

# Laser-Assisted Liposuction for Facial and Body Contouring and Tissue Tightening: A 2-Year Experience With 75 Consecutive Patients

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Internal liposuction remains the standard and most reliable method to remove fat and contour the face and body. The recent introduction (2006 FDA clearance) of a higher and more controlled energized internal laser system is purported to increase tissue contraction and damage unwanted fat deposits through dual 1064 nm/1320-nm wavelengths that are initially used at a deep level of subcutaneous fat, and subsequently at a shallow level beneath the dermis along with liposuction. Using classical principles of selective photothermolysis, the sequential exposure of these wavelengths on target tissue chromophores results in selective thermo-lipolysis and thermo-denaturation of collagen fibers (H<sub>2</sub>O) within the septal architecture and lower reticular dermis for enhanced skin retraction (accommodation) and contraction. This article reviews this innovative laser system, discusses the latest clinical protocol changes, tabulates the measurements of time and energy during each phase of treatment and temperature endpoints, and correlates the histologic findings to energy deposition. The collected objective data are used to improve on the safety and efficacy treatment profiles at 11 sites in 75 consecutive patients. Further clinical studies and comparative trials are recommended to validate these outcomes.

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Classical photothermolysis<sup>1</sup> with various wavelengths (924-10,600 nm) by internal laser-assisted liposuction (iLAL) is based on both selective thermo-lipolysis and controlled thermo-denaturation of collagen (H<sub>2</sub>O) within the subdermal septae and lower reticular dermis. Considerable clinical experience with this type of energized liposuction has demonstrated the following: (1) disruption and liquefaction of fatty tissue,<sup>2-6</sup> (2) coagulation of small blood and lymphatic vessels,<sup>2-4</sup> (3) induction of collagenesis with remodeling,<sup>2,3</sup> and (4) promotion of tissue tightening by clinical evaluation after thermal injury.<sup>6-8</sup> Despite the practice of sound laser principles and accumulation of isolated notable clinical outcomes, iLAL has not been readily accepted because of undistinguished and unproven advantages over previous liposuction methods.<sup>5,9-11</sup>

Indeed, the singular benefit of using laser energy subdermally during liposuction may reside in its ability to facilitate production, remodeling, and tissue tightening of collagen fibers rather than damaging fat cells. All liposuction devices remove lipocytes and cellular debris. In contrast, only certain liposuction systems, such as laser-assisted devices, incorporate thermal energy to stimulate cascades of photobiologic responses to the subdermis and skin.<sup>12</sup> Numerous clinical, experimental, and histologic publications have reported that *external* application of 1064 nm<sup>13-19</sup> and 1320 nm<sup>20-30</sup> wavelengths on skin can lead to increased fibroblast numbers, new collagen synthesis and reorganization, and greater tissue tightening and elasticity. A few *external* laser lipolysis studies<sup>31,32</sup> have offered even claims of fat destruction by application of 1064 nm/1320 nm neodymium-doped yttrium aluminium garnet wavelengths, but these findings remain controversial.<sup>33,34</sup> Until further optimization of laser penetration and absorption through the skin is achieved,<sup>35,36</sup> *internal* laser exposure remains the most effective, reliable, and safe method to perform laser-assisted lipolysis.

Currently, few iLAL devices provide multiple wavelengths that can be fired separately or sequentially, distributing energy in a dose-dependent relationship to receptive chromophores for optimal thermal damage. Recently, an upgraded dual wave-

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**Table 1** Absorption Profiles of Individual and Combine Wavelengths<sup>38-40</sup>

Wavelengths	Fatty Tissue*	Water (Collagen)*	Hemoglobin*
1064 nm	1	1	1
1320 nm	5.9	11.5	0.1
Blend 1 (1:1) 1064 equal to 1320	3.5	6.3	0.6
Blend 2 (1:5:1) 1.5× more 1064 than 1320	3.0	5.2	0.6
Blend 3 (2:1) 2× more 1064 than 1320	2.6	4.5	0.7

\*The absorption units of thermal energy of the 1032-nm wavelength and ratios of 1064 nm:1320-nm wavelengths by tissue chromophores were compared with values obtained with the 1064-nm wavelength.

length device has demonstrated its potential to deliver increased tissue tightening and lipolysis.<sup>37</sup> This article discusses the protocols, histologic findings, clinical results, and complications with this new generation laser system.

## Laser System

Since the introduction of the single wavelength 1064 nm 6 W neodymium-doped yttrium aluminium garnet Smartlipo system (Cynosure Inc., Westford, MA, 2006 FDA clearance), the workstation has undergone developmental changes to emit a second 1320-nm wavelength (FDA clearance 2008). The 1064-nm wavelength has a 3-5 times greater absorption profile for methemoglobin, less affinity to water, but possesses a relatively higher depth of penetration and more diffuse distribution of energy than the 1320-nm wavelength. In contrast, the 1320-nm wavelength exhibits a higher absorption profile in fat and water, with significantly more localized and concentrated heating than that observed with the 1064-nm wavelength. This enhanced Smartlipo MPX platform allows each pulsed wavelength to be fired alone, or more ideally in succession at 40 Hz, to achieve maximum benefit and effec-

tiveness than that obtained normally from each wavelength alone. The consequent use of 3 ratios of the 1064 and 1320 nm wavelengths, as well as the 2 individual wavelengths, permits physicians the opportunity to select 5 different photoabsorption thermal profiles that can be delivered within fatty tissue, water (collagen fibers), and hemoglobin (Table 1). In the multiplexing mode, the "blended" delivery increased power and speed, provided more uniform distribution of energy, and improved regulation of temperature and heat profiles for faster emulsification of fat and more controlled dermal and subdermal tissue tightening and coagulation. By increasing the contribution of the 1064 nm over 1320 nm in Blend 3, for example, a more diffuse and uniform delivery and distribution of laser energy (heat) is obtained primarily for the deeper subcutaneous layer, targeting fatty tissue, intracellular water, and hemoglobin. In contrast, after equalizing the contributions of 1320 nm over 1064 nm in Blend 1 mode, a more concentrated and higher amount of laser energy can be delivered to the immediate subdermal tissue (<5 mm under the dermis), focusing on fatty tissues and water (collagen) for eventual tissue tightening and redistribution. In 2009, power was increased for both the 20 W 1064 nm and 12 W 1320-nm wavelengths to 30 and 16 W, respectively, allowing a maximum of 46 W of total power.

