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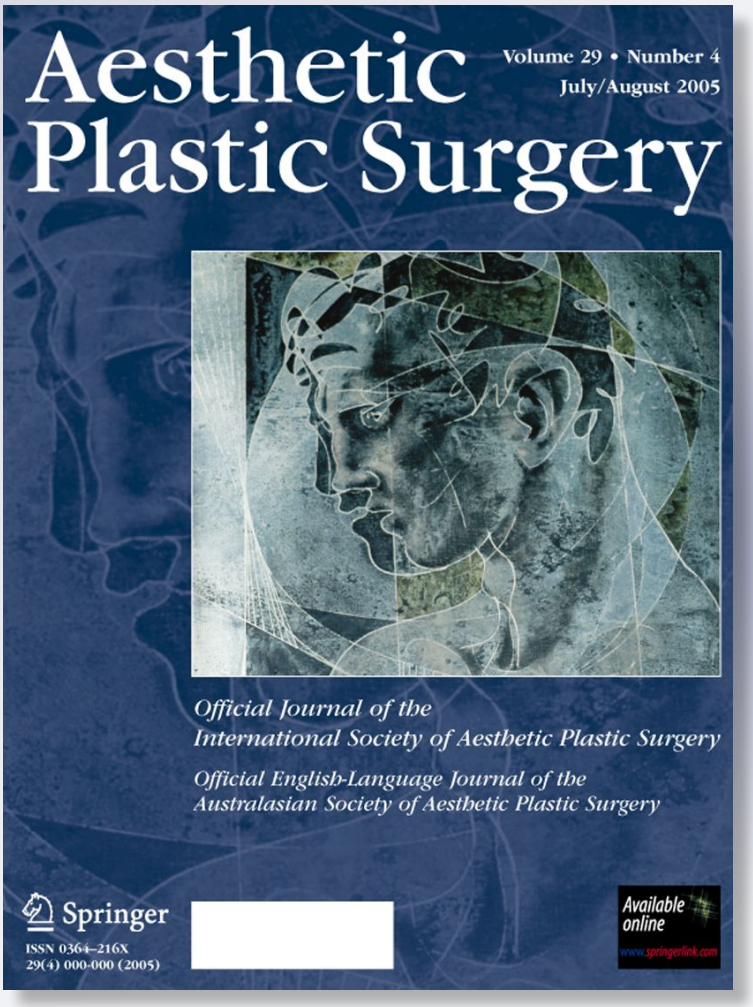
Aesthetic Plastic Surgery

ISSN 0364-216X

Aesth Plast Surg
DOI 10.1007/s00266-012-9885-2



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ORIGINAL ARTICLE

1,000 Consecutive Cases of Laser-Assisted Liposuction and Suction-Assisted Lipectomy Managed With Local Anesthesia

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Received: 16 June 2011 / Accepted: 9 February 2012

Abstract
Background Advances in suction-assisted lipectomy (SAL) include improved instrumentation, better understanding of fluid dynamics, and an improved concept of appropriate indications. The tumescent technique uses subcutaneous injection of isotonic fluid containing vasoconstrictive and analgesic agents and is proved to be safe, with low morbidity and mortality rates. Laser-assisted liposuction (LAL) using local infiltration of an anesthetic and no general anesthesia or sedation has been developed, with claims of fat destruction and skin tightening. This study aimed to review 1,000 consecutive cases of LAL and SAL performed with the patient under local anesthesia and to determine whether this represents a safe technique with few complications.
Methods During a period of 22 months, 581 consecutive patients (486 females and 95 males) underwent 1,000 LAL/SAL operations, 545 of whom had multiple procedures performed. None of the patients had a body mass index (BMI) higher than 30 kg/m^2. The patients ranged in age from 18 to 62 years. The fat aspirate ranged from 50 to 1,400 ml. Patients were given an oral sedative, an antibiotic, and an analgesic. Ringer's lactate solution containing lidocaine and epinephrine was injected into the subcutaneous space. The 1,064-nm and/or 1,320-nm neodymium:yttrium-aluminum-garnet (Nd:YAG) laser was used for laser lipolysis followed by SAL using standard and/or power-assisted liposuction (PAL) cannulas. The treated areas included the neck, triceps, male breast, midback, flanks, axilla, abdomen, mons pubis, thighs, presacrum, and knees. No patient was administered intravenous sedation or general anesthesia.
Results The average number of areas treated was 1.8, and no major complications or mortalities were observed. There were three burns, two infections, one hematoma, and one seroma. A total of 73 secondary procedures were performed (7.3%). No tertiary procedures were required.
Conclusion For appropriately selected patients, comparable results can be obtained with an excellent safety profile and short recovery period using LAL and SAL with the patient under local anesthesia. The awake patient is able to participate in body positioning and to provide physiologic monitoring. No major complications occurred in this series. The burn and hematoma complications occurred in the first 25 cases and may have been related to a learning curve. One case of cellulitis occurred in the triceps region, and a second infection occurred in the abdomen. Both responded to antibiotics. Altogether, 73 touch-up procedures (7.3%) were performed. The amounts of fat removal were comparable with the volumes obtained using traditional liposuction. In conclusion, this series demonstrated that LAL/SAL using local anesthesia is a safe procedure for selected patients, with acceptably low morbidity and revision rates.
Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors at www.springer.com/00266

