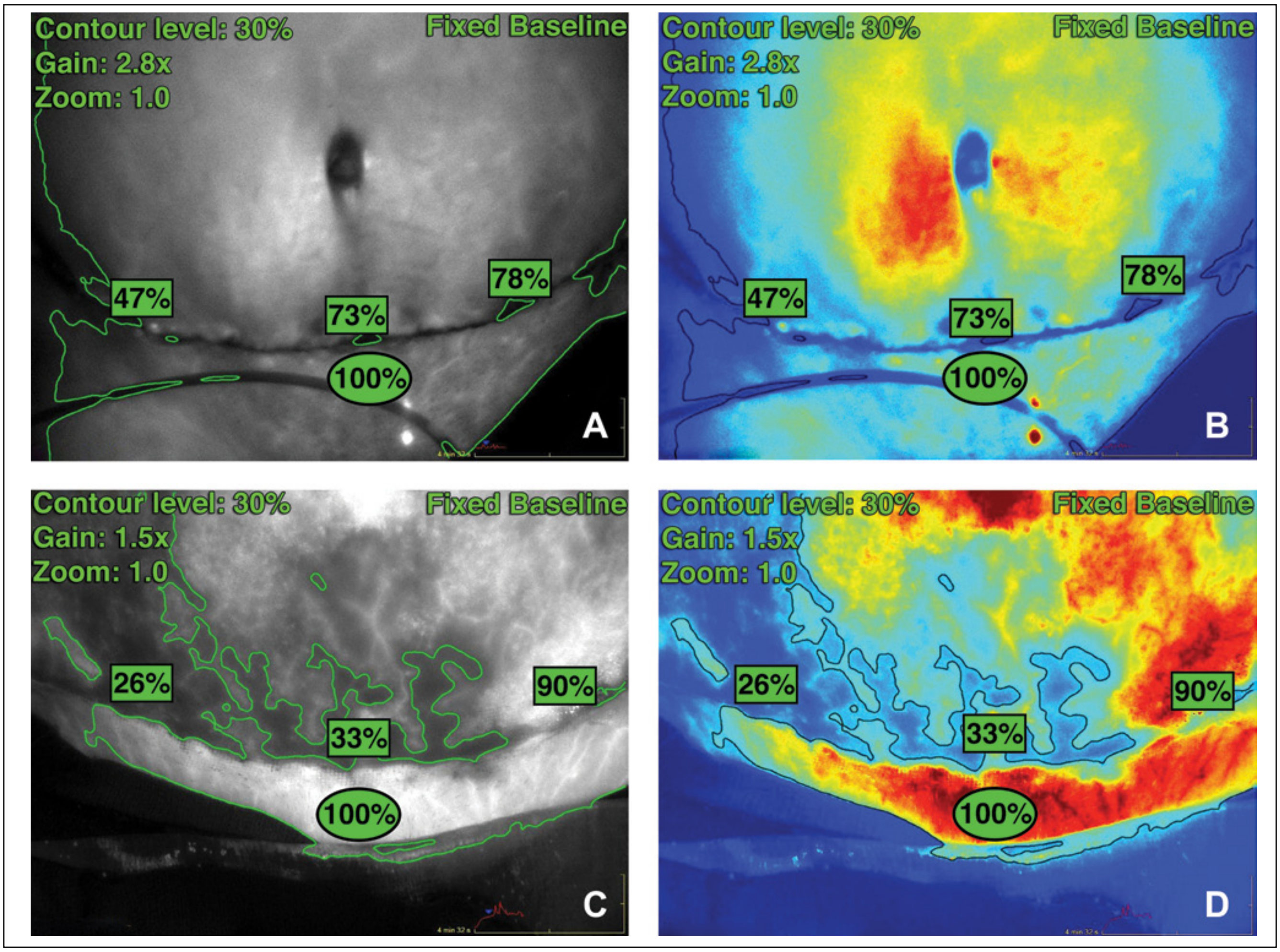

Figure 2. Intraoperative fluorescent imaging immediately after final closure, juxtaposing black-and-white and color stills. (A, B) This 28-year-old woman underwent traditional abdominoplasty, and (C, D) this 51-year-old woman underwent lipoabdominoplasty. Red indicates well-perfused areas; blue indicates poorly perfused areas.

corresponding values for the study group were 609 mL, 1163 mL, 474 mL, and 1028 mL. The difference in mean aspirate volumes relates to the addition of abdominal flap liposuction in the study group. Data pertaining to operating time, tumescent infiltrate volume, lipoaspirate volume, and perfusion appear in Table 1.

