

# Laser-Assisted Liposuction: Here's the Skinny

Eric C. Parlette, MD<sup>\*,†</sup> and Michael E. Kaminer, MD<sup>†,‡</sup>

Liposuction is one of the most popular cosmetic procedures. The advent of laser-assisted liposuction is the next evolutionary step in the market of body contouring. The goal of laser-assisted liposuction is to facilitate liposuctioning, enhance tissue tightening, and reduce downtime and morbidity. Several different protocols using different devices and wavelengths generate variable results. Current laser-assisted lipolysis technology and techniques are reviewed with respective expectations. As laser lipolysis technology and coinciding experience grow, so will the ability to achieve the aims of more efficient, safer, and cosmetically pleasing body sculpting.

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The demand for cosmetic procedures is expanding as a result of the multitude of cosmetic procedures that are easily performed in office settings with great efficacy, little downtime, and low morbidity. The attraction toward more invasive procedures has decreased. Patients' expectations coincide with this changing market. Concern has been voiced regarding a relative decrease in interest in liposuction compared with simpler, quicker cosmetic procedures. Nonetheless, liposuction continues to be one of the most popular cosmetic procedures because it remains the gold standard for body contouring and sculpting. Liposuction was reported as the most common surgical cosmetic procedure by the 2007 Cosmetic Surgery National Data Bank Statistics.<sup>1</sup>

Laser-assisted lipolysis is the wave of the future for liposuction, liposculpting, and tissue tightening. Laser-assisted liposuction is meant to facilitate and enhance the results of standard liposuction. Laser-adipose tissue interactions have been studied since the early 1990s.<sup>2</sup> Laser lipolysis is reported to increase safety, facilitate suctioning, reduce patient discomfort, enhance tissue response, and reduce recovery time.<sup>2,3</sup>

## Background

Body contouring with fat removal was first reported in 1921 by Duiarrier by using curettage.<sup>4</sup> Liposculpting has evolved

dramatically during the past several decades, with many innovations being introduced that have greatly improved efficacy and safety.<sup>4</sup> The advent of tumescent anesthesia for liposuction has greatly improved the safety profile of liposuction.<sup>4</sup> The tumescent technique eliminates the need for general anesthesia and hospital stays and reduces the risk of bleeding complications. Lidocaine can be safely used in doses of 35 mg/kg with the tumescent technique.<sup>4</sup> Very precise amounts of epinephrine (recommended not to exceed 0.7 mg/kg) in the tumescent solution help to constrict the microvasculature in addition to the tamponading effects of the large volumes of solution.<sup>4</sup>

Liposuction has many indications including body sculpting, breast reduction, axillary hyperhidrosis amelioration, lipoma removal, and removal of isolated genetic fat accumulations. Many mechanical adjuncts to routine liposuction have been used during the past decade such as ultrasound-assisted liposuction (both internal and external), power-assisted liposuction, vibroliposuction, and laser-assisted liposuction.<sup>4,5</sup> Carbon dioxide lasers have been used after traditional liposuction for subdermal tissue tightening of the neck.<sup>2</sup> This procedure has both safety and cosmetic limitations with a large resulting submental scar.<sup>2</sup> A 635-nm diode laser has been used with a transcutaneous application before liposuction to liquefy fat.<sup>2</sup> The results have been debatable.<sup>2</sup>

Current laser-assisted liposuction is designed to provide more selective adipose damage, facilitate fat removal, enhance hemostasis, and increase tissue tightening. There are multiple wavelengths that have recently been studied (Table 1). The various wavelengths for laser-assisted liposuction have been selected based on the theory of selective photothermolysis. The goals of laser lipolysis are:

1. The heating of adipocytes to cause increased liquefaction.

\*Uniformed Services University of Health Sciences, Dermatology Associates, Winchester, MA.

†Skin Care Physicians, Chestnut Hill, MA.

‡Yale University School of Medicine, Cutaneous Oncology, Department of Dermatology, New Haven, Conn. and Dartmouth Medical School, Department of Medicine (Dermatology), Hanover, NH.