Safe management of the increased thermal capabilities and variable temperature profiles by dual wavelengths during MPX treatments led to the development of 2 feedback mechanisms to harness that energy. In 2007, a motion-sensing delivery system was incorporated into the hand piece, using an advanced microchip, called an accelerometer, which measured the movement of the hand piece and determined the appropriate energy delivered, based on the motion sensitivity rating at 3 separate control option settings. As the surgeon decelerated the reciprocating movement of the hand piece, the amount of laser energy was reduced automatically to ensure a safe level of power distribution. When the hand piece was motionless, the laser system was shut off within 0.2 seconds to prevent uneven focal heating.

In 2009, a temperature sensor was attached 1 cm from the distal tip of the cannula, creating a (ThermaGuide, Cynosure Inc., Westford, MA) that tracked continuous tissue temper-

**Table 2** Current Protocol

Phase 1. Tumescence Anesthesia 50-100 cc/5 × 5 cm <sup>2</sup>					
Phase 2. Deep MPX					
Average energy (J) 5 × 5 cm <sup>2</sup>					
All body	1064 nm	1320 nm	Pre-jowl, neck, upper inner thigh, knee	1064 nm	1320 nm
	30 W	15 W		20 W	10 W
	Blend 3			Blend 3	
	2-3000 J/5 × 5 cm <sup>2</sup>			1-2000 J/5 × 5 cm <sup>2</sup>	
Phase 3. Liposuction (superficial and deep fat layers)					
Phase 4. Shallow MPX					
Average energy (J) 5 × 5 cm <sup>2</sup>					
All body	1064 nm	1320 nm	Pre-jowl, neck, upper inner thigh, knee	1064 nm	1320 nm
	10-15 W	10-15 W		6-10 W	6-10 W
	Blend 1			Blend 1	
	≈400-1000 J/5 × 5 cm <sup>2</sup>			≈400-600 J/5 × 5 cm <sup>2</sup>	

**Table 3 Patient Demographic Data**

<b>75 Patients (69 females; 6 males)</b>
<b>Average age: 50.0 (range, 21-72 years)</b>
<b>Average height: 65 in (range, 59-70 in)</b>
<b>Average weight: 145.1 lbs (range, 110-225 lbs)</b>
<b>Average BMI: 24.9 kg/m<sup>2</sup> (range, 19.5-36.5 kg/m<sup>2</sup>)</b>
<b>Average body fat: 32.7% (range, 17.0%-40.3%)</b>

atures which were displayed on the panel screen. When the recommended target temperature was attained, an audible signal was triggered. If the surrounding tissue temperatures exceeded the preset threshold level, the laser automatically was shut down for safer and more uniform treatment. A previous clinical study<sup>37</sup> with the ThermaGuide cannula recommended temperature guidelines between 55 and 60°C for ideal lipolysis of deeper fatty tissue and between 45 and 50°C that reflected surface temperatures of 38-42°C for optimal skin tightening. Predictable endpoint skin temperature monitoring was captured real time with a visual color map by a thermal infrared imaging system (FLIR ThermaView E45, Niceville, FL) to ensure skin safety and to induce tissue tightening. A hand-held infrared noncontact thermometer (MiniTemp MT6, Raytek Corporation, Santa Cruz, CA) was used simultaneously with the ThermaView to measure rapidly surface skin temperatures by spot-checking a site within the 5 × 5 cm<sup>2</sup> throughout laser treatments.

## Clinical Protocol

iLAL treatments were indicated for patients with moderate collections of adiposity and mild-to-moderate degrees of skin laxity. Patient exclusion criteria included pregnancy and uncontrolled diabetes mellitus, collagen disorders, cardiovascular diseases, and bleeding disorders. Standardized digital photography, weight, height, percent body fat, and body mass index were obtained before surgery. With the patient in the upright position, each treatment site was marked into 5 × 5 cm<sup>2</sup>. Patients were offered preoperative medication for pain and sedation and received antibiotic coverage for 5 days.

One patient consented for tissue punch biopsies during phases of her laser-assisted liposuction surgery to determine microscopic changes from deep and shallow laser injury. Samples were fixed in 10% formaldehyde-buffered solution, paraffin embedded, sectioned at 4-5 μm, and stained with hematoxylin-eosin stains. The pathologist interpreted the microscopic findings in each specimen without knowledge of the treatment phase.

Buffered 0.5% lidocaine with (1:200,000) epinephrine was administered above fascial levels within each site for preliminary pain relief. In phase 1, 50-100 mL of tumescent

