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New Advances in Liposuction Technology

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Although suction-assisted liposuction under tumescent anesthesia remains the traditional method for body sculpting, newer technologies promise to increase efficiency, decrease surgeon fatigue, and minimize complication. Power-, ultrasound-, and laser-assisted devices are ideal in large volume cases and in areas of fibrous tissues as an adjunct to traditional liposuction. Although skepticism remains chemical lipolysis, more commonly termed mesotherapy or lipodissolve may be an alternative to surgical treatment of localized fat. This article reviews the recent advancements in the field of liposuction and the current literature which support their use.

Semin Cutan Med Surg 27:72-82 © 2008 Elsevier Inc. All rights reserved.

KEYWORDS liposuction, technology, ultrasound-assisted, laser-assisted, power-assisted, lipodissolve

Liposuction has undergone a series of evolutionary steps since its inception more than 2 decades ago. The Fischers first introduced the idea of sharp suction techniques for fat removal in 1974 as an alternative to lipocurettage.¹ Illouz further refined the field of liposuction with the introduction of high power negative pressure suction connected to blunt tip cannulas in 1977.² Illouz also is credited for the development of the “wet technique,” in which hypotonic saline solution with hyaluronidase is infiltrated in the subcutaneous tissue as a method of hydrodissection to facilitate fat removal. Both Fournier and Fischer have been credited for introducing criss-cross tunnel formation technique in the late 1970s to further refine body sculpting.^{1,3} Several major advancements have also been contributed to the field of liposuction, including the introduction of tumescent anesthesia, the refinement of cannulas for specific body sites, and the use of manual syringe suction for fine contouring and autologous fat transfer.

Despite the many advances in traditional liposuction, limitations of the technique include postoperative edema and ecchymoses, surgeon fatigue, limited effectiveness in more fibrous areas, and difficulty in avoiding surface contour irregularities. Unlike traditional tumescent liposuction (TL), several new technologies in liposuction promise to facilitate the removal of fat, allowing for faster procedure time, reducing strain on the surgeon, and decreasing patient recovery time and postopera-

tive pain. They are particularly useful in larger-volume cases and in areas of more fibrous tissue, such as backs, male flanks, and breasts, as well as secondary liposuction procedures. These innovations include ultrasound-assisted, power-assisted, and laser-assisted liposuction. In addition, this article will discuss Lipodissolve, a nonsurgical method of chemical lipolysis. Each technology is uniquely suited to specific circumstances, and it is up to the surgeon to determine the best treatment modality for his or her patient seeking fat reduction.

Current Technique and Instrumentation

Perhaps the most significant contribution to the safety and efficacy of liposuction has been the introduction of TL by Dr. Jeffrey Klein in the 1980s.⁴ TL offers various advantages by avoiding the need for general anesthesia. The TL technique consists of infiltrating a high volume of very dilute solution of lidocaine and epinephrine using a peristaltic pump and an infiltration cannula to hydrodissect the subcutaneous space (Fig. 1). This step allows the surgeon to treat multiple areas of disproportionate fat distribution while maintaining prolonged anesthesia and vasoconstrictive effects to minimizing blood loss and lidocaine toxicity.⁵ The patient is awake but comfortable during TL, allowing real-time patient feedback and cooperation. TL has an outstanding safety record, with low reported complication rates. No fatalities have been reported as a result of TL,⁶ whereas liposuction performed under general anesthesia carries significant risk to the patient, with an estimated mortality rate of 20 per 100,000, attributed primarily to pulmonary thromboembolism.⁷⁻⁹