Address reprint requests and correspondence to: Eric C. Parlette, MD, 99 Needham Street, #1304, Newton, MA 02461. E-mail: [ecparlette@hotmail.com](mailto:ecparlette@hotmail.com).

**Table 1** Laser-Assisted Liposuction Devices

Laser	System	Wavelength	Pulse Output (Max)	Rep Rate (Max)
SlimLipo	Diode	924 975	30 W	Continuous
LipoLite: Syneron	Nd:YAG	1064 nm	12 W	50 Hz
SmartLipo: Cynosure	Nd:YAG	1064	10 W	40 Hz
SmartLipo MPX: Cynosure	Nd:YAG	1064 nm/1320 nm	20 W/12 W	40 Hz
ProLipo: Sciton	Nd:YAG	1064 nm 1319 nm	25 W	50 Hz
CoolLipo: CoolTouch	Nd:YAG	1320 nm	15 W	50 Hz

2. The heating of adipocytes to disrupt their membrane and allow extracellular drainage and facilitated suctioning.
3. The heating of collagenous fibrous septae and reticular dermis for enhanced tissue tightening.
4. The heating of microvasculature to improve hemostasis, reduce postoperative bleeding, and shortened recovery time.

The effects of laser-assisted lipolysis are caused by photo-thermal energy. The laser light is converted to heat energy in the fat, collagenous tissues (water), and hemoglobin. Denaturation of structural proteins has been shown to occur between 40 and 45°C.<sup>6</sup> Histologic evaluation has demonstrated adipocyte tumefaction, lysis, and liquefaction, which all increase with increasing energy and temperatures.<sup>7</sup> The near infrared laser has been shown to effectively destroy human adipocytes with cytoplasmic retraction and disruption of membranes.<sup>7,8</sup> Greater lysis and liquefaction facilitates subsequent liposuction. Denaturation of structural proteins in the collagenous fibrous septae and reticular dermis should theoretically stimulate collagen remodeling with tissue tightening.

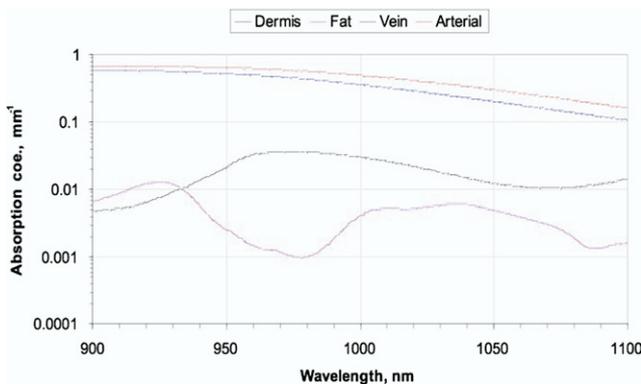
The different wavelengths have varying absorption coefficients for fat, water, and hemoglobin (Fig. 1). Fat contains approximately 14% water. Collagen is approximately 60% to 70% water. Appropriate laser selection allows preferential targeting of fat and/or water (collagen). The highest ratio of fat:dermal light absorption affords the highest selectivity for fat melting as is seen with the 924-nm diode (Table 2). Greater light absorption in the fat directs the focus of energy

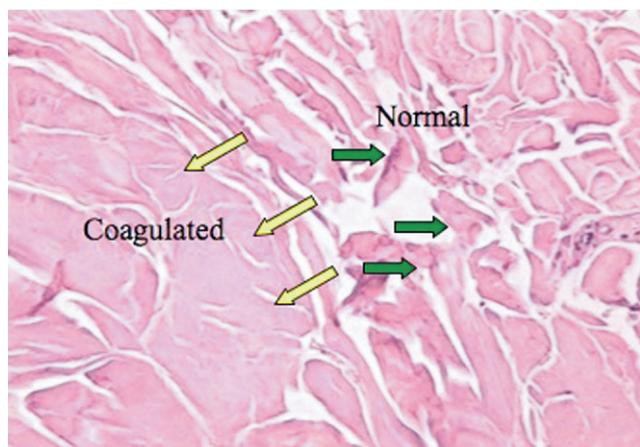
and heating to the adipose tissue. Thereby, the collateral thermal diffusion will be more limited to the fibrous, collagenous septae of the adipose tissue and to the deep reticular dermis. This may equate to safer collagen heating with less risk of collateral damage. Additionally, with greater liquefaction of fat before suctioning, less vigorous mechanical suctioning is necessary. Thereby, more fibrous septae remain intact with maintenance of the collagenous scaffolding. The intact septae, when heated by the laser, will increase tissue retraction.