Keywords Fat destruction · Laser-assisted liposuction · Local anesthesia · Skin tightening · Suction-assisted lipectomy

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Published online: 24 March 2012

Advances in the evolution of suction-assisted lipectomy (SAL) include improved instrumentation, a better understanding of fluid dynamics, reduced anesthesia requirements, and an improved concept of appropriate indications. In most cases, the procedure is performed using the superwet and tumescent techniques with the patient under general anesthesia, which has many advantages but may carry a small but significant risk to the patient [1–3]. Alternatively, the procedure may be performed using local anesthesia [4].

Use of the tumescent technique in liposuction has proved to be safe, with very low morbidity and mortality rates [5–7]. Various methods such as ultrasound-assisted liposuction (UAL), power-assisted liposuction (PAL), and laser-assisted liposuction (LAL) aim to decrease the postoperative recuperation period, reduce operator fatigue, or assist with the removal of fibrous fatty deposits (Fig. 1).

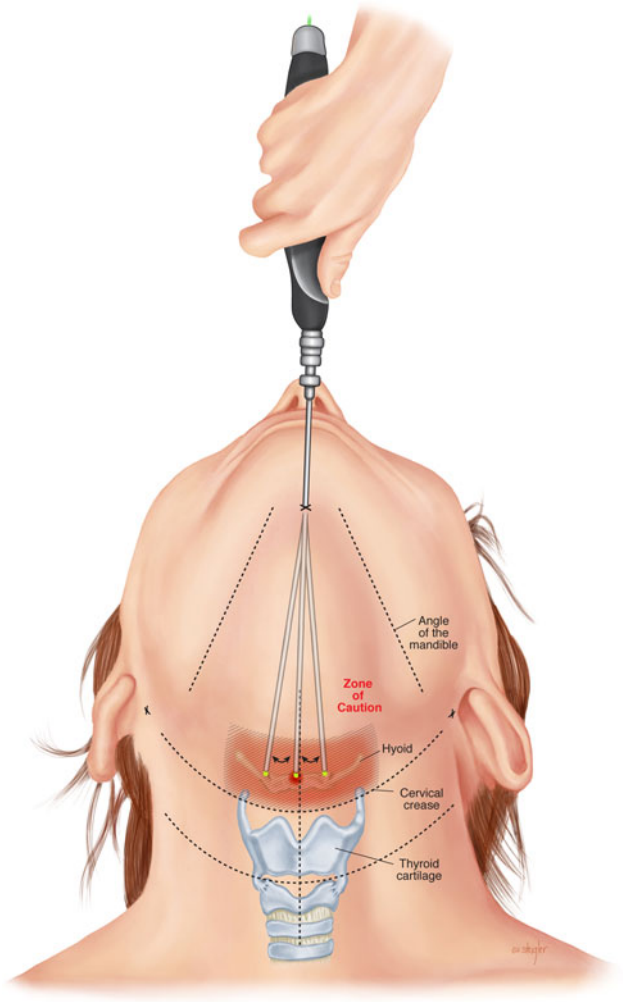

Fig. 1 Anterior schematic view of laser-assisted liposuction (LAL) applied to the hyperextended neck, indicating areas of caution in the midline

Recently, LAL using local infiltration of anesthetic and no general anesthesia or sedation has been developed [8], with claims of fat destruction and skin tightening [9]. Less postoperative pain has been reported by the treated patients, but these results have not been proved clinically in blinded studies [10, 11]. This study reviewed 1,000 consecutive cases of LAL and SAL performed with the patient under local anesthesia to determine the complication and revision rates.