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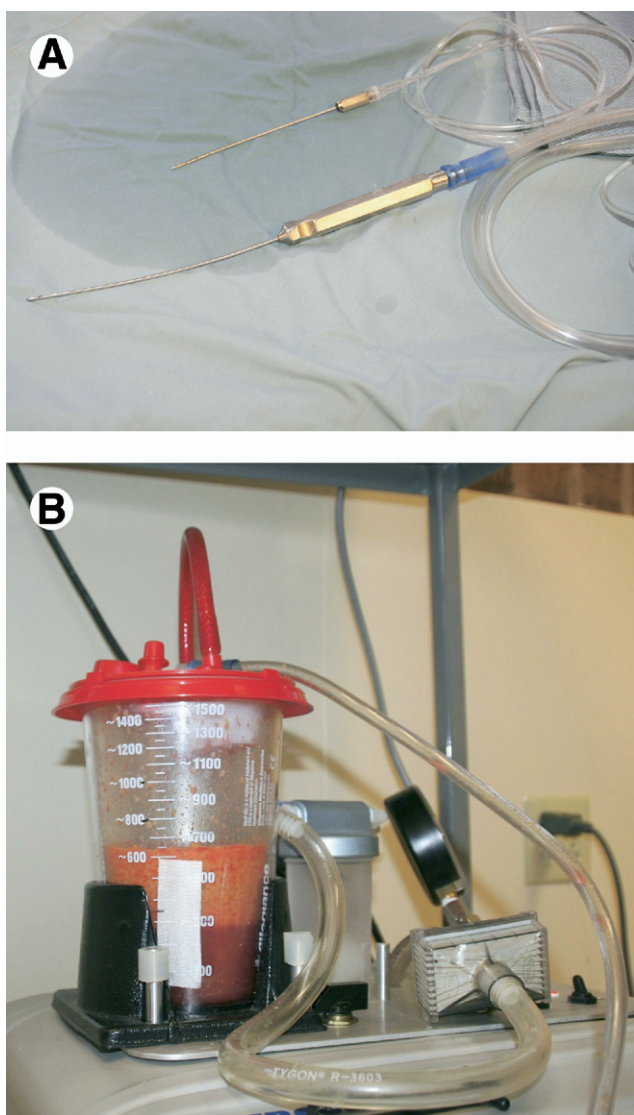


Figure 1 (a) Infiltration cannula (top) for infiltration of tumescent anesthesia and liposuction cannula (bottom) connected to plastic tubing for fat aspiration. (b) Negative suction pump and collection canister with fat aspirant. (Color version of figure is available online.)

Once adequate anesthesia and vasoconstriction have been achieved, a liposuction cannula connected to an aspirating device is tunneled through the hydrodissected subcutis (Fig. 2). Cannula selection is dependent on the body site and degree of contour refinement. Aggressive cannulas typically contain multiple, distally placed ports, larger diameters (greater than 3 mm), and tapered ends. They are preferable in areas of fibrous tissue or during the initial debulking of high volume sites. Aggressive cannulas may increase damage to surrounding tissues, blood loss, or risk of hematoma or seroma formation. Less aggressive cannulas, on the other hand, are ideal for small areas, sites with loose adipose tissue, and where superficial contouring is desired.¹⁰ These cannulas are typically 1 to 3 mm in diameter with blunt tips and one to two proximally placed ports.

Although traditional liposuction is advantageous for large areas of fat removal or for multiple sites, manual syringe liposuction is well-suited for fine contouring areas such as



Figure 2 Range of cannula tips with various sizes and number of ports. (Color version of figure is available online.)

the face and neck. Low-negative pressure suction is created manually by pulling back on the syringe plunger. Various locking devices can be used to secure the plunger in a set position, creating a vacuum for suctioning (Fig. 3). Manual syringe liposuction is most practical for harvesting smaller volumes of fat for autologous fat transfer.¹¹ Studies have shown aspirant from power suction may have similar adipocyte viability in comparison to low pressure manual suction.¹² However, because of the extensive fragmentation of lipocytes in ultrasound-, power-, and laser-assisted devices, aspirate from these newer technologies are not suitable for fat transfer.

Ultrasound-Assisted Liposuction

Ultrasound assisted liposuction (UAL) was developed by Zocchi in the 1980s to improve the penetration through fat including fibrous areas while decreasing the work of the surgeon. The rapidly vibrating instruments were designed to emulsify adipocytes, creating subcutaneous microcavitations before aspiration. An ultrasonic generator is used to convert electrical energy to vibration using a piezoelectric crystal in the hand piece at a frequency of 20 to 30 kHz. These ultrasonic waves cause repetitive expansion and passive contrac-



Figure 3 Locking device, manual syringe suction. (Color version of figure is available online.)