solution (500 mg lidocaine, 1 mg epinephrine, 20 mL, 8.4% sodium bicarbonate, 1000 mL normal saline) was infiltrated into the deep and superficial layers of fat within each 5 × 5 cm<sup>2</sup>, adhering to the superwet technique, defined as infiltration-to-aspiration ratios of about 1:1.5 (Table 2). During the subsequent phases of laser activation within the tissues, both patient and surgical personnel were protected with special eyeglasses. In phase 2, deep MPX Blend 3 treatment delivered between 1000 and 2000 J per square in the neck, upper inner thighs and knees (20 W 1064 nm/10 W 1320 nm) and between 2000-3000 J per square in the remainder of the body sites (30 W 1064 nm/15 W 1320 nm) within the deep layer of subcutaneous fat, using either a 600 or 1000 μm optical fiber within a stainless steel microcannula. The 1000 μm fiber was not recommended for usage in the face and neck because of greater release of heat energy. The diffuse reddish tone of the helium–neon transilluminated light through the skin and indicated the desired depth for laser lipolysis. In phase 3, liposuction with multifenestrated 2.4-4.0 mm cannulas removed the liquefied fat and tissue debris under a vacuum pressure of 450-500 cm Hg, allowing immediate contour assessment and creating an evacuated environment that facilitated rapid elevation of threshold subdermal temperatures during the subsequent shallow lasering phase. In phase 4, shallow MPX Blend 1 treatment was distributed approximately between 400 and 600 J per square in the prejowl/neck, upper inner thighs, and knees (6-10 W 1064 nm/6-10 W 1320 nm) and about 400-1000 J per square in the remainder of the body sites (10-15 W 1064 nm/10-15 W 1320 nm). The optimal thermal injury was confined within the upper layer of the subcutaneous fat (5 mm from the dermis; brighter and concentrated helium–neon glow), monitored by the ThermaGuide and the ThermaView systems, achieving skin surface temperature endpoints between 38°C and 42°C. When surface temperatures returned to baseline levels, a second shallow MPX treatment was repeated to each square to raise the probability of enhanced tissue tightening from additional controlled thermal injury. Whenever skin temperature rose above 43°C (47°C = epidermolysis/necrosis), cold compresses were applied immediately to the hot spots to return temperatures to the desired levels. Temporary ¼ in drains were inserted into dependent sites and removed within 1-2 days. Compression garments with sponge inserts were applied for 2-3 weeks, after which a series of weekly external ultrasound treatments were given to reduce irregularities and swelling.

## Patients

Since 2008, 75 consecutive patients underwent dual plane laser lipolysis based on their demographics and presence of localized lipodystrophy associated with mild-to-moderate skin laxity

**Table 4 Distribution of iLAL Sites in 75 Patients**

Sites	Number	Sites	Number	Sites	Number	Sites	Number
Jowls/neck	21	Brassiere rolls	7	Abdomens	30	Anterior/Posterior thighs	11
Brachii	8	Lumbar rolls	8	Saddle bags	4	Knees	3
Axillary rolls	5	Hip rolls	12	Upper inner thighs	6		