Multiple laser systems exist for laser-assisted liposuction. Current technology uses small, 1- to 2-mm optical fibers inserted through small cannulas to transmit the laser into the subcutaneous tissue (Fig. 2).<sup>5</sup> The 924 nm has the highest fat absorption with less collagen heating. There may be better fat melting but less tissue tightening unless used in combination with another wavelength, ie, 970 nm. The 1064-nm laser has good tissue penetration and scatter with relatively low fat absorption, allowing broader tissue heating.<sup>6</sup> The 1320-nm laser has greater fat absorption with less tissue penetration and scatter, so there is less collateral heat transfer and may therefore be preferable when treating around vital areas and thinner skin, ie, neck.<sup>6,9</sup> Heat diffusion induces collagen injury and remodeling with subsequent tissue tightening (Fig. 3).<sup>3</sup> Lower dermal temperatures of 48 to 50°C are adequate to induce tissue tightening.<sup>3</sup> At these temperatures, the

**Table 2** Absorption Coefficient of Different Wavelengths for Dermis and Fat

Wavelength	Dermis	Human Fat	Fat/Dermis Ratio
924 nm	0.084	0.177	2.102
968 nm	0.367	0.046	0.127
1064 nm	0.082	0.059	0.721
1344 nm	2.068	0.086	0.041

**Figure 1** Absorption coefficients for dermis, fat, and hemoglobin.**Figure 2** Fiber-optic laser with insertion cannula (figure courtesy of Palomar).



**Figure 3** Coagulated collagen in deep reticular dermis following laser lipolysis (figure courtesy of Palomar).

skin surface will reach about 41°C.<sup>3</sup> Clinical correlation of these theories remains highly variable among reported results.<sup>6,10</sup>

Laser-assisted lipolysis affords increased hemostasis.<sup>6</sup> The near infrared wavelengths are known to have fairly good absorption by hemoglobin thereby improving hemostasis with the use of laser-assisted liposuction. The 1320 nm laser converts hemoglobin to methemoglobin. The 1064-nm laser