Materials and Methods

Over a 22-month period, 581 patients underwent 1,000 consecutive LAL with SAL operations with local anesthesia. All the procedures were performed in an American Association for Accreditation of Ambulatory Surgery (AAAASF)-accredited, office-based operating room. Of the 581 patients, 545 underwent two or more procedures.

All the patients were evaluated and screened preoperatively by the two operating surgeons. History, physical exam, laboratory values, photographs, and medical clearance when indicated were obtained for all the patients. The patients all provided informed consent, and none had a body mass index (BMI) greater than 30 kg/m^2. The patient skin types ranged from Fitzpatrick 1 through 6. The 581 patients comprised 486 females (83.6%) and 95 males (16.4%) ranging in age from 18 to 62 years (average, 33 years). The age group with the largest number of patients and the highest percentage was the 25- to 35-year-old segment (267 patients, 46%). The SmartLipo neodymium:yttrium-aluminum-garnet (Nd:YAG) laser-assisted liposuction device (Cynosure Corp., Westford, MA) was used for all the patients.

The first 500 patients underwent the procedure with the single-platform, 1,064-nm-wavelength device, and the second group of 500 patients had procedures using the Multiplex (MPX) 1,064/1,320-nm dual-wavelength platform. Except for the different wavelengths noted earlier, all the patients underwent identical procedures.

The exclusion criteria ruled out medical contraindications to liposuction or the medicines used, BMI exceeding 30 kg/m^2, severe skin laxity, patient objection to an awake procedure, and unrealistic patient expectations. The same criteria used for traditional SAL were applied to determine the adequacy of skin for LAL including the pinch test, presence or absence of dermal striae, and subjective determination of elasticity.

On the day of surgery, the areas to be treated were marked with the patients in the standing upright position, and the patients were given one dose of oral antibiotic with the option of 10 mg oral diazepam and one tablet of hydrocodone with acetaminophen. After a standard sterile

prep and drape, the incision sites were given an injection of 1% lidocaine with epinephrine. A 14-gauge needle was used for puncture site access to allow introduction of an infiltration cannula or a 20-gauge spinal needle. Ringer's lactate solution containing 0.10 or 0.15% lidocaine, 12 ml of sodium bicarbonate, and 1.5 ml of a 1:1,000 epinephrine concentration was injected into the deep and intermediate subcutaneous spaces using the tumescent infiltration technique. Tumescent volumes ranged from 200 to 3,700 ml depending on the anatomic region treated.

After infiltration of the local anesthetic, the 1,064-nm Nd:YAG laser at a frequency of 40 Hz or the 1,064/1,320-nm Nd:Yag dual-wavelength laser at 25 Hz was used through fiberoptic cables with diameters of 300, 600, and 1,000 μm. The applied power setting ranged from 7 to 38 W, with a total energy application ranging from 2,000 to 64,000 joules per site.

The fiberoptic cannula was placed in the deep and intermediate subcutaneous spaces moving at a rate of at least 1 cm/s. When a natural curvature in the anatomy, bony prominence, or other area at risk for an "end hit" thermal injury was encountered, the laser was intermittently switched off as needed to minimize the risk of a burn. For example, the neck in the hyperextended position warrants caution in the area of the midline. This area typically corresponds to the soft tissue just above the thyroid cartilage (Figs. 2, 3).

Suction-assisted lipolysis then was performed using standard manual 3.0-, 2.7-, and 2.0-mm Mercedes-style-tip liposuction cannulas and/or 3.0-, 4.0-, and 5.0-mm Mercedes-style-tip PAL cannulas in the same subcutaneous planes. A closed suction drain was placed where 1 l or more of total aspirate was removed. All access incisions were closed with 5-0 nylon, and the patients were placed in compression garments.

The treated areas included the neck, triceps, male breast, midback, flanks, axilla, abdomen, mons pubis, lateral thigh, medial thigh, presacral area, buffalo hump, calves, and knees. No patients underwent intravenous conscious sedation or general anesthesia, and no anesthesia providers were required or present.

All the patients were awake and conversant during the procedure and participated with positioning throughout. Continuous-pulse oximetry and intermittent blood pressure monitoring readings were recorded. The patients were orally hydrated with at least 500 ml of fluids before discharge. Patients were discharged the same day, typically within 15 min after completion of the procedure, with an escort and then were seen in a follow-up visit on postoperative days 7 and 60. Prescriptions were given for oral analgesics and antibiotics when indicated. All the patients returned to normal daily activities within 36 h of the procedure.