Table 5 Phase Measurements of MPX Treatments in 75 Patients

Sites	Average No. 5 × 5 cm <sup>2</sup>	min/5 × 5 cm <sup>2</sup>	Tumes.	Blend 3	SAL/5 × 5 cm <sup>2</sup> min/5 × 5 cm <sup>2</sup>	Blend 1
			Vol/5 × 5 cm <sup>2</sup> min/5 × 5 cm <sup>2</sup>	Joules/5 × 5 cm <sup>2</sup> min/5 × 5 cm <sup>2</sup>		Joules/5 × 5 cm <sup>2</sup> min/5 × 5 cm <sup>2</sup> Temperature: 38°
Jowls/Neck	6	8.2 min/5 × 5 cm <sup>2</sup>	32 mL/5 × 5 cm <sup>2</sup> 2.5 min/5 × 5 cm <sup>2</sup>	2000 J/5 × 5 cm <sup>2</sup> 2.5 min/5 × 5 cm <sup>2</sup>	25 mL/5 × 5 cm <sup>2</sup> 1.8 min/5 × 5 cm <sup>2</sup>	400 J/5 × 5 cm <sup>2</sup> 1.3 min/5 × 5 cm <sup>2</sup>
Brachia	8 (Bilateral)	7.5 min/5 × 5 cm <sup>2</sup>	55 mL/5 × 5 cm <sup>2</sup> 1.7 min/5 × 5 cm <sup>2</sup>	2500 J/5 × 5 cm <sup>2</sup> 2.8 min/5 × 5 cm <sup>2</sup>	50 mL/5 × 5 cm <sup>2</sup> 1.6 min/5 × 5 cm <sup>2</sup>	678 J/5 × 5 cm <sup>2</sup> 1.7 min/5 × 5 cm <sup>2</sup>
Axillary rolls	8 (Bilateral)	6.8 min/5 × 5 cm <sup>2</sup>	60 mL/5 × 5 cm <sup>2</sup> 1.6 min/5 × 5 cm <sup>2</sup>	3000 J/5 × 5 cm <sup>2</sup> 2.3 min/5 × 5 cm <sup>2</sup>	40 mL/5 × 5 cm <sup>2</sup> 1.6 min/5 × 5 cm <sup>2</sup>	700 J/5 × 5 cm <sup>2</sup> 1.5 min/5 × 5 cm <sup>2</sup>
Brazier rolls	8 (Bilateral)	6.5 min/5 × 5 cm <sup>2</sup>	50 mL/5 × 5 cm <sup>2</sup> 1.8 min/5 × 5 cm <sup>2</sup>	2500 J/5 × 5 cm <sup>2</sup> 2.3 min/5 × 5 cm <sup>2</sup>	40 mL/5 × 5 cm <sup>2</sup> 1.2 min/5 × 5 cm <sup>2</sup>	740 J/5 × 5 cm <sup>2</sup> 1.2 min/5 × 5 cm <sup>2</sup>
Lumbar rolls	8 (Bilateral)	6.4 min/5 × 5 cm <sup>2</sup>	54 mL/5 × 5 cm <sup>2</sup> 1.5 min/5 × 5 cm <sup>2</sup>	3000 J/5 × 5 cm <sup>2</sup> 1.9 min/5 × 5 cm <sup>2</sup>	78 mL/5 × 5 cm <sup>2</sup> 1.8 min/5 × 5 cm <sup>2</sup>	655 J/5 × 5 cm <sup>2</sup> 1.2 min/5 × 5 cm <sup>2</sup>
Hip rolls	8 (Bilateral)	7.6 min/5 × 5 cm <sup>2</sup>	60 mL/5 × 5 cm <sup>2</sup> 1.6 min/5 × 5 cm <sup>2</sup>	3000 J/5 × 5 cm <sup>2</sup> 2.3 min/5 × 5 cm <sup>2</sup>	85 mL/5 × 5 cm <sup>2</sup> 1.9 min/5 × 5 cm <sup>2</sup>	939 J/5 × 5 cm <sup>2</sup> 1.8 min/5 × 5 cm <sup>2</sup>
Abdomen	28	6.3 min/5 × 5 cm <sup>2</sup>	75 mL/5 × 5 cm <sup>2</sup> 1.8 min/5 × 5 cm <sup>2</sup>	3000 J/5 × 5 cm <sup>2</sup> 1.8 min/5 × 5 cm <sup>2</sup>	85 mL/5 × 5 cm <sup>2</sup> 1.9 min/5 × 5 cm <sup>2</sup>	900 J/5 × 5 cm <sup>2</sup> 1.3 min/5 × 5 cm <sup>2</sup>
Saddle bags	8 (Bilateral)	4.8 min/5 × 5 cm <sup>2</sup>	40 mL/5 × 5 cm <sup>2</sup> 1.3 min/5 × 5 cm <sup>2</sup>	2000 J/5 × 5 cm <sup>2</sup> 1.3 min/5 × 5 cm <sup>2</sup>	35 mL/5 × 5 cm <sup>2</sup> 1.1 min/5 × 5 cm <sup>2</sup>	513 J/5 × 5 cm <sup>2</sup> 1.1 min/5 × 5 cm <sup>2</sup>
Upper inner thigh	10 (Bilateral)	4.1 min/5 × 5 cm <sup>2</sup>	40 mL/5 × 5 cm <sup>2</sup> 1.0 min/5 × 5 cm <sup>2</sup>	2000 J/5 × 5 cm <sup>2</sup> 1.0 min/5 × 5 cm <sup>2</sup>	35 mL/5 × 5 cm <sup>2</sup> 1.1 min/5 × 5 cm <sup>2</sup>	466 J/5 × 5 cm <sup>2</sup> 1.0 min/5 × 5 cm <sup>2</sup>
Anterior thigh	32 (Bilateral)	5.5 min/5 × 5 cm <sup>2</sup>	50 mL/5 × 5 cm <sup>2</sup> 1.7 min/5 × 5 cm <sup>2</sup>	2500 J/5 × 5 cm <sup>2</sup> 1.5 min/5 × 5 cm <sup>2</sup>	62 mL/5 × 5 cm <sup>2</sup> 1.2 min/5 × 5 cm <sup>2</sup>	490 J/5 × 5 cm <sup>2</sup> 1.1 min/5 × 5 cm <sup>2</sup>
Posterior thigh	32 (Bilateral)	4.4 min/5 × 5 cm <sup>2</sup>	57 mL/5 × 5 cm <sup>2</sup> 1.0 min/5 × 5 cm <sup>2</sup>	2500 J/5 × 5 cm <sup>2</sup> 1.2 min/5 × 5 cm <sup>2</sup>	51 mL/5 × 5 cm <sup>2</sup> 1.0 min/5 × 5 cm <sup>2</sup>	582 J/5 × 5 cm <sup>2</sup> 1.2 min/5 × 5 cm <sup>2</sup>
Knees	4 (Bilateral)	4.0 min/5 × 5 cm <sup>2</sup>	50 mL/5 × 5 cm <sup>2</sup> 1.0 min/5 × 5 cm <sup>2</sup>	2000 J/5 × 5 cm <sup>2</sup> 1.0 min/5 × 5 cm <sup>2</sup>	30 mL/5 × 5 cm <sup>2</sup> 1.0 min/5 × 5 cm <sup>2</sup>	612 J/5 × 5 cm <sup>2</sup> 1.0 min/5 × 5 cm <sup>2</sup>
Average	13	6.0 min/5 × 5 cm <sup>2</sup>	51.9 mL/5 × 5 cm <sup>2</sup> 1.5 min/5 × 5 cm <sup>2</sup>	2308 J/5 × 5 cm <sup>2</sup> 1.8 min/5 × 5 cm <sup>2</sup>	50 mL/5 × 5 cm <sup>2</sup> 1.4 min/5 × 5 cm <sup>2</sup>	640 J/5 × 5 cm <sup>2</sup> 1.3 min/5 × 5 cm <sup>2</sup>

(Table 3). The total aspirate that was estimated to be removed from each patient averaged 1900 ± 175 mL (range, 155-3200 mL) from 11 anatomical sites, as listed in Table 4.

## Results

### Phase Measurements of Time and Energy

iLAL was performed in compliance to protocol to ensure consistency of technique for patient safety and “comparable” clinical evaluations. The average values of joule-energy and time of de-

liverance were calculated on every patient, based on the 5 × 5 cm<sup>2</sup> within the total treatment sites (Table 5): tumescent infiltration (51.9 mL/5 × 5 cm<sup>2</sup> (1.5 min/5 × 5 cm<sup>2</sup>), Blend 3 (2308 J/5 × 5 cm<sup>2</sup>, 1.8 min/5 × 5 cm<sup>2</sup>), and SAL (50 mL/5 × 5 cm<sup>2</sup>), and Blend 1 (640 J/5 × 5 cm<sup>2</sup>, 1.3 min/5 × 5 cm<sup>2</sup>). Because the average total time to complete the various treatments for each square was about 6.0 minutes, the duration of the entire surgical procedure can be estimated, that is, 28 × s × 6 minutes/ = 168 minutes. The 600 μ fiber delivered the energy to obtain subdermal and dermal heat.