Figure 4 Lysonix ultrasound wave device. A bifunctional hollow cannula for simultaneous fat aspiration and liquefaction. (Courtesy of Byron Medical.) (Color version of figure is available online.)

tion of adipocytes, resulting in rupture of their cellular membrane and liquefaction of fat, creating microcavitations. The probe is then moved in a smooth axial back-and-forth motion in a speed slightly slower than standard suction cannula. Unlike traditional liposuction technique, care must be made to avoid tenting the skin to reduce “end hits,” which results from the tip of the probe impacting the undersurface of the skin causing skin necrosis. Because these instruments penetrated the subcutaneous tissue so easily, complications such as thermal burns, skin necrosis, scarring, seroma formation, and peripheral nerve injury were initially reported.^{13,14} Since then, manufacturers have increased the diameter of the ultrasound device and required skin protectors at the entry sites to avoid burns.

Second-generation devices (Fig. 4) are bifunctional cannulas that deliver both ultrasound waves to liquefy fat and simultaneous fat aspiration (Lysonix, Mentor). These cannulas have a large diameter which required longer incisions to accommodate skin protectors. At the same time, they have a narrower lumen (2 mm), which limits the efficiency of fat aspiration. Third-generation devices, such as VASER (Sound Surgical Technologies LLC), have returned to the initial solid probe technology, which maintains a liquid environment for dispersion of the ultrasonic energy and accelerates the emulsification process.¹⁵ This however, requires a 2-stage process which can be time consuming, with emulsification of fat followed by the use of a suction cannula to expel the sonicated fat.¹⁶ Small grooves near the tip of the probe help disperse the ultrasonic energy, increasing the efficiency of fat emulsification and reducing complication (Fig. 5).

UAL is designed to work in conjunction with traditional liposuction as a pretreatment method for difficult to treat areas before suction lipoplasty. More areas can be treated in patients with less surgeon fatigue. Controversy exists whether UAL improves esthetic outcome and enhances skin retraction. A randomized blinded prospective study by Scuderi and coworkers¹⁶ compared the efficacy, side effects, and cost between ultrasonic, power-assisted, and traditional tumescent liposuction. 45 cosmetic patients with similar body habitus were randomly assigned to each group. Esthetic results evaluated by a panel of

blinded surgeons were not statistically significant. The ultrasonic device produced the highest percentage fat and triglyceride level in the aspirant, though no systemic lipid abnormalities were noted postoperatively. Ultrasound liposuction also produced less bloody aspirant and may reduce local trauma, decreasing post operative ecchymoses and edema in patients. More recent studies using the VASER system by experienced surgeons also noted fewer complications compare with the 5% complication with earlier UAL devices.¹⁶ Disadvantages of the ultrasound system include more operating time, more equipment cost, and a steep learning curve. Thus proper hands-on instructions are essential to minimize the unique risks associated with ultrasonic devices including skin and fat necrosis, burns, and nerve injury.

Powered Liposuction

Powered lipoplasty, also termed vibroliposuction by Malak and Rebelo, incorporates a motor- or pneumatic-driven sys-



Figure 5 VASER ultrasound-assisted liposuction device. Ultrasonic probe with small grooves to disperse vibratory energy and maximize fat fragmentation efficiency. (Photo courtesy of Sound Surgical Technologies LLC.) (Color version of figure is available online.)

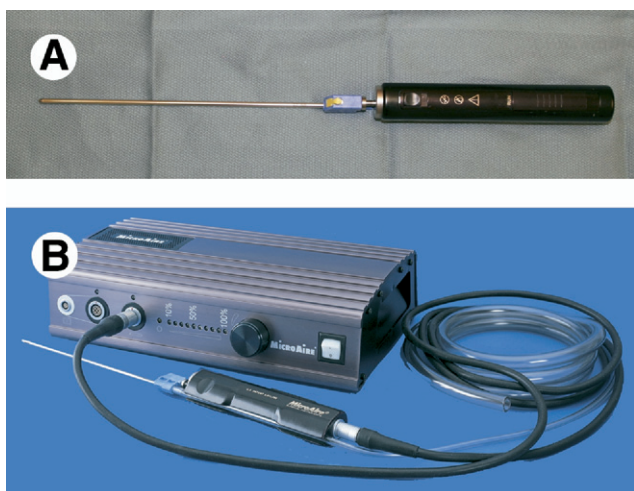


Figure 6 Powered-assisted liposuction device by MicroAire. This motorized handle is connected to a cannula tip which oscillates back and forth to allow better penetration through adipose tissue (top). The cannula is also connected to a standard plastic tubing for fat aspiration. A power cord connects to the motorized electric control console (bottom). (Courtesy of MicroAire Surgical Instruments, LLC, Charlottesville, VA.) (Color version of figure is available online.)

tem that creates a reciprocal, or “to-and-fro” motion of the cannula tip (Fig. 6).¹⁷ This oscillating movement mimics the work of a surgeon during traditional suction-assisted liposuction. As a result, surgeons experience less fatigue during power liposuction with easier penetration and removal of adipose tissue.