In the control group, mean left inguinal, midline, and right inguinal relative perfusion values were 61%, 57%, and 67%, respectively. The corresponding values for the study group were 62%, 50%, and 55% (P = .885, .571, and .205, respectively). Mean abdominal flap perfusion was 62% for the traditional abdominoplasty group and 56% for the lipoabdominoplasty group (P = .550). (Additional examples of perfusion images are shown in Figure 2.)

All 18 patients experienced satisfactory aesthetic outcomes based on surgeon assessment at each follow-up, clinical photographs, and patient satisfaction. There were no major complications or required revisions in either group. In the control group, there was 1 incident of an exposed suture, which caused delayed wound healing in an adjacent small area. In the study group, there was 1 episode of fat necrosis, which was confined to a small area just under the incision; this was likely secondary to a deep suture at Scarpa's fascia. Another patient in the study group experienced a minor seroma that resolved spontaneously.

DISCUSSION

The benefits of combining abdominal liposuction with abdominoplasty are well recognized. For patients with significant lipodystrophy of the abdominal flap, surgeons can establish a more aesthetic contour of the abdomen than is possible with either procedure alone. Some surgeons, concerned about perfusion-related complications, choose to stage the procedures, but doing so exposes the patient to a second anesthetic, increases downtime, and incurs additional costs.

According to the medical literature, complication rates for lipoabdominoplasty and traditional abdominoplasty do not differ significantly. However, such findings have been largely based on retrospective studies that rely on subjective clinical outcomes, such as wound complications, revision rates, and/or patient satisfaction.[3,5-8,12] In a review of 487 patients who underwent abdominoplasty combined with closed liposuction of the flap and flanks, Dillerud[12] ascertained that wide undermining posed significant risks for flap necrosis and that liposuction, obesity, and age did not significantly affect the incidence of slough.

Saldanha et al[6,7] popularized a lipoabdominoplasty technique that entails selective undermining, enabling suction in all abdominal regions without increased risk to tissue perfusion. The technique preserved perforating abdominal vessels, the neural chain, and lymphatic vessels, yielding fewer perfusion-related complications (eg, seroma, hematoma, and skin slough) than traditional abdominoplasty. Moreover, suprapubic sensibility was maintained.

In an evaluation of 114 patients, Heller et al[3] found that modified transverse abdominoplasty with extensive liposuction and limited paramedian supraumbilical dissection produced fewer complications than did traditional abdominoplasty. This success was attributed to a reduced tension midline closure in the suprapubic region, less lateral undermining in the upper abdomen, and greater preservation of intercostal arteries.

Results of a chart review of 161 patients, conducted by Samra et al,[5] provided evidence that lipoabdominoplasty is not associated with significantly higher complication rates in high-risk patients secondary to smoking or a previous supraumbilical scar. In addition, Stevens et al[2] found no significant difference in morbidity rates between abdominoplasty with adjunctive liposuction and abdominoplasty alone in a retrospective study of 406 consecutive cases—even when the morbidity rates were stratified by age, BMI, operating time, and the amount and location of liposuction. Important factors included “appropriate patient selection, meticulous perioperative care, and limited operating times.”[2]

The fact that the complication rate was not higher for the combined procedure in these studies may be attributable to the following: (1) technique (advocates of the procedure recommend limiting undermining to what is necessary for plication and proper contour); (2) tumescent infiltration with epinephrine to reduce blood vessel caliber, making the vessels less prone to injury[3,7]; and/or (3) use of relatively blunt suction cannulas that preserve the integrity of larger perforators, as demonstrated previously.[6]

Despite the sizable body of clinical data supporting lipoabdominoplasty, we believed that an objective evaluation was necessary to further validate the procedure’s safety. To that end, we measured abdominal flap perfusion with laser-assisted videoangiography in patients who underwent traditional abdominoplasty (control group) and those who underwent lipoabdominoplasty (study group). Authors of recent studies[13-20] have confirmed the utility of this type of imaging in operative settings. For example, it has been applied in breast reconstruction, where it can distinguish between superficial inferior epigastric artery (SIEA) and deep inferior epigastric perforator (DIEP) dominance better than handheld Doppler devices. It has also been utilized in free-tissue transfer procedures, where it provides real-time early detection of vascular compromise to guide appropriate management.

