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The Selective Laser-induced Melting Procedure— Advanced Laser Body Sculpting

a report by
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History of Liposuction

Liposuction has come a long way since Charles Dujarrier's failed attempt in 1921 to sculpt the lower legs of a well-known ballerina.[1] Modern-day suction-assisted liposuction (SAL) was developed by two Italian cosmetic surgeons, father and son Arpad and Giorgio Fischer, in 1975.[1] They used a blunt-ended, hollow cannula to cut and suction adipose tissue through a series of criss-cross tunneling movements.[1] In 1984, the French plastic surgeon Yves-Gerard Illouz modified the blunt cannula and introduced the so-called 'wet technique' to reduce bleeding and facilitate suctioning. This technique involved the injection of hypotonic saline and hyaluronidase into adipose tissue to facilitate fat removal and reduce trauma (reviewed in references 2 and 3). Pierre Fournier, another French surgeon, demonstrated an early interest in liposuction and developed the 'dry technique.' While this method of liposuction was not universally accepted, he is credited with refining the Fischers' criss-cross technique and traveled the world to teach liposuction to other surgeons of different specialties.[2] In 1985, dermatologist Jeffrey Klein revolutionized the field by introducing 'tumescent anesthesia,' a technique to avoid general anesthesia. Tumescent anesthesia consists of injecting large volumes of very dilute amounts of lidocaine and epinephrine to provide regional anesthesia and to vasoconstrict and compress capillaries to reduce intra-operative blood loss, reduce post-operative pain, and reduce post-operative bleeding and bruising.[4,5] This breakthrough was immediately embraced by dermatological practitioners and many other surgeons as it allowed them to safely perform liposuction in an office setting.[2] In direct contrast to the risks of a liposuction procedure performed under general anesthesia, there has never been a death with tumescent anesthesia-guided liposuction.

Alternatives to Conventional Liposuction

Ultrasound-assisted Liposuction

Following the innovative modification introduced by Dr Klein, practitioners of liposuction have tried to modify the technique to alleviate drawbacks including the amount of operator effort required, blood loss, patient discomfort, and patient downtime. In 1992, Michele Zocchi introduced internal ultrasound (iUAL), a sequential procedure consisting of an internal cannula to fragment adipose tissue followed by suction.[6] In 1998, Barry Silberg launched external ultrasound (XUAL), which externally delivers ultrasonic waves through a paddle or pads and is also followed by suction.[7] Although fibrous areas such as the male breast and back are particularly responsive to iUAL, unpleasant side effects such as seromas, skin loss, and peripheral nerve injury have precluded iUAL from being truly embraced by practitioners.[8–12] On the other hand, XUAL is more widely used due to easier movement of the cannula, reduced blood loss, reduced patient pain and discomfort, and good skin retraction.[7,13–15]

Laser-assisted Liposuction

Laser-assisted liposuction (LAL) was developed around the same time as ultrasound-assisted liposuction; however, early results were not promising. Apfelberg's 1996 progress report stated that no clear benefit was observed with the neodymium: yttrium–aluminium–garnet (Nd:YAG) laser following testing on 51 patients and the device was not approved by the US Food and Drug Administration (FDA).[16,17] Part of the failure of this early device was attributed to the laser fiber being located inside the aspiration cannula, which led to increased mechanical damage and overheating of the device.[18] These technical difficulties were later rectified with the next generation of lasers that positioned the laser fiber outside the aspiration cannula.[18] Despite these modifications, preliminary studies have generated somewhat variable results. In a randomized, double-blinded study conducted by Prado et al., the authors compared the efficacy of the 1,064nm Nd:YAG laser (SmartLipo™, Cynosure, Westford) with SAL in 25 patients. While less pain and lower lipocrits were reported for the 1,064nm-treated side, there were no major clinical differences between the two treatments.[19] Conversely, the Kim study treated 20 patients with the 1,064nm device and observed excellent patient tolerance, quick recovery times, and dermal tightening, although there was no control treatment.[20] The Goldman study examined the ability of the 1,064nm laser to reduce fat and tighten skin in the submental area in 82 patients.[21] The authors attributed the observed cosmetic benefits, such as skin retraction, to collagen neoformation, which was revealed by histological samples collected from patients post-treatment.[21] While skin retraction was previously observed with conventional liposuction, it is believed that LAL may offer even more dramatic benefits, especially for sites resilient to skin retraction following liposuction, i.e. the face.[22] Preliminary results in LAL studies thus far appear to validate this theory.[18,20,21,23]