True technological advances in the development of powered liposuction occurred in the 1990s, but earlier prototypes of motor-driven liposuction devices date back as early as the 1970s. In 1975, Arpad and Fischer described the “cellusuciatome,” a hollow cannula that housed an internal blade designed to break up aspirated fat.^{18,19} In 1995, Gross developed the “liposhaving” technique in which a cannula with an internal rotating blade was used to break up adipose tissue through an open incision technique.²⁰

In the 1990s, manufacturers began to create more sophisticated power-assisted device with reciprocating cannulas. The vibration allowed easy penetration of even fibrous fat but generated less thermal energy and decreased the risk of cutaneous burns and necrosis compared with previous ultrasonic technology.^{18,21,22} The first power liposuction devices were driven by compressed gas; these units were loud and sometimes distracting.^{10,18,21} Newer devices are powered by a motorized or pneumatic unit with varying rates of vibration and lengths of to-and-fro movement (Table 1).

The limited number of small (21 to 50 patients), prospective, internally controlled studies²³⁻²⁵ comparing powered assisted liposuction to manual liposuction have demonstrated several advantages of powered liposuction. Although the final esthetic results were similar, these side-by-side comparisons demonstrated that powered liposuction increases the rate of fat extraction thus decreasing surgeon fatigue and intraoperative time. The decrease in operative time may ac-

count for the statistically significant decrease in intraoperative pain, postoperative edema and ecchymoses seen by Katz and coworkers.²³ In addition, the vibratory sensation of the cannula has been hypothesized to distract from the perception of pain.¹⁰ Patients in one comparison study were more satisfied with powered liposuction results than those from manual liposuction.²³ However, this may be a function of slower to resolve swelling and bruising in traditional liposuction, not necessarily an inferior surgical result with manual liposuction.¹⁰ Finally, difficult to contour areas, such as the periumbilical region, can be sculpted by fixing the position of the cannula and allowing the reciprocating tip to remove adipose tissue.^{10,21}

Disadvantages of power liposuction are related to the increased surgical trauma with a power-driven device. The oscillating movement of the cannula may create larger diameter tunnels than the actual cannula size used.¹⁰ The surgeon should be aware of this effect and select cannula sizes accordingly. There is a risk of seroma formation with the use of power-assisted liposuction, estimated at 1.4% in a study of 207 patients.²⁶ This complication rate is similar to manual liposuction and may be increased by larger-diameter, longer cannulas, and larger volume cases.¹⁰

As with most new technology, a learning curve is associated with the powered-liposuction device. One study showed that surgeons who had performed fewer than seven cases did not note any benefit in fat extraction per minute in comparison to traditional liposuction. In surgeons who had performed eight or more cases of powered liposuction, a 45% increase in fat extraction was noted.²⁶ Slowing physician stroke time is necessary to maximizing fat extraction through powered cannulas, and this purposeful decrease in physician movement requires experience.^{10,27} Cost is a final drawback to power-assisted technology, with most units priced between \$5000 and \$13,000.

Laser-Assisted Lipolysis System

Recent advances in laser technology have produced several laser assisted lipolysis systems, which are designed to ablate and liquefy fat to augment the outcome of conventional liposuction. In the early 1990s, Apfelberg published one of the first double-blinded multicenter studies comparing laser-assisted liposuction with manual liposuction.²⁸ The prototype device consisted of a 40 W YAG laser fiber threaded inside a 4- or 6-mm cannula. Negative suction drew fat globules into the cannula, which were then sheared off by a laser beam. Although patients reported less postoperative pain and surgeons noted subjective ease of use and decreased manual fatigue on the laser-treated side, blinded surgeons did not note any statistically significant differences in postoperative ecchymosis, edema, or clinical outcome.