Mayr et al[21] performed laser-assisted videoangiography in 15 patients to assess abdominal blood supply after traditional abdominoplasty that entailed wide undermining. Three patients experienced perfusion-related complications, which the authors attributed to a mean reduction of 82.8% in perfusion of the abdominal flap at the midline, just above the incision, relative to the unoperated flank.

In contrast, our mean reductions in perfusion were 38% for the traditional abdominoplasty group and 44% for the lipoabdominoplasty group (difference not significant). The greater mean relative perfusion of the abdominal flap may be attributable to the control site (groin vs flank), to the fact that our mean perfusion is based on measurements at 3 sites, and/or to surgical technique. Importantly, neither group experienced perfusion-related complications, indicating that both the decreased relative perfusion and the small discrepancy in relative perfusion between the groups were not clinically significant in our study.

Through fluorescence imaging, we confirmed preservation of the perforators intraoperatively in areas that underwent liposuction (Figure 1B). Although this has been established elsewhere,[8,22] it emphasizes an advantage of liposuction with limited undermining vs traditional wide undermining. We did not find that preserving the perforators leads to higher abdominal flap perfusion; this may be secondary to the tumescent infiltration with epinephrine, as discussed earlier in this article.

Another concern of some surgeons regarding lipoabdominoplasty is increased operating time. Although abdominal flap liposuction was performed in conjunction with lipoabdominoplasty in our study, the mean operating time for this combination procedure did not differ significantly from that of traditional abdominoplasty. This may be attributable to the less-extensive undermining inherent in lipoabdominoplasty, which decreases dissection time and thus compensates for the liposuction component.

As part of the superwet liposuction technique, lipoabdominoplasty patients received tumescent infiltration with a solution that included epinephrine, which has vasoconstrictive effects that undoubtedly lowered tissue perfusion. Although infiltrate is a confounding factor in our study, it represents a standard of care that minimizes blood loss during liposuction. Given the less-extensive undermining associated with lipoabdominoplasty, it is likely that the overall perfusion of the abdominal flap would have been higher in this group once the epinephrine had been completely metabolized. This was not verified in our study because the imaging was performed immediately after closure.

An approach to avoid the confounding influence of epinephrine would be to image each patient's abdominal flap several hours after the vasoconstrictive effects of epinephrine had disappeared. However, doing so would have been logistically difficult given that our SPY machine is always in the operating room, which is on a different floor from the recovery area. Furthermore, we wanted to avoid prolongation of anesthesia and minimize patients' recovery time. We did not wish to inconvenience our patients by maintaining an intravenous line for dye administration while they were awake and recovering.

Another limitation of our methodology is the fact that patients who had abdominal liposuction also underwent less undermining relative to the control group. A study could be designed to isolate the effect of liposuction alone, while holding dissection and tumescent infiltration constant by administering wide undermining and tumescent solution to both groups, or to compare wide and limited undermining while controlling for liposuction and tumescent infiltration. Although such studies would better isolate the influence of a specific variable on perfusion, they would also require alteration of surgical protocols, which would not be ethical for elective procedures designed to maximize results. Moreover, those methodologies would not have allowed us to accomplish our study's primary goal, which was to objectively compare perfusion between 2 common body contouring procedures.

Our small sample size (n = 18) is another shortcoming. A larger population would have enhanced the power of our study, but the high costs associated with the SPY machine and dye kit would present logistical challenges in a large-scale study of an elective procedure.

The fact that the operations were performed by different surgeons is another limitation of our study. However, to minimize this effect, similar operative sequences were utilized in each surgical procedure, and 2 surgeons were involved in almost every case.

CONCLUSIONS

To our knowledge, this study represents the first objective comparison of abdominal flap perfusion in limited-undermining lipoabdominoplasty and traditional abdominoplasty. Based on laser angiography, we found no significant difference in intraoperative perfusion between these surgical procedures. These findings coincide with the successful clinical outcomes observed in our study and with findings of other authors who advocate lipoabdominoplasty as safe, effective, and associated with complication rates similar to those of traditional abdominoplasty.