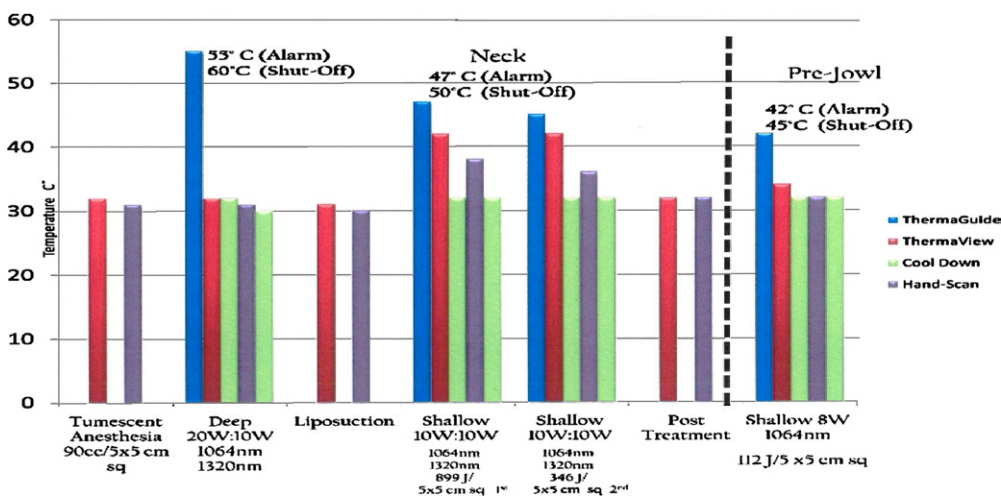
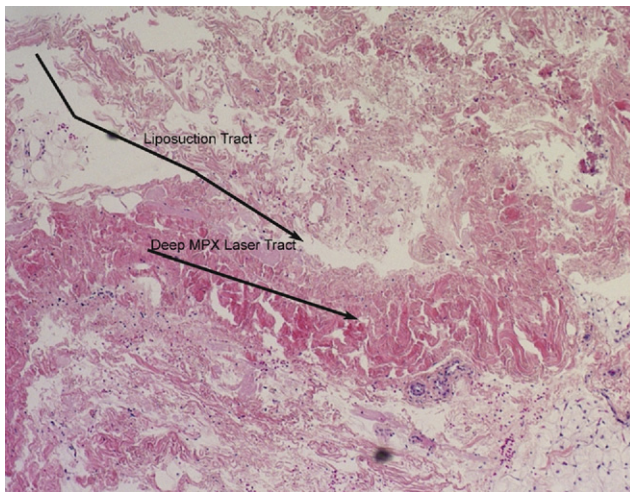


Figure 1 Correlations of Deep and surface skin temperatures during phases of MPX treatments.

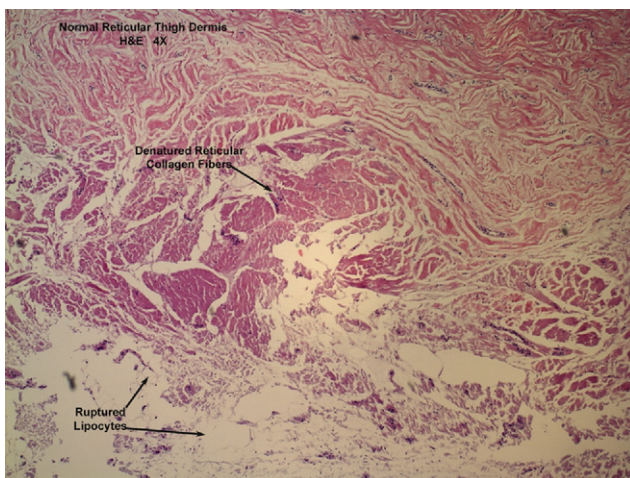




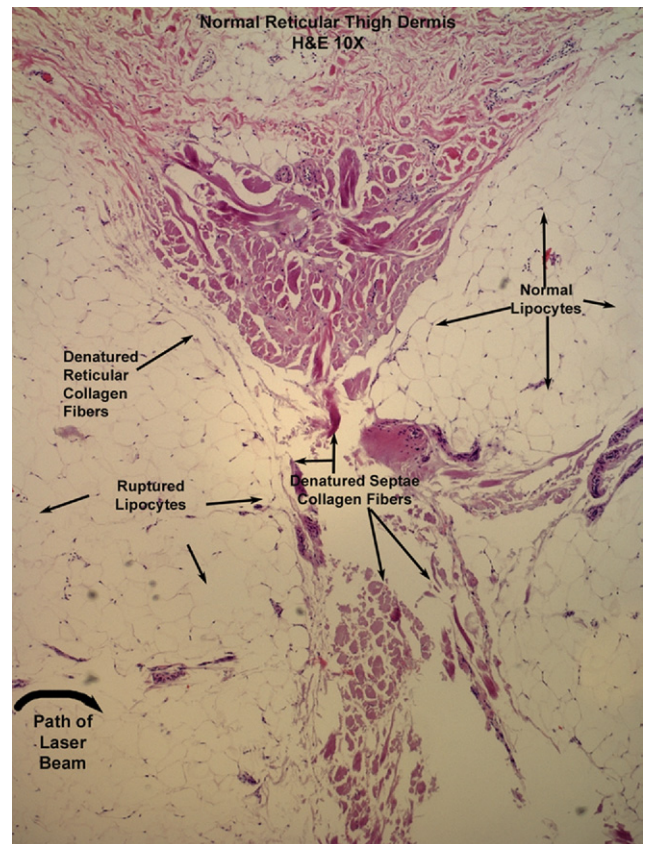
**Figure 2** Photomicrograph of deep subcutaneous fat in thigh tissue exposed to deep MPX treatment (Blend 3, 20 W 1064 nm/10 W 1320 nm, 2000 J) with 600  $\mu\text{m}$  fiber, showing liposuction/laser tracts and irreversible damage to lipocytes.