Cook and coworkers introduced the use of carbon dioxide laser for neck rejuvenation in 1997.²⁹ In combination with neck liposuction and plication, laser resurfacing through a submental incision produced dermal injury and sclerosis that resulted in excellent neck tightening. The larger hand piece combined with the need for a 2.5 cm submental incision

Table 1 Current Liposuction Technology—At A Glance

Technique	Goal	Device and Manufacturer	Equipment	Pros	Cons	Cost
Traditional suction liposuction	Tumescent anesthesia for hydrodissection followed by negative pressure suction for fat removal	-	<ul style="list-style-type: none"> ● Cannula ● Plastic tubing ● Aspiration device 	<ul style="list-style-type: none"> ● Standard treatment ● Proven safety and efficacy ● Low cost 	<ul style="list-style-type: none"> ● Surgeon fatigue 	Low
Manual syringe liposuction	Negative pressure suction created manually via syringe plunger	-	<ul style="list-style-type: none"> ● Syringe (10 or 30 cc) ● Cannula 	<ul style="list-style-type: none"> ● Small volume sculpting ● Quiet ● Minimal equipment needed ● Useful for fat harvesting for autologous fat transfer ● Low cost 	<ul style="list-style-type: none"> ● Surgeon fatigue ● Small volume 	Low
Ultrasound liposuction	Emulsify fat using ultrasound wave	Vaser, Sound Surgical Technologies LLC	<ul style="list-style-type: none"> ● Ultrasound generator: Dimension 46 cm × 43 cm ● Solid grooved ultrasonic probes in various diameter (2.2 mm, 2.9 mm, 3.7 mm) and lengths (11 cm, 18 cm, 26 cm, 33 cm) ● Skin protectors 	<ul style="list-style-type: none"> ● Reduce surgeon fatigue ● Useful for fibrous areas ● Experienced surgeon may note decrease in post operative ecchymoses and edema 	<ul style="list-style-type: none"> ● Learning curve for surgeon ● More time consuming than traditional liposuction ● First generation devices associated with thermal burns, seromas, peripheral nerve injury and scarring ● Need to use skin protectors to prevent skin necrosis ● “End hits” may cause scarring and skin necrosis ● Expensive startup costs 	Contact manufacturer

Table 1 Continued

Technique	Goal	Device and Manufacturer	Equipment	Pros	Cons	Cost
		LySonix, Mentor	<ul style="list-style-type: none"> • Ultrasonic generator • Probes (solid) and cannula (bifunctional) in sizes 2.0–3.5 mm • Bifunctional hollow cannula allows for simultaneous fat emulsification and aspiration • Skin protectors 			Contact manufacturer
Powered liposuction	Motor- or pneumatic-driven device which produces oscillating movement of the cannula tip for easier penetration and removal of adipose tissue	Well-Johnson (no longer in production)	<ul style="list-style-type: none"> • Electric • Driven by 30-V brushless moter • Stroke: 3 mm • Vibration 26000/min 	<ul style="list-style-type: none"> • Less time consuming than traditional lipo • Reduce surgeon fatigue • Useful for fibrous areas and large volume cases • MicroAire PAL quietest of all powered devices 	<ul style="list-style-type: none"> • Learning curve for surgeon • Pneumatic devices generally noisy • Increase risk of seroma formation with larger diameter/longer cannulas 	N/A
		MicroAire PAL	<ul style="list-style-type: none"> • Electric • Stroke: 2 mm • Vibration 4000/min 			Approximately \$5000
		Byron ARC	<ul style="list-style-type: none"> • Pneumatic (compressed gas) • Stroke: 1 cm 			Contact manufacturer
		Medtronic/Xomed PowerSculpt (no longer in production)	<ul style="list-style-type: none"> • Electric • Driven by 140-W brushless moter • Stroke: 2.8 mm 			N/A