Fig. 2 Pre- and postoperative lateral schematic views of laser-assisted liposuction (LAL) applied to the neck showing the area in which the energy (and heat) used may accumulate when the anterior and postauricular approaches overlap

Results

A total of 581 patients underwent 1,000 LAL operations with oral medications and a local tumescent anesthetic. The most common areas treated were the abdomen (32.2%) and the flanks (23.9%) (Table 1). The time required for injection of the tumescent solution ranged from 9 to 23 min (mean, 14 min) and varied with both the anatomic location and the volume of the tumescent solution administered. The total operating time ranged from 28 to 205 min depending on the volume of the aspirate, the number of

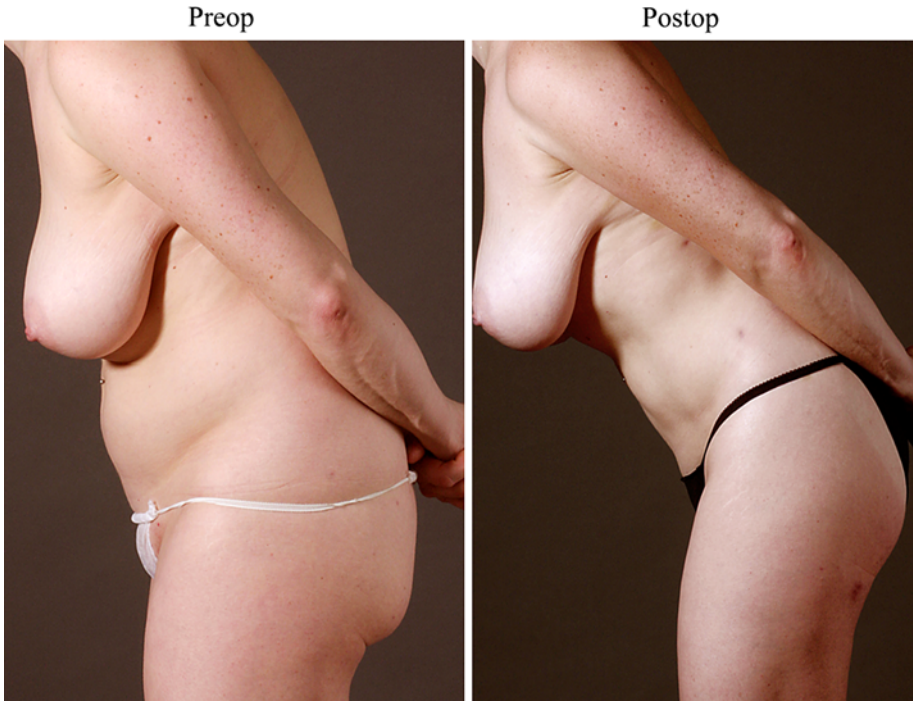

Fig. 3 Preoperative and 1-year postoperative lateral flexed views of a 41-year-old woman who underwent laser-assisted liposuction (LAL) of the abdomen, flanks, and midback in three operations involving 2,400 ml of aspirate and 89,000 J

Table 1 Anatomic areas by number of cases and percentage

Anatomic area	*n*	%
Abdomen	409	34.5
Flanks	303	25.6
Lateral thighs	101	8.5
Medial thighs	88	7.4
Midback	78	6.6
Neck	62	5.2
Axilla	42	3.5
Knees	39	3.3
Hips	27	2.3
Male chest	21	1.8
Presacrum	7	0.6
Buttocks	5	0.4
Buffalo hump	2	0.02
Mons pubis	1	0.01
Calves	1	0.01
Total	1,186	100.0

areas treated, and the anatomic locations. The average number of procedures performed for each patient was 1.8. The fat fraction of the aspirate ranged from 50 to 1,400 ml, again, depending on the anatomic area. For example, the abdominal LAL cases had a mean total aspirate volume of 870 ml with a mean fat fraction of 430 ml. The average time required for abdominal LAL totaled 74 min. This figure included time for tumescence, laser application, and SAL (Fig. 4, 5).