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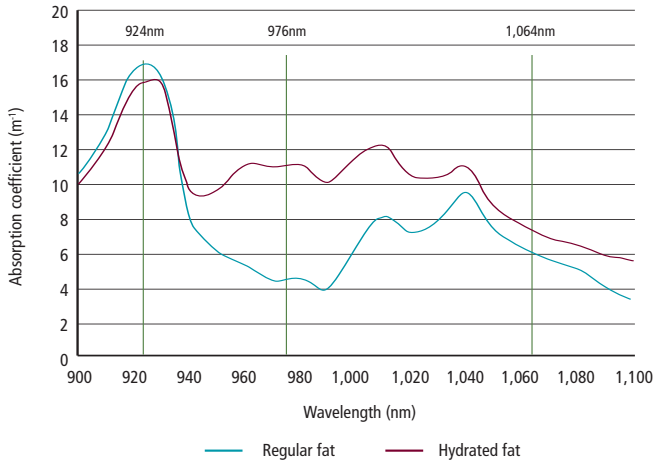
Figure 1: Absorption Spectrum of Human Fat Under Physiological Conditions and Super-hydrated Conditions (e.g. with Tumescence)



Unique Features of SlimLipo™

A promising new LAL device is the SlimLipo™ system and handpiece (Palomar Medical Technologies, Inc., Burlington), which was recently cleared by the FDA for laser-assisted lipolysis. The SlimLipo handpiece was uniquely designed to release fat by photothermolytic heating with its advanced tip design and optimal wavelength selection. The SlimLipo tip is designed with rounded angles to minimize the mechanical damage that has been observed with other tips containing sharp angles. Unlike the high-temperature spikes of standard laser fibers, the expelled energy from the SlimLipo tip is evenly distributed in the immediate treatment area, allowing for smoother and more uniform heating of fat with easier extraction. While currently available laser tips can overheat focal areas and generate bubbles or mechanical shock waves, the SlimLipo handpiece delivers smooth heating using continuous wattage or long pulses. This prevents overheating and enables effective and safe disruption of the adipocytes and coagulation of the surrounding cells. Other advantages of the SlimLipo system include a highly selective wavelength blend of 924 and 975nm that, respectively, allow for maximal absorption by fat and by connective tissue with higher water content such as dermis. The 924nm wavelength enables the device to glide through adipocytes and liberate lipids with minimal effort compared with non-fat-selective lasers. The 975nm wavelength results in more efficient heating of the hydrated adipose tissue after tumescence, as well as of the dermis. Both of these wavelengths are also absorbed by capillaries, leading to a combination of effects that translate into clinical benefits. As detailed below, these benefits include reduced post-operative pain, bruising, bleeding, and downtime for the patient. Additionally, there is less fatigue and effort required by the physician performing the procedure.

Optimal Wavelengths for Fat Thermolysis and Tissue Retraction

The choice of the optimal wavelength for laser thermolysis of fat is critical to maximize penetration, to minimize tissue trauma, and for the success of the procedure. Palomar's research team deciphered an absorption profile for human fat that shows a clear peak in fat absorption at the 924nm wavelength (see *Figure 1*).[24] This wavelength provides maximum selectivity for fat while simultaneously providing sufficient optical penetration for maximal volume heating of adipose tissue surrounding the tip. Evidence of this 'lipid-liberation' effect is seen in the amount of translucent oily layer floating on the surface of the aspirate. This localized heating of adipose tissue also heats nearby connective tissue, which contributes to the shrinkage of adipose tissue.

The second wavelength of 975nm was chosen for SlimLipo because it corresponds to a peak in water absorption (see *Figure 1*). This wavelength optimizes the tip's performance in hydrated adipose tissue following tumescence and near the dermis to enable skin retraction. Tissue retraction with SlimLipo arises through a combination of effects. It is commonly believed that fat volume loss itself leads to skin retraction due to the skin's inherent elasticity (especially in younger patients). Beyond this volume loss, however, skin does not typically retract further, leading to redundant skin. Clinical experience and previous studies have shown that proper heating of the dermis provides additional skin retraction. In principle, as the adipose connective tissue also contains collagen, heating of the septa together with reduced mechanical trauma to the tissue helps to preserve and tighten the adipose connective tissue, leading to further skin retraction. Fairly immediate skin smoothing is observed, while over time the skin retraction becomes even more pronounced as the septa and meshwork separating adipocytes are replaced with new connective tissue to remodel skin and body contours.