### Temperature Endpoints

During dual levels of MPX laser treatments, monitoring of deep, shallow, and surface skin temperatures served as clinical endpoints, along with palpation and creation of optimal contours during the procedure. In 25 consecutive cases, simultaneous measurements of internal and skin temperature changes were measured during each phase of the surgical procedure to understand their inter-relationships, leading to safer and more consistent and/or effective outcomes. A typical temperature profile within a single  $5 \times 5 \text{ cm}^2$  during iLAL in the pre-jowl and neck sites emphasized the dependency between temperature rise and energy deposition within the subdermal tissue and skin (Fig. 1).



**Figure 3** Photomicrograph of shallow laser injury  $<5 \text{ mm}$  below dermis in thigh tissue, exposed to shallow MPX treatment (Blend 1, 8 W 1064 nm/8 W 1320 nm, 446 J) with 600  $\mu\text{m}$  fiber, showing denaturation of lower reticular dermal collagen fibers and ruptured lipocytes at surface skin temperatures between 40 and 41°C.



**Figure 4** Photomicrograph of deep MPX (Blend 3, 20 W 1064 nm/10 W 1320 nm, 2000 J) and shallow MPX (Blend 1, 8 W 1064 nm/8 W 1320 nm, 446 J) with 600  $\mu\text{m}$  fiber, demonstrating denaturation of collagen fibers within lower reticular dermis and septal supporting structures, and ruptured lipocytes at surface skin temperatures between 40 and 41°C.

After tumescent infiltration, the surface skin temperature ranged between 30°C and 32°C (36.3°C oral temperature) as determined by the ThermaView and MiniTemp handheld scanner. During deep MPX treatment (20 W 1064 nm/10 W 1320 nm), delivering 2000 J with the 600  $\mu\text{m}$  fiber, the temperature surrounding the ThermaGuide registered 55°C at 10 mm below the skin without a significant change in baseline skin temperatures. After liposuction, the skin maintained its baseline temperatures. During shallow MPX treatment (8 W 1064 nm/8 W 1320 nm), depositing 646 J at 1-5 mm below the skin, ThermaGuide temperatures registered at 47°C, whereas surface skin temperatures were recorded at 42°C (ThermaView) or 38°C (MiniTemp handheld scanner). Because elevated skin temperatures return to near baseline levels after 2-5 minutes after termination of shallow lasing, the skin may be re-challenged safely, with additional lasing to temperatures between 38°C and 42°C for possible increased tissue tightening.

### Histology Studies

After deep MPX Blend 3 exposure (20 W 1064 nm/10 W 1320 nm) with 2000 J/5  $\times$  5  $\text{cm}^2$  at 55°C, irreversible damage to the lipocytes was observed with rupture of cell



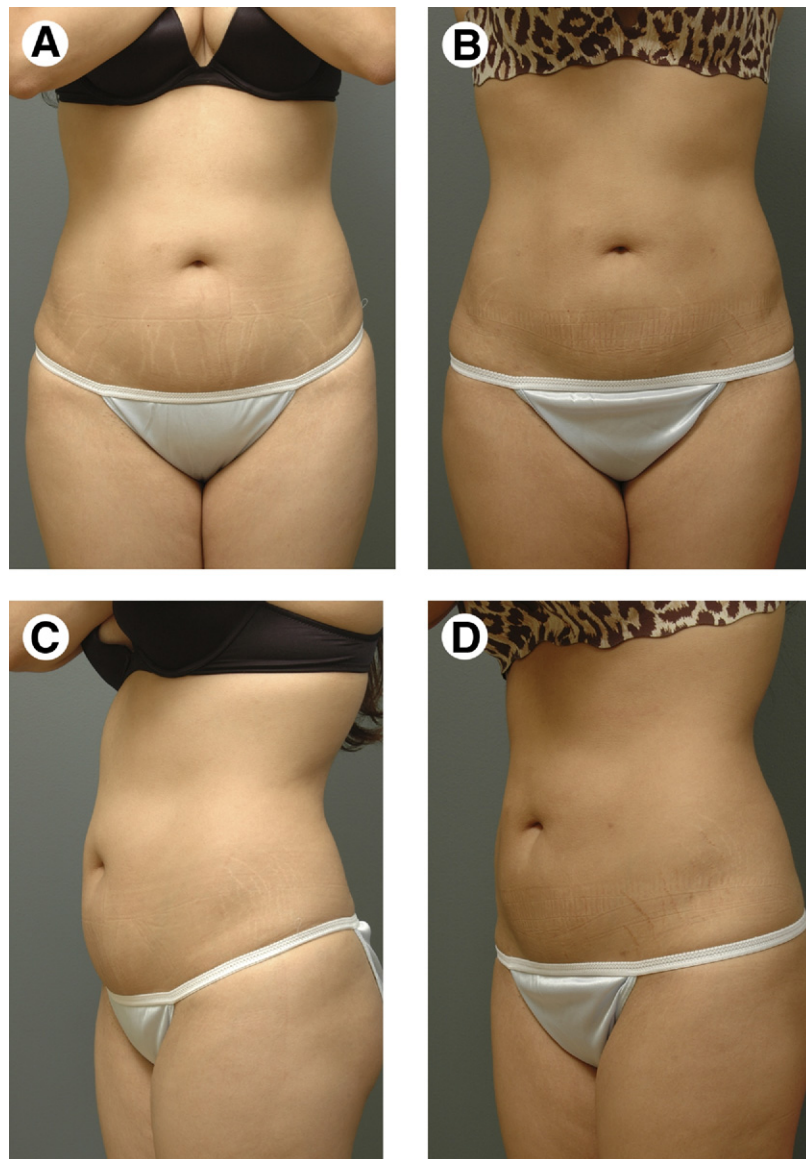
membranes, release of intracellular lipids, and coagulation of surrounding fibrous support structures (Fig. 2). During shallow MPX Blend 1 exposure (8 W 1064 nm/8 W 1320 nm) with  $446 \text{ J/5} \times 5 \text{ cm}^2$  at  $47^\circ\text{C}$ , less than 5 mm from reticular dermis, threshold surface skin temperatures were measured between  $40^\circ\text{C}$  and  $41^\circ\text{C}$ , which resulted in denaturation of collagen fibers at the lower reticular dermis and thermal rupture of subjacent lipocytes (Fig. 3). At the completion of both deep and shallow laser exposures, denatured collagen fibers were observed both at the lower reticular dermis and septal supporting fibers along with ruptured lipocytes (Fig. 4).