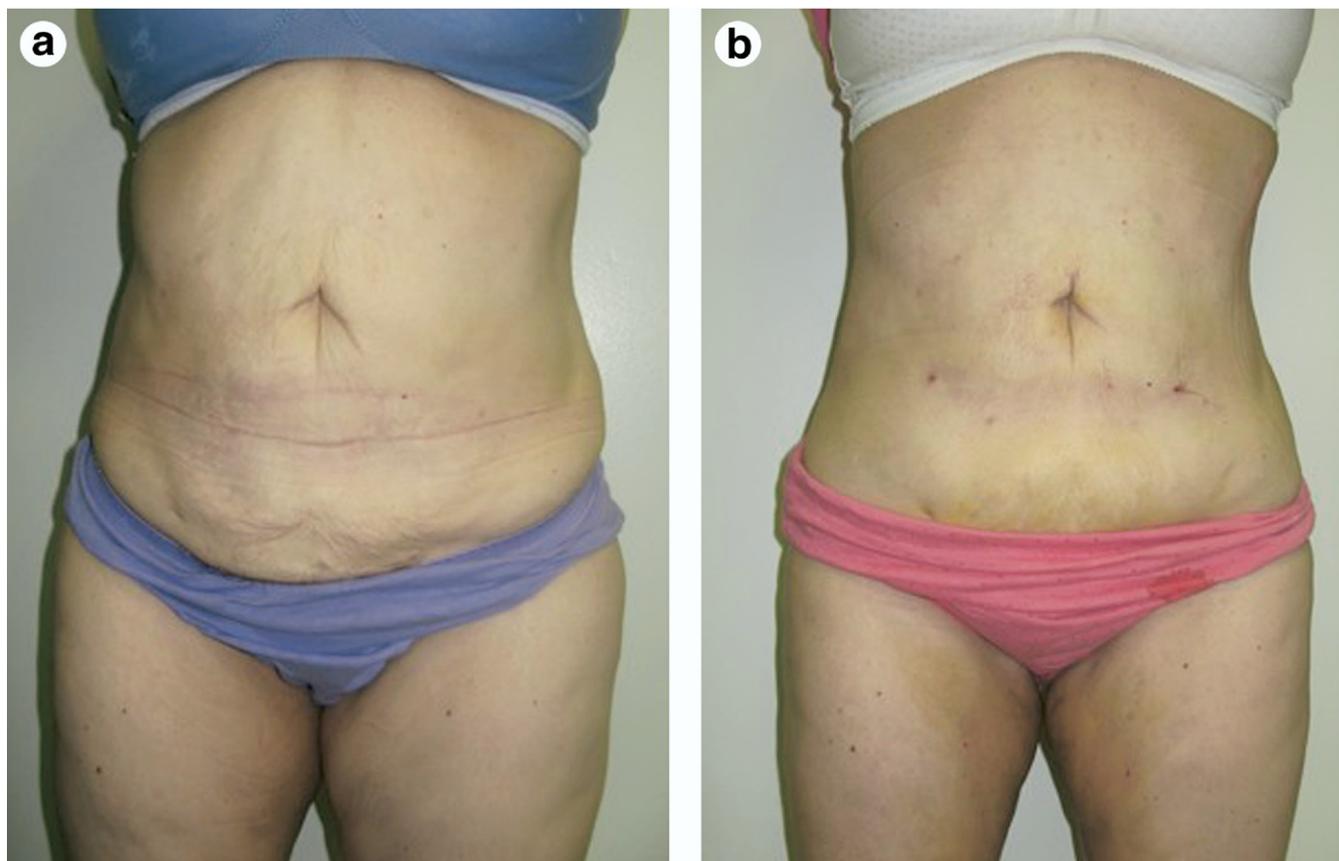
has 3 to 5 times greater absorption by methemoglobin, further enhancing hemostasis with the synergistic 1064 nm/1320 nm unit.<sup>6</sup>

## Clinical Applications

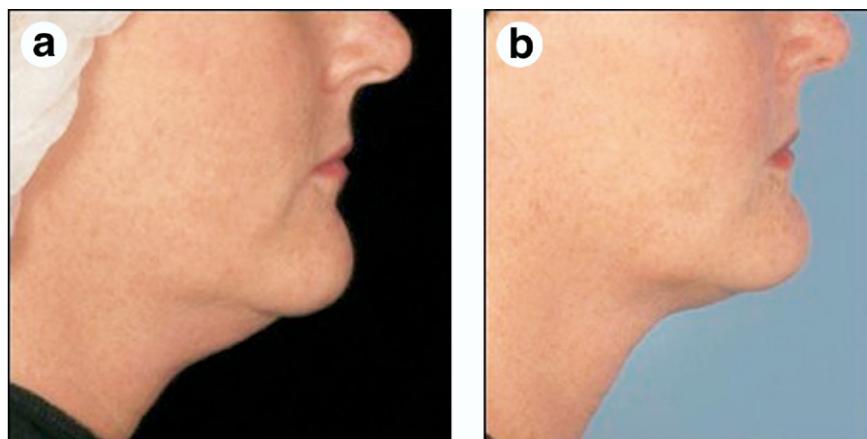
Laser-assisted lipolysis can be used either exclusively or as an adjunct to standard liposuction. The procedure may be performed before or after suctioning depending on the anatomic treatment site, the desired effect of the laser, and the specific laser used.

The perioperative procedures and protocol for laser-assisted liposuction are very similar to traditional tumescent liposuction. The patient is marked out for liposuction and specific areas to be targeted with the laser, whether it be fibrous areas which are more difficult to suction or more flaccid skin for enhanced tightening. The patient is anesthetized locally with the standard tumescent formulation. Standard cannula approach sites are incised to allow optimal access to the treatment areas. Great care must be taken to assure that every person in the operating room, including the patient, is wearing the appropriate laser safety goggles.