All the patients were discharged the same day after the procedure. No mortalities or major postsurgical complications were observed. Two patients treated in the neck sustained partial-thickness burns (0.2%), which healed with conservative treatment. One patient had a burn of the flank skin, treated with steroid injections and scar revision. One patient had a postoperative hematoma (0.1%) of the thigh, treated with aspiration and observation. Two infections (0.2%) were treated successfully with a course of antibiotics. A total of 73 patients (7.3%) underwent secondary or touch-up procedures for further fat resection (Table 2).

Discussion

This series of patients who had LAL performed with local anesthesia experienced no major complications. The burn and hematoma complications occurred in the first 25 cases for each respective laser platform and may have been related to a learning curve with the equipment. For example, the power setting in watts varies greatly from areas of thin dermis such as the neck to areas of thick dermis such as the back.

One cellulitis case occurred in the triceps region bilaterally and responded to oral antibiotics. Axillary incisions were used and were the likely source of the break in sterility, but no clear source was identified. The second cellulitis case involved the supraumbilical region and required intravenous antibiotics. All cultures were negative. The topical antimicrobial agent (benzalkonium spray) used in

Fig. 4 Preoperative and 1- year postoperative anterior views of 31-year-old woman who underwent laser-assisted liposuction (LAL) of the medial and lateral thighs and the knees in two operations involving 1,750 ml of aspirate and 54,000 J

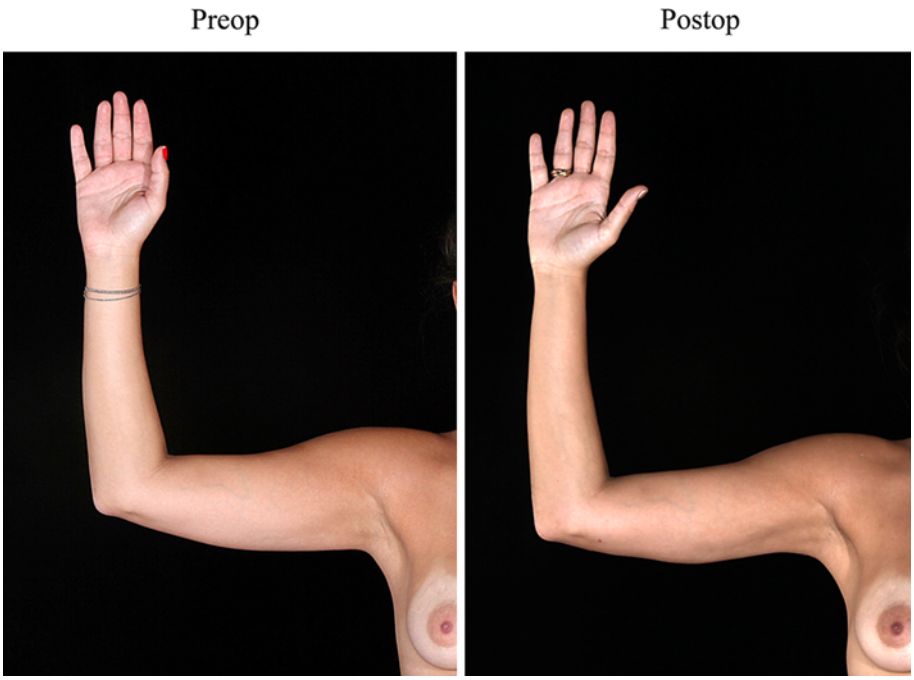

Fig. 5 A 1-year postoperative anterior view of a 25-year-old woman who underwent laser-assisted liposuction (LAL) of the triceps and axilla in one operation involving 1,450 ml of aspirate and 49,000 J

this second case has since been discontinued by the manufacturer and is no longer used (Fig. 6).

Temporary hyperpigmentation of the access incisions occurred in several darker pigmented patients, which resolved with time. Two cases of burns occurred in the midline neck and healed with local wound care. A third burn on the flank skin of a Fitzpatrick six skin-type patient required a scar revision and steroid injections. The hematoma was drained in the office and resolved. The seroma case resolved with needle aspiration and compression. Since the seroma case, a closed suction drain is routinely placed if more than 1 l of aspirate is removed from the abdomen. None have been observed since the initiation of this protocol.