Disclosures

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

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REFERENCES

1. Swanson E. Prospective clinical study reveals significant reduction in triglyceride level and white blood cell count after liposuction and abdominoplasty and no change in cholesterol levels. *Plast Reconstr Surg*. 2011;128(3):182e-197e.
2. Stevens WG, Cohen R, Vath SD, et al. Does lipoplasty really add morbidity to abdominoplasty? Revisiting the controversy with a series of 406 cases. *Aesthetic Surg J*. 2005;25(4):353-358.
3. Heller JB, Teng E, Knoll BI, Persing J. Outcome analysis of combined lipoabdominoplasty versus conventional abdominoplasty. *Plast Reconstr Surg*. 2008;121(5):1821-1829.
4. Weiler J, Taggart P, Khoobehi K. A case for the safety and efficacy of lipoabdominoplasty: a single surgeon retrospective review of 173 consecutive cases. *Aesthetic Surg J*. 2010;30(5):702-713.
5. Samra S, Sawh-Martinez R, Barry O, Persing JA. Complication rates of lipoabdominoplasty versus traditional abdominoplasty in high-risk patients. *Plast Reconstr Surg*. 2010;125(2):683-690.
6. Saldanha OR, De Souza Pinto EB, Mattos WN Jr, et al. Lipoabdominoplasty with selective and safe undermining. *Aesthetic Plast Surg*. 2003;27(4):322-327.
7. Saldanha OR, Federico R, Daher PF, et al. Lipoabdominoplasty. *Plast Reconstr Surg*. 2009;124(3):934-942.
8. Matarasso A. Liposuction as an adjunct to a full abdominoplasty. *Plast Reconstr Surg*. 1995;95(5):829-836.
9. Matarasso A. Liposuction as an adjunct to a full abdominoplasty revisited. *Plast Reconstr Surg*. 2000;106(5):1197-1205.
10. Levesque AY, Daniels MA, Polynice A. Outpatient lipoabdominoplasty: review of the literature and practical considerations for safe practice. *Aesthetic Surg J*. 2013;33(7):1021-1029.
11. Huger WE Jr. The anatomic rationale for abdominal lipectomy. *Am Surg*. 1979;45(9):612-617.
12. Dillerud E. Abdominoplasty combined with suction lipoplasty: a study of complications, revisions, and risk factors in 487 cases. *Ann Plast Surg*. 1990;25(5):333-343.

13. Francisco BS, Kerr-Valentic MA, Agarwal JP. Laser-assisted indocyanine green angiography and DIEP breast reconstruction. *Plast Reconstr Surg*. 2010;125(3):116e-118e.
14. Murray JD, Jones GE, Elwood ET, et al. Fluorescent intraoperative tissue angiography with indocyanine green: evaluation of nipple-areola vascularity during breast reduction surgery. *Plast Reconstr Surg*. 2010;126(1):33e-34e.
15. Sood M, Glat P. Potential of the SPY intraoperative perfusion assessment system to reduce ischemic complications in immediate postmastectomy breast reconstruction. *Ann Surg Innov Res*. 2013;7(1):9.
16. Pestana IA, Coan B, Erdmann D, et al. Early experience with fluorescent angiography in free-tissue transfer reconstruction. *Plast Reconstr Surg*. 2009;123(4):1239-1244.
17. Phillips BT, Lanier ST, Conkling N, et al. Intraoperative perfusion techniques can accurately predict mastectomy skin flap necrosis in breast reconstruction: results of a prospective trial. *Plast Reconstr Surg*. 2012;129(5):778e-788e.
18. Newman MI, Samson MC, Tamburrino JF, et al. An investigation of the application of laser-assisted indocyanine green fluorescent dye angiography in pedicle transverse rectus abdominus myocutaneous breast reconstruction. *Can J Plast Surg*. 2011;19(1):e1-e5.
19. Komorowska-Timek E, Gurtner GC. Intraoperative perfusion mapping with laser-assisted indocyanine green imaging can predict and prevent complications in immediate breast reconstruction. *Plast Reconstr Surg*. 2010;125(4):1065-1073.
20. Newman MI, Samson MC. The application of laser-assisted indocyanine green fluorescent dye angiography in microsurgical breast reconstruction. *J Reconstr Microsurg*. 2009;25(1):21-26.
21. Mayr M, Holm C, Hofter E, et al. Effects of aesthetic abdominoplasty on abdominal wall perfusion: a quantitative evaluation. *Plast Reconstr Surg*. 2004;114(6):1586-1594.
22. Graf R, de Araujo LR, Rippel R, et al. Lipoabdominoplasty: liposuction with reduced undermining and traditional abdominal skin flap resection. *Aesthetic Plast Surg*. 2006;30(1):1-8.