### Postoperative Outcomes, Morbidity, and Recovery

Patients were highly satisfied with their changes in body contouring and degree of tissue tightening, especially in areas of skin laxity, such as the face and/or neck, brachium, abdomen, and thigh (Figs. 5-8). Patients observed about 80% clinical improvement at 2-3 months with a very low incidence of side effects such as bruising and swelling. Each patient was asked to record their impression of the degree of intraoperative and postoperative pain on a visual analog scale from 0 to 10. Patient responses indicated an average intraoperative pain level of 1.5 (SD,  $\pm 0.5$ ) and a 1-3 day postoper-



**Figure 5** (A-D) This 72-year-old patient underwent iLAL with 150 mL tumescent fluid to the lower third of the face and entire neck, deep Blend 3 at  $55^\circ\text{C}$  (20 W 1064 nm/10 W 1320 nm 2000 J/5 cm  $\times$  5 cm segments), 150 mL aspiration, and Blend 1 at  $45^\circ\text{C}$  (10 W 1064 nm/10 W 1320 nm/5 cm  $\times$  5 cm segment) to achieve surface skin temperatures between  $38$  and  $42^\circ\text{C}$ . Her postoperative results at 1 year indicate improvement in fat contour and tissue tightening at her jowl and neck regions. (Used with permission.)



**Figure 6** (A-D) This 21-year-old patient received iLAL with 800 mL tumescent fluid to her entire abdomen, deep Blend 3 @ 55°C (30 W 1064 nm/15 W 1320 nm 2500 J/5 cm × 5 cm<sup>2</sup>), 550 mL aspiration, and Blend 1 at 45°C (10 W 1064 nm/10 W 1320 nm/5 cm × 5 cm<sup>2</sup>) to achieve surface skin temperatures between 40 and 41°C. Her postoperative improvement at 1 year demonstrates contouring of her waist and abdomen with tissue tightening of her striated skin.

ative pain level of 2.5 (SD, ± 0.7). Almost all patients were able to resume their pre-surgical routines by the seventh day, depending on the extent and sites of their procedures.

### Complications

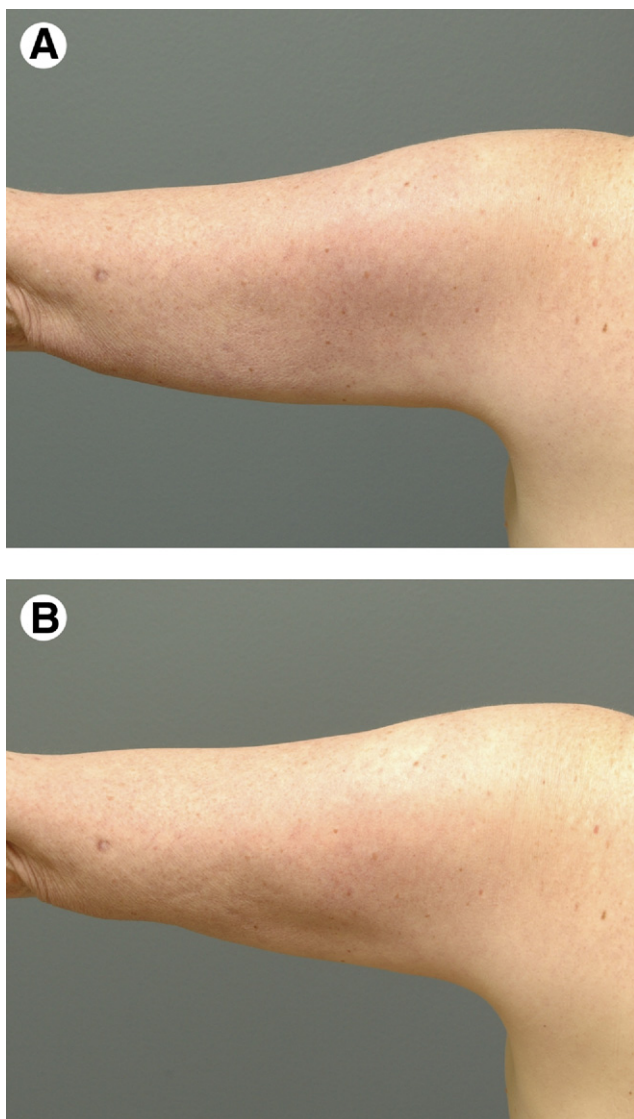
Approximately 5% of patients developed nodularity within 6 weeks after surgery, especially in the upper abdomen and periumbilical sites. Irregularities were managed successfully by a series of external ultrasound treatments. In the lower abdomen and upper and/or lower extremities, temporary and limited ecchymoses resolved within 2-3 weeks. Transient localized sponginess was observed in the abdomen of 3 patients that spontaneously disappeared within a month of surgery. There were no incidences of seroma formation, hematomas,

end-hits (blisters, dyschromias, scarring), permanent nerve injuries, perforations, or fracturing of the fiber tips.