In none of the aforementioned cases were the complications unique to LAL and SAL alone. They have been described in relation to other body-contouring techniques with and without energy application. By comparison, the

Table 2 Patient data

	1,064-nm Nd:YAG *n* (%)	1,064/1,320-nm Nd:YAG *n* (%)	Total *n* (%)
Procedures	500	500	1,000
Patients	341	240	581
Female	278 (82)	208 (87)	486 (84)
Male	62 (18)	33 (13)	95 (16)
Average age (years)	35.4	30.1	32.8
Procedures/patient	1.5	2.1	1.8
Touch-up cases	29 (5.8)	44 (8.8)	73(7.3)
Burns	1 (0.2)	2 (0.4)	3 (0.3)
Infections	1 (0.2)	1 (0.2)	2 (0.2)
Hematoma	1 (0.2)	0 (0.0)	1 (0.1)
Seroma	0 (0.0)	1 (0.2)	1 (0.1)

Nd:YAG neodymium:yttrium-aluminum-garnet

Table 3 Patient age distribution

Age (years)	*n*	%
18–25	69	11.9
26–35	267	46.0
36–45	171	29.4
≥46	74	12.7
Total	581	100.0

seroma rate for UAL is reported to be 2.6 to 11.4% [12]. The burn rate with UAL is 0.9% [12], and the infection rate for traditional liposuction is 0.1% [13].

A total of 73 touch-up procedures (7.3%) were performed for patients who desired further fat resection, comparable with the 9.5% rate previously reported for traditional liposuction [13]. The most common areas treated secondarily were the abdomen (32.2%) and flanks (23.9%), although all anatomic areas were represented. Except for further fat resection, no other common factors were identified in the touch-up group. No tertiary procedures were required. This study included patients who underwent corrective treatment with LAL and SAL after liposuction or chemical lipolysis procedures such as mesotherapy performed by other health care practitioners. None of these patients were in the secondary touch-up category (Table 3).

The time required for infiltration of the tumescent solution is significantly greater for the awake patient than for the sedated patient. The rate of tissue distension is correlated with pain in the awake patient, and the solution must be injected much more slowly. In our series, the additional time averaged 14 min per area for tumescence. It is important to note that the total operating time with LAL using local anesthesia is longer than with SAL alone regardless of the type of anesthesia. For example, using the abdominal LAL case as a comparison, our average operating time per case was 74 min. We compared this with 62 SAL abdominal cases and found the average time to be 60 min for liposuction alone, or 19% less time (Table 4). However, given the time required for induction and awakening of the anesthetized patient and for the increased physiologic monitoring demand required, the additional

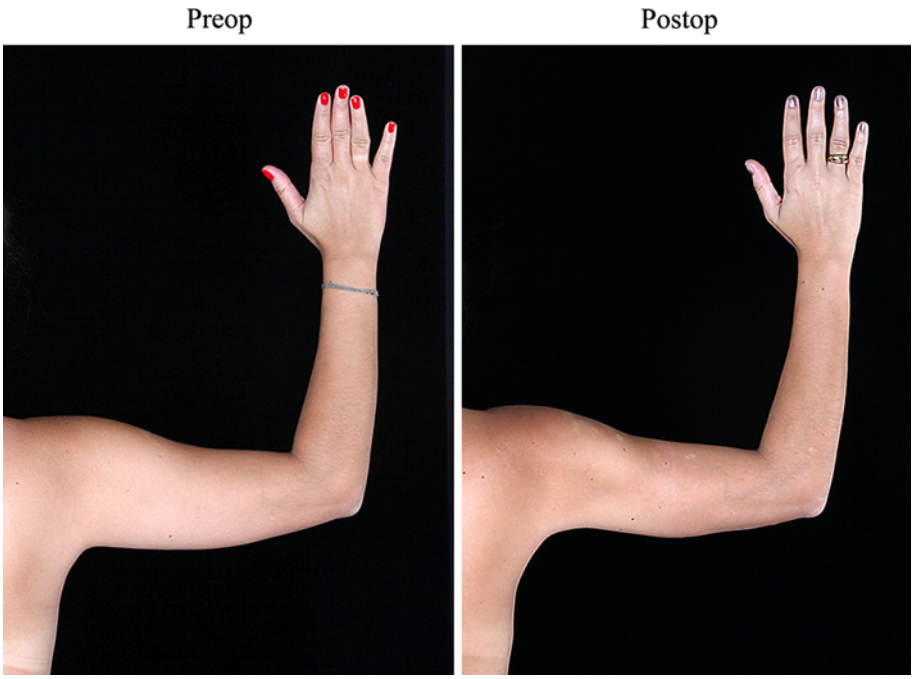

Fig. 6 A 1-year postoperative posterior view of a 25-year-old woman who underwent laser-assisted liposuction (LAL) of the triceps and axilla in one operation involving 1,450 ml of aspirate and 49,000 J

Table 4 Comparison of suction-assisted lipectomy (SAL) alone and laser-assisted liposuction (LAL) of the abdomen

	Abdomen SAL alone	Abdomen LAL with SAL
Cases	69	409
Total complications	1	2
Operating time (abdominal portion) (min)	60	74
Average total aspirate (ml)	700	870

time for injection of the awake patient is not seen as a significant drawback. The complication rates and total aspirate volumes also were comparable (Table 4).