Laser-assisted liposuction techniques continue to evolve as different devices and wavelengths are introduced. During initial studies in which we used 1064-nm and 1320-nm lasers, we performed laser lipolysis before suctioning. The laser



**Figure 4** (a) Before laser lipolysis. (b) 5 days after laser lipolysis of the abdomen and inner thighs using the Palomar SlimLipo. (Photos courtesy of Neil Goodman, MD, and Palomar.)



**Figure 5** (a) Before laser lipolysis. (b) 3 months after laser lipolysis of the neck using the Palomar SlimLipo. Photos courtesy of Robert Weiss, MD, and Palomar.)

did not seem to facilitate the subsequent suctioning. As a result, we now perform liposuction and fine liposculpting before the laser lipolysis. We then use the laser as an adjunct to treat special need areas such as more flaccid skin regions and more fibrous fatty areas.<sup>11</sup> The areas we most commonly treat are the inner thighs, periumbilical region, upper abdomen, posterior arms, breasts, and neck. Approximately 4000 to 5000 J per 100 cm<sup>3</sup> are administered to focus areas. The addition of the 1320-nm wavelength greatly increases the energy absorption by the collagen and may thereby improve tissue tightening. The addition of laser with the set-up time and treatment time does prolong the duration of surgery considerably. Noticeable treatment results may be gradual over the course of several months.<sup>3</sup> The added benefits of laser are highly variable between studies, ranging from significant enhancement to no difference from liposuction alone.<sup>2,10</sup>

Studies with the 924 nm/970-nm diode laser system show greatest results with laser lipolysis before gentle postlaser suctioning (R.A. Weiss, unpublished data, 2009). The 924-nm laser has very high fat specificity, which results in much more effective fat liquefaction than other wavelengths. More gentle suctioning of liquefied fat is all that has been necessary after laser lipolysis with the 924-nm diode. When the 924-/970-nm diode is used, the procedure time is not significantly different than traditional liposuction. Additionally, the recovery time has been considerably shorter with significantly less bruising, presumably because of a combination of laser hemostasis and a reduced need for harsh mechanical liposuctioning (Fig. 4a and 4b). The 924-nm diode is combined with the 970-nm diode which has high collagen selectivity promoting enhanced tissue tightening. Less need for harsh mechanical suctioning reduces disruption of adipose fibrous bands and septae, offering collagenous scaffolding for heating and secondary tissue contraction. This explains the excellent tissue tightening encountered with the 924-nm/970-nm laser lipolysis (Fig. 5a and 5b).

Laser-assisted lipolysis can improve the safety of liposuction by reducing bleeding. Proper understanding of the laser systems is necessary to reduce the associated risks of the laser. Thermal skin damage can occur if energy is delivered

imperfectly or too highly concentrated.<sup>11</sup> By liquefying fat, concern arises regarding free circulating lipids. Goldman and coworkers<sup>12</sup> reported no increase of circulating triglycerides or cholesterol following laser-assisted lipolysis with the 1064 nm laser. Subsequent evaluation by Prado and coworkers<sup>10</sup> demonstrated the possible risk of increased circulating triglycerides and free fatty acids if the fat emulsification is not aspirated after large areas of laser lipolysis.<sup>10</sup> This may affect hepatic and renal function. For treatment of large areas, suctioning may be prudent, but further studies are needed. Despite arguments regarding efficacy, it is agreed that the laser-assisted liposuction is less painful than liposuction alone.<sup>10</sup> Disadvantages of laser-assisted liposuction include the cost of the laser and the necessary training time. Treatment time may lengthen with the use of laser-assisted lipolysis.<sup>2,10</sup> The ability to achieve the desired level of tightening and facilitate suctioning has varied among reports and devices. Furthermore, laser may make the fat unusable for fat transplantation.<sup>5</sup>

Laser-assisted lipolysis is a rapidly expanding field of interest. Its potential may be enormous and could radically change the paradigm of liposculpture. As experience and technology grow together, efficacy and safety will likely become less and less operator dependent.

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