Table 1 Continued

Technique	Goal	Device and Manufacturer	Equipment	Pros	Cons	Cost
Laser-assisted lipolysis system	Laser energy causes adipocyte rupture and liquefaction for ease of removal	Smartlipo, Cynosure	<ul style="list-style-type: none"> • 1064 nm • Power output max: 6 W • Pulse width: 150 msec • Aiming Beam: Diode 3mW at 635 nm • Dimension "28" × "9" × "25.5" • Wt: 83.5 lbs (38 kg) 	<ul style="list-style-type: none"> • Reduce surgeon fatigue • Useful for fibrous areas • May be helpful in fine contouring • Tissue coagulation may reduce bleeding • Collagen degeneration and reticular dermis reorganization may contribute to skin tightening 	<ul style="list-style-type: none"> • Learning curve for surgeon • Two-pass technique (first with laser then with suction canula) is more time consuming than traditional lipo • Expensive startup costs 	Contact manufacturer
		Coolipo, Cooltouch (currently undergoing FDA approval)	<ul style="list-style-type: none"> • 1032 nm • 400 micro laser fiber • Power output: 4–8 W • Pulse width: 100 microsec 			Contact manufacturer
Lipodissolve	Chemical lipolysis using subcutaneous injection using phosphatidylcholine and/or deoxycholate	Europe: Lipostabil N (Artegoda Pharmacy, Germany). U.S.: compounding pharmacies	<ul style="list-style-type: none"> • Solution: phosphatidylcholine 25–50 mg/mL, 2.5–4.7% deoxycholate • 30-gauge needle • Various meso-guns 	<ul style="list-style-type: none"> • Nonsurgical treatment • Reduction of small fat deposits of loose adipose tissue over body and lower 1/3 of face 	<ul style="list-style-type: none"> • Expected side effects (pain, erythema, edema, pruritus, warmth). Requires multiple treatments • No large randomized-controlled studies on safety and efficacy 	\$300–\$1500 depending on site(s) and amount of solution used

made this technique less applicable to other parts of the body. In 2002, Neira and coworkers³⁰ reported the use of an external low-level 635 nm 10 mW diode laser device showing gross and microscopic damage to adipose tissue. A subsequent study by Brown and coworkers³¹ did not reproduce the same results.

Recently, new laser systems have promoted adipocyte rupture by utilizing small optical laser fibers (1-2 mm in size) introduced through a small cannula directly into the subcutaneous fat. A confluent red diode aiming beam at the tip of the cannula provides visual guidance through transcutaneous illumination during treatment (Fig. 7). Traditional liposuction is then used to extract the lysed adipose tissue. Collagen degeneration and reticular dermis reorganization may promote tissue tightening. In addition to its effect on adipocyte rupture and collagen retraction, the laser also causes small blood vessels to coagulate immediately, reducing bleeding, edema, and ecchymosis in comparison with manual liposuction. Because of the small caliber of the fiber optic tip, it has been used in areas prone to surface irregularities such as the upper abdomen, upper thigh, periumbilical region, arms, and jawl. No significant changes in triglycerides and lipid profiles were noted postoperatively among patients treated with laser lipolysis without aspiration.

Few studies have been published in regards to the histological changes and efficacy of the laser assisted device. Using pulsed 1064 nm Nd:YAG laser (Smartlipo, DEKA, Italy) on freshly excised human skin and subcutaneous fat, Ichikawa and coworkers³² demonstrated evidence of adipocyte rupture and coagulation of collagen fibers. Histological examination of infranatant aspirate from laser-assisted lipoplasty compared with traditional suction lipoplasty by Badin and coworkers³³ also noted disrupted architecture of adipocytes and cellular membrane rupture. In addition, they noted histological reduction in bleeding in the laser-assisted side from coagulation of small vessels. Prado³⁴ in his prospective randomized double blinded trial treated 25 patients with the laser-assisted system on one side and the traditional liposuction on the contralateral side. Although there were no differences in the cosmetic results, postoperative edema, or ecchymoses between laser-assisted lipoplasty compared with liposuction alone, postoperative pain was lower in the laser-assisted side. As expected, surgical time was longer for the laser-assisted lipoplasty side. Complications were similar to traditional liposuction with no side effects related directly to the laser such as burns and skin necrosis. Kim and coworkers³⁵ in their small 30 patient pilot study reported moderate skin tightening with the use of the 1064 nm laser to treat small areas (less than 100 cm³) of unwanted fat in the submental, upper arm, thigh and abdomen without liposuction. An average subjective improvement of 37% was noted. Objectively, a 17% reduction in fat volume was noted with MRI. Though no formal measurements were made, the authors also noted subjective dermal tightening.

Although laser-assisted liposuction systems have not demonstrated a clear and significant clinical difference in esthetic outcome over conventional liposuction, they may reduce arm motion and fatigue for the surgeon. In experienced sur-

geons' hands, it may result in less trauma, ecchymoses and edema.³³ By producing more damage to the adipocytes themselves, one disadvantage of laser-assisted lipoplasty is that it renders the fat unsuitable for fat transfer. Large volume liposuction may require higher laser energies, increasing the risk of burns and skin necrosis. In addition, this technique is more time consuming, as the surgeon has to move the laser cannula relatively slowly through the skin to allow for necessary time for the laser-tissue interaction³³ and a second pass with a suction cannula is necessary for fat aspiration.