### Discussion

Current lipoplasty remains safe and effective for localized and moderately extended areas of fat deposits. With advances in patient selection, tumescent anesthesia, operative techniques, fluid and electrolyte resuscitation, and reliable devices, liposuction remains one of the most successful procedures for patients and surgeons. When a relatively new energized device for liposuction is introduced, there exists the necessity for continued improvements to maximize its profiles for safety and efficacy through generational changes



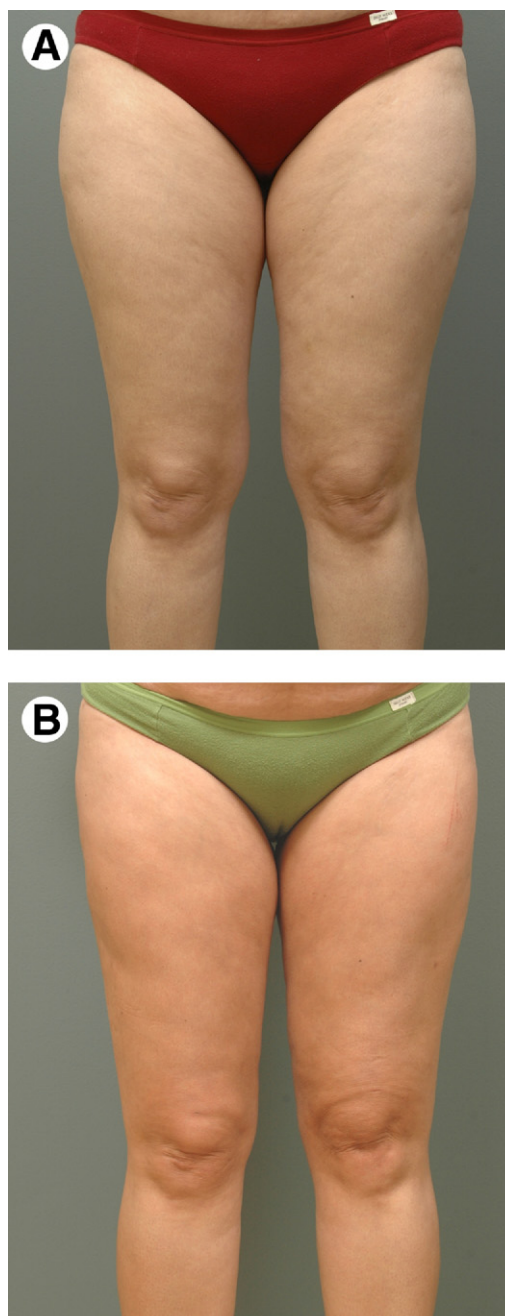


**Figure 7** (A, B) This 55-year-old patient was treated with iLAL to her brachii for excess fat and skin laxity. She received on each arm 200 mL tumescent fluid, deep Blend 3 at 55°C (20 W 1064 nm/15 W 1320 nm 2000 J/5 cm × 5 cm segment), 180 mL aspiration, and Blend 1 at 44°C (10 W 1064 nm/10 W 1320 nm/5 cm × 5 cm<sup>2</sup>) to achieve surface skin temperatures between 40 and 42°C. Her post-operative results at 1 year demonstrate contouring and tissue tightening.

from the original device. In addition, its most current modified form must demonstrate at least equal or superior results to existing successful technologies.<sup>41</sup>

This early clinical experience with one of the many iLAL devices on the market has attempted to develop an algorithm that results in safe and acceptable clinical results with reduced side effects and downtime. The use of multiple wavelengths that can specifically target structures by selective photothermolysis and provide sufficient controlled laser energy may possess tissue advantages (tightness and coagulation) that make it more suitable than other forms of non-thermal liposuction. This study does not address the issue of comparison of technologies in the clinical setting, but does

report that iLAL with the MultiPlex dual laser system represents a safe and effective addition for the liposuction surgeon. Moreover, histologic findings in the deep and shallow modes produce microscopic changes of lipocytic damage and collagen denaturation that contribute directly to its observed clinical results in skin-challenged patients. Optimal outcomes can be anticipated with selection of candidates with localized



**Figure 8** (A, B) This 41-year-old patient received iLAL treatment to her anterior thighs, saddlebags, and medial knees. She was treated on each side with 1200 mL tumescent fluid, deep Blend 3 at 55°C (30 W 1064 nm/15 W 1320 nm, 2000 J/5 cm × 5 cm<sup>2</sup>), 1300 mL aspiration, and Blend 1 at 45°C (10 W 1064 nm/10 W 1320 nm/5 cm × 5 cm<sup>2</sup>) to achieve surface skin temperatures between 38 and 40°C. Her postoperative result at 1 year demonstrates improvement of contouring, tissue tightening, and cellulite.



fat deposits and mild-to-moderate skin laxity, attention to temperature and energy profiles during dual layer lasering, and judicious use of wetting tumescent solution.

Although our preliminary experience demonstrated tissue retraction and tightening, smooth postoperative recovery and down time, and low morbidity rates, side-by-side comparison studies with this iLAL device and another energized or nonenergized liposuction devices must be done to substantiate its purported claims. Thus far, there exist no publications in peer-review medical journals comparing most current higher energy, more chromophore-specific single or multiple wavelengths iLAL devices to other established methods of liposuction. Putting aside the added expense with new equipment and the learning curve to any recent device, the MultiPlex system in the hands of properly trained surgeons on optimally selected patients can be very successful and safe. Further advancement and acceptance of iLAL will require controlled clinical trials that demonstrate comparisons of benefit and limitations among current energized liposuction devices along with studies that provide objective data on the effects of energy on the facilitation of tissue contraction.

## Conclusions

iLAL can provide safe, consistent, and effective removal of fat and tissue tightening to areas of mild-to-moderate fat collections and skin laxity. Modifications of technique and attention to temperature thresholds with new complementary technologies emphasize safer distribution of energy by the activation of sequential dual laser wavelengths within the deeper subcutaneous fatty tissue and immediate subdermal layer. Further studies are needed to validate these findings.

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