Clinical Data

Our less than optimal results with a number of devices on the market led us to investigate a better method of laser lipolysis or liposculpting. The SlimLipo system of wavelengths and unique optical delivery compared with conventional fiber delivery systems and less selective wavelengths has delivered impressive clinical results in our current experience. The theoretical advantages to the combination of wavelengths and use of a wavelength specifically targeting adipose tissue have translated into actual improved clinical outcomes and end-user utility. Conventional 300–500µm diameter fibers in competitive systems require the use of greater force, pose an increased risk of snagging or breaking when used in fibrous areas, and deliver unreliable energy once re-cleaved. These factors require the treating physician to rely more heavily on conventional suction techniques to achieve a good end-result. None of these factors are a concern with the use of the rounded larger diameter fibers of the SlimLipo system. Additionally, competitive systems with conventional fibers deliver more concentrated energy at the tip. This may result in irregular heating of fat and dermis, more easily punctured skin, and a resulting increased risk of less than optimal outcome with irregular depressions.

Data from our studies using SlimLipo to treat excess fat in the abdomen, thighs and arms show impressive results (see *Figures 2–5*). Nearly 50% of patients exhibited good improvement in their cosmetic outcomes as early as two weeks post-treatment, and by six weeks nearly 90% demonstrated excellent improvement. Given that progressive improvement over time is typically observed, we anticipate these results will show further enhancement at six and 12 months post-operatively with further retraction and contouring of treated areas. All of the patients shown were treated under tumescent anesthesia alone (0.1% lidocaine with 1:1,000,000 epinephrine) with a range of infiltrate volume of 1,300–2,200cc. Aspirate volumes ranged from 250–950cc (average 300cc). Only one to two incisions were made for each treatment site and patients were treated by the study protocol, which required the use of the 924nm wavelength at 17W.

Figures 2–4 show significant fat reduction and smooth contouring of the skin in the abdomen and thigh regions. These patients demonstrated insignificant bruising and minimal post-operative pain and tenderness. Tenderness was controlled by ibuprofen alone and no narcotic pain medications were required. Bruising was seen in only two patients and was insignificant compared with standard suction lipoplasty. Additionally, the amount and time of drainage through puncture sites was minimal compared with standard liposuction. As a result of the decreased bruising, tenderness, and drainage of tumescent solution, all patients returned to work the next day. Additionally, swelling was minimal, with most patients noticing improvement in the contour of treated areas within seven days.

All study subjects were given self-assessment questionnaires to fill out regarding various aspects of their SlimLipo treatment. Subjects were asked to indicate whether they agreed, were uncertain, or disagreed with the following statements:

- the appearance of unwanted fat is significantly improved in the treatment area;
- my skin looks smoother after the treatment;
- my skin is much tighter in the treated area;
- this treatment works well to improve localized fat deposits;
- I would choose to do this procedure again; and
- I would recommend this treatment to a friend.

The results from this survey mirrored physician observations (see *Figure 5*). At all time-points, 100% of subjects agreed that SlimLipo treatment significantly improved the appearance of fat and worked well on localized fat. At two weeks post-treatment, 83% of subjects felt their skin was smoother and 67% felt their skin was tighter; by three months post-treatment these numbers had increased to 100%. Perhaps one of the best indicators of a successful cosmetic procedure is whether the patients would recommend the procedure to family and friends. When asked this question at the six-week follow-up visit, 100% of patients indicated they would recommend this procedure and would choose it again for themselves. Patients were extremely satisfied with the procedure and all of them reported that the appearance of unwanted fat was significantly improved in the treatment area. Another positive outcome was that all treated patients felt their skin looked smoother at six months post-treatment—an end-point that is more difficult to achieve with plain or traditional liposuction alone.

Limited and Transient Side Effects

Compared with other wavelengths used in our office, patients treated with the SlimLipo handpiece experienced less downtime and fewer side effects. While some patients reported minor tenderness, bruising was minimal and most patients were able to return to work the following morning. Patients experienced the expected immediate side effects of trace or mild erythema, bruising, and edema, but most of this was completely resolved by one week. Marked improvements in side effects and downtime for this procedure compared with traditional liposuction may be attributed to more complete heating and subsequent breakdown of fat conferred by the 924nm wavelength. We observed other benefits, including smaller and fewer numbers of incisions. This is believed to have contributed to quicker recovery, reduced post-operative pain, and reduced tissue trauma.