The application of laser energy also added time to the operation and averaged about 1 min per 1,000 joules applied. In this series, that added approximately 4–40 min to the operation. The physiologic demands on an awake patient under local anesthesia is less than on the anesthetized patient, and the additional time requirement did not increase the morbidity or complication rates in this series. The same end points were used to determine the adequacy of fat resection (e.g., the pinch test and visual assessment) as those used for liposuction without laser assistance and local anesthesia, and the same equipment was used for the SAL portion of the operation.

The higher lidocaine doses required to achieve full analgesia for the awake patient limit the number of areas that can be treated at a single setting. To maintain a lidocaine dose to the body weight limit of 40 mg/kg lidocaine, multiple or large areas are treated over two or more operative sessions.

The patients who underwent more than one procedure had their procedures scheduled with a 24-h interval. None of the 581 patients experienced any signs or symptoms of lidocaine toxicity with this technique. In our experience, dividing the treatments over several days did not deter patients from scheduling the procedure after they were informed that the reasons involved patient safety with the medications.

Liposuction with the patient under general anesthesia or conscious sedation remains the gold standard of fat removal for patients who require large volumes of fat removed from multiple areas simultaneously, those who have a documented needlephobia, and those who need to be monitored for preexisting medical conditions.

Use of the laser does not preclude the use of general anesthesia or conscious sedation. In our practice, we also have managed LAL cases using conscious sedation (not included in this study) for the aforementioned indications. The purported benefits of LAL are derived from the wavelength-specific effects of the laser on the chromophores and the nonspecific effects on the soft tissues from heat. Although the primary target of the 1,064-nm wavelength is hemoglobin and that of the 1,320-nm wavelength is water, the laser causes selective photohyperthermia, in which laser-light energy is converted into heat energy when absorbed [9]. The 1,064- and 1,320-nm lasers elicit varying amounts of hydroxyproline synthesis and types 1 and 3 collagen with dermal thickening [14]. In our experience, there was a photothermic effect on the fat, which translated into ease of instrument passage within the subcutaneous fat space and skin thickening postoperatively consistent with a nonspecific thermal effect or heating of the dermis from the lasers. The skin thickening was a predictable postoperative event at 3–8 weeks, and the patients were instructed to massage the areas daily until the fibrosis subsided.

The majority of the cases were managed with PAL. Previous studies have demonstrated that PAL reduces procedure time, intraoperative pain, and surgeon fatigue while producing higher fat aspirate volumes per area [15, 16]. Findings also have shown that aesthetic outcomes were mainly dependent on the surgeons. We found this to be consistent with our experience using LAL, and further studies regarding the wavelength-specific benefits of lasers are warranted.

For appropriately selected patients with small areas of fat excess and satisfactory skin elasticity, liposuction using local anesthesia has delivered reproducible results with an excellent safety profile and a short recovery period [6, 17]. The patient is alert and conversant throughout the procedure and can participate in positioning quickly and safely. Many surgeons would agree that the awake patient provides an accurate method of physiologic monitoring. Obviating traditional anesthesia allowed patients to return to work in substantially less time. In this series, every patient returned to his or her normal daily activities by postoperative day 2 (many the next day). In our series, LAL performed with local anesthesia resulted in the same safety profile.

Conclusion

In conclusion, this series of 1,000 consecutive cases demonstrated that LAL and SAL using local anesthesia are a safe and efficacious procedures for appropriately selected patients with localized lipodystrophy. The complication rate is very low, with a correspondingly low touch-up rate. In addition, the short recovery period, small incision size, and avoidance of traditional anesthesia offer an attractive alternative for patients who normally would not consider traditional methods of body contouring.

Disclosures Christopher T. Chia and Spero J. Theodorou are consultants for Cynosure Corporation.

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