Chemical Lipolysis

Chemical lipolysis, often termed lipodissolve, is a subcutaneous injection procedure that uses the combination of phosphatidylcholine and deoxycholate in solutions. Targeted areas include small fatty deposits of the body (thighs, hips, abdomen, flanks) and lower third of the face.³⁶ Many regard Lipodissolve as a form of mesotherapy, but physicians of the European Network Lipolysis (ENL) and its U.S. counterpart, the American Society for Esthetic Lipodissolve, strongly disagree with this categorization.³⁷ Dr. Sergio Maggiori first used phosphatidylcholine in subcutaneous injections for the treatment of xanthelasma in the late 1980s.³⁸ Cosmetic use began in Brazil in the late 1990s,^{36,39} but its use in Europe has increased over the past several years, where it is marketed as Lipostabil N (Artegoda Pharmacy, Germany) for off-label use in lipolysis. Although the biologic activity and mechanism of action for either phosphatidylcholine or deoxycholate are not well understood,^{36,40} *in vitro* studies have demonstrated histologic evidence of adipocyte lysis and active lipophages at 8 weeks after injection.^{37,41}

The protocol for chemical lipolysis usually involves 1 to 3 treatment sessions separated by 1- to 8-week intervals (14 days most commonly with older regimens, 8 weeks with newer protocols). A solution containing phosphatidylcholine (25-50 mg/mL final concentration) and 2.5% to 4.7% sodium deoxycholate is administered with a 30-gauge needle to an injection depth of approximately 1 cm, targeting the mid-layer subcutaneous tissue (Fig. 8).^{36,37} Injections are spaced 1 to 2 cm apart. Although no toxicology or pharmacokinetic studies have been performed to identify maximum dosages for either phosphatidylcholine or deoxycholate,³⁹ some authors advocate the maximum dosage of phosphatidylcholine at 2500 mg or 100 mL of solution per session.^{37,42}

There is a relative paucity of research and published data on the safety, efficacy, and mechanism of action of chemical lipolysis, though clinical data are improving.⁴³ The ENL has an ongoing 10-year prospective study on chemical lipolysis involving a portion of the nearly 5000 patients observed by the organization's physicians.⁴⁴ Additional ongoing studies by the ENL include investigations using animal models, serum blood values following injection, ultrasonic studies, combined use with other procedures, and dosing regimens.³⁷ Myers and coworkers reported their experience treating 100 patients with localized fat deposits. Chemical lipolysis demonstrated a 28% skin thickness reduction with an average of 1.98 treatment sessions.³⁶ Duncan in 2005 performed a small



Figure 7 Laser-assisted liposuction device. SmartLipo fiberoptic handpiece and power source. (Courtesy of Cynosure.) (Color version of figure is available online.)

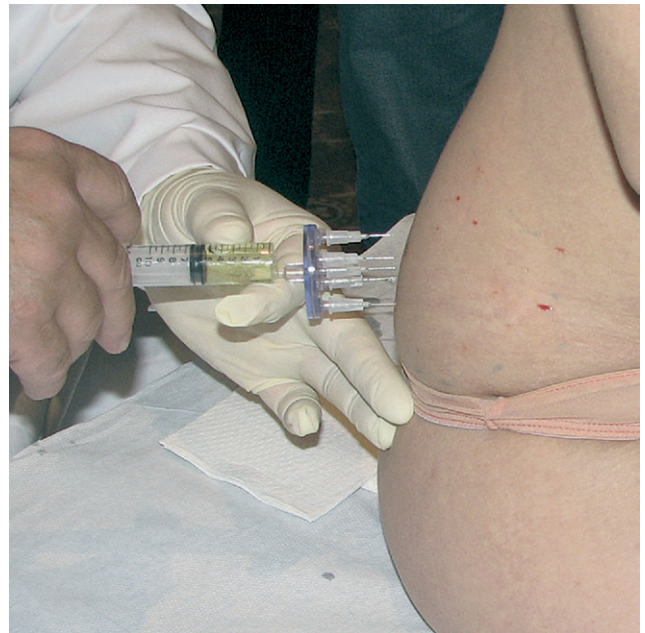


Figure 8 Injection device for Lipodissolve. (Courtesy of Dr. Dirk Brandl.) (Color version of figure is available online.)

case study of 43 patients with 117 injection sites.³⁷ Thirty percent of patients reported dramatic improvement, while 67% of patients reported mild to moderate improvement in treated areas.