Figure 2: Smooth Contouring of Bilateral Thighs

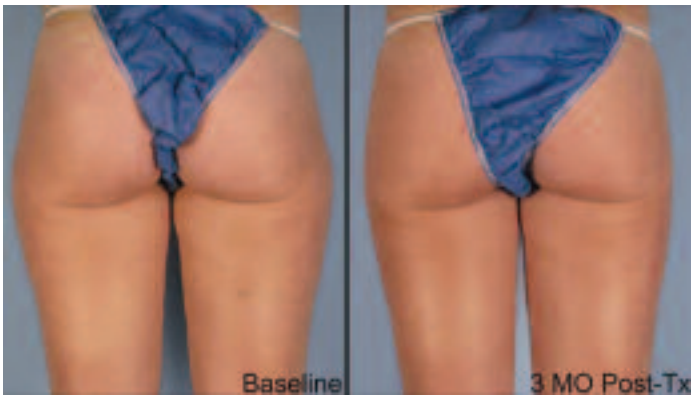


Figure 3: Minimal Bruising and Quick Results Observed in Flank Region

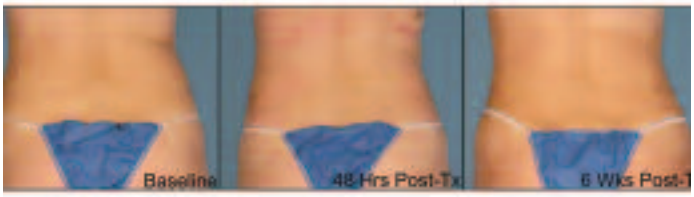
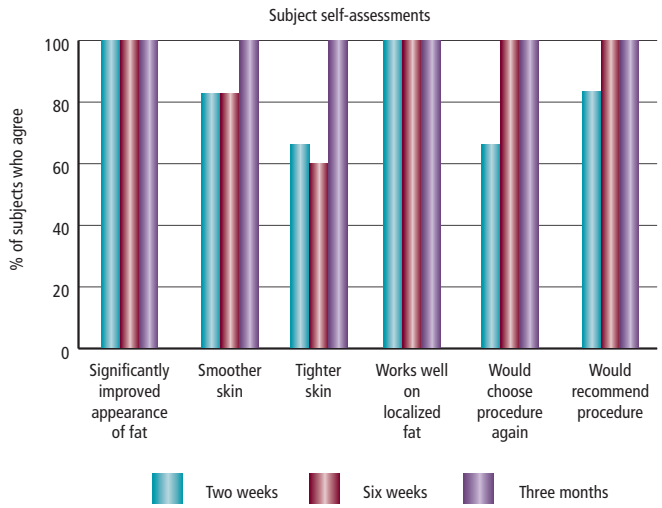


Figure 4: Flattening and Sculpting of Upper and Lower Abdomen

Figure 5: Percentage of Subjects Giving Positive Assessments for SlimLipo™ Treatment at all Follow-up Visits



The Fat-selective SlimLipo Handpiece Delivers Safety and Patient Satisfaction

Laser lipolysis with the new SlimLipo handpiece offers many benefits to both the physician and the patient. From a practitioner's perspective, the SlimLipo procedure requires less effort than traditional liposuction, in addition to being quicker and having smoother results. This ease of treatment, especially in difficult regions to treat, such as the submental region and flanks, may be explained by both highly selective wavelengths and unique delivery-tip design. Patients were pleased with the minimal recovery time following treatment. The ability to return to work within one to two days was markedly different from previous experience with other laser devices or traditional liposuction alone. Conclusions drawn from this pilot study were that this treatment was milder than its predecessors and offered significantly improved experiences and outcomes. Significantly reduced tissue trauma, bruising, bleeding, and pain were confirmed. Clinical results were excellent, with improvement in 100% of patients at six weeks post-treatment. Patients reported a high level of satisfaction with this procedure, appreciating the minimal downtime as well as the smoothing and tightening of their skin. All patients agreed they would opt to undergo the procedure again and would recommend the procedure to family and friends. ■

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