Controversy exists as to which of the 2 agents is the active ingredient for lipolysis. Although initial studies reported phosphatidylcholine as the active agent, some authors produced similar clinical efficacy with deoxycholate alone.⁴⁵ Small case series by both Rotunda and Odo using deoxycholate alone have demonstrated clinical efficacy in lipolysis.^{45,46} Salti and coworkers⁴⁷ performed a double-blinded randomized side-by-side comparison of combined phosphatidylcholine/deoxycholate solution injections to deoxycholate injections alone in 37 patients. A reduction of fat was observed in 92% of all patients with no statistically significant difference between treatment side.

Experts in the injection lipolysis field report a 4 cm reduction in abdominal circumference per session is attainable in trained hands.⁴¹ Approximately 72% of patients require at least 2 sessions for satisfactory results.⁴¹ Soft fat deposits seem to respond better than more fibrous areas.⁴² Use of Lipodissolve in the lower eyelid fat pad, a technique developed by Dr. Rittes,⁴⁸ is no longer endorsed by Network Lipolysis due to concerns of ocular complications such as retroorbital bleeding and infection.⁴⁴

Expected side effects of chemical lipolysis injection include localized pain, erythema, edema, pruritus, and warmth. Pain is usually mild and well tolerated; analgesics are seldom required.³⁶ Pain is correlated with the concentration of deoxycholate.⁴⁵ Immediate injection pain can be alleviated by mixing lidocaine with the chemical lipolysis solution.⁴⁵ Rare side effects include hematoma formation, hives, infection, injection site hyperpigmentation, and a slight cholinergic response including increased or watery stools.^{37,42}

It must be emphasized that only trained professionals⁴⁴ should perform chemical lipolysis and extensive patient counseling must take place before treatment. Lipostabil N, phosphatidylcholine, and deoxycholate are not Food and Drug Administration-approved in the U.S for chemical lipolysis. Lipostabil N is approved in Europe for the treatment of coronary atherosclerosis, while phosphatidylcholine is used in the U.S. as a surfactant for treating premature neonates with pulmonary immaturity.³⁷ Off-label use in the United States requires special compounding by pharmacies.⁴⁹ Because no standard formulation exists, additives in the compounding process such as prescription medications, herbal extracts, vitamins and minerals⁵⁰ may cause an anaphylactic reaction. Serious complications such as skin necrosis have occurred in the hands of untrained or unskilled professionals, but a recent retrospective study found no cases of skin necrosis in over 17,000 patients.⁴² Although chemical lipolysis may show some promise in treating localized fat deposits, large, randomized placebo-controlled trials are needed to determine the safety and efficacy of this procedure. The American Society for Dermatologic Surgery (ASDS) cautions physicians performing chemical lipolysis to evaluate the risk of medical liability and to communicate with their insurance carrier.⁵⁰ The ASDS states “further study is warranted before this technique [chemical lipolysis] can be endorsed.”⁵⁰

Conclusion

In 2006, liposuction was the most common cosmetic surgery performed in the United States.⁵¹ As the American epidemic of obesity and the public's demand for liposuction continues to rise, so does the interest in new technology and techniques to improve the efficacy and safety of these body sculpting procedures. Power-assisted, ultrasound-assisted, and laser-assisted liposuction devices are designed to facilitate fat removal while reducing the workload of the surgeon. They are ideal for large volume cases or in areas of fibrous fat. In contrast, Lipodissolve is best suited for use in small areas of loose adipose tissue. As with any new technique, a learning curve is associated with adapting each method. With more sophisticated equipment, costs also increase for each procedure. Traditional blunt suction-assisted lipoplasty under tumescent anesthesia has proven during the past 2 decades to be a safe and effective method for body sculpting. New advances in lipoplasty have provided many options for surgeons. While the techniques outlined above have demonstrated in small series to have similar complication rates as traditional liposuction, more rigorous studies are needed to demonstrate their safety and efficacy. The choice of the ideal technique always depends on the surgeon's expertise and preference.

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