Treatment of Cellulite Using a 1440-nm Pulsed Laser With One-Year Follow-Up
Barry E. DiBernardo
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Cellulite is an important cosmetic problem for approximately 85% of postpubertal women.\(^1\,^2\) Pathogenesis of this condition involves subcutaneous fat extending into the dermis, altering connective tissue, and reduced microcirculation.\(^3\,^4\) Patients present with irregular skin dimpling and raised areas primarily on the thighs and buttocks; the surface of the affected skin is said to resemble cottage cheese or an orange peel. Cellulite may also be present on the upper arms, lower abdomen, and breasts, and it is found in both slim and obese patients, although the condition may be more noticeable in the latter.\(^1\,^3\)

Anatomically speaking, cellulite has structural features that lend themselves as potential targets for treatment. Cellulite is characterized by a greatly-thickened hypodermal fat layer and hypodermal fat lobules that extend upward into the dermis. The result is a herniated fat layer at the dermal-hypodermal interface. Ultrasound imaging has been used to view this interface\(^5\,^6\) and measure the thickness of the skin of the thigh and hips.\(^5\) Given that the acoustic impedance of the dermis differs greatly from that of the hypodermis, a high contrast is obtainable in a false-color image. The nonhomogeneities of the dermis cause many reflections that make the image appear bright.
whereas the more homogeneous hypodermis makes the image appear dark. In a study of 44 patients, Querleux obtained cross-sectional images showing hypodermal herniations into the dermis in women with cellulite.

The hypodermal fat layer in skin is normally divided into chambers by fibrous connective tissue septae that are perpendicular to the skin surface. The fibrous tissue strands extend from the dermal layer, through the hypodermal fat layer, and connect to the underlying muscle layer. When cellulite is present, the percentage of fibrous septae (versus adipose tissue) is higher than normal. Cellulite is therefore associated with not only increased adipogenicity but also altered connective tissue.

A time-honored treatment for cellulite is massage. This technique is directed toward impaired microcirculation. Developed in France during the 1970s, the Endermologie ESI (LPG Systems, Valence, France) mechanically mobilizes subcutaneous fat and improves lymphatic drainage by kneading the skin between two revolving rollers. The procedure is usually performed twice weekly for 15 sessions.

Evidence to support its efficacy is not strong, possibly because at the time of these studies, ultrasonography and magnetic resonance imaging were not yet used to measure efficacy of cellulite treatments.

An assortment of noninvasive devices has been approved by the Food and Drug Administration for temporary improvement in the appearance of cellulite, including the VelaSmooth system (Syneron Medical Inc., Irvine, California) and TriActive system (Deka, Florence, Italy). The VelaSmooth system combines 700-nm light with bipolar radio frequency energy and mechanical manipulation of the skin and fat. Heat generated by the light and radio frequency energy may increase the dissociation of oxygen from oxyhemoglobin and its subsequent diffusion to fat tissue. The mechanical manipulation of the skin improves circulation and may stretch the connective tissue bands that surround the adipose tissue. Twice-weekly treatment for six weeks has resulted in thigh circumference reduction and visual improvement.

The TriActive system relies on six 809-nm diode lasers, localized cooling, and mechanical massage. The laser energy stimulates blood and lymphatic flow and neovascularization. Contact cooling reduces edema, and massage mobilizes fluids by stimulating lymphatic drainage. Two to three treatments weekly for a total of 12 to 15 sessions have been suggested.

Other devices include a handheld system that kneads the skin, an 810-nm diode laser that also massages, a suction and mechanical massage device with 650-nm light and 915-nm laser energy, and a vacuum massage device, with or without a 660- to 880-nm probe or 880-nm light pad. Subcision, mesotherapy and injection lipolysis, ultrasound- and laser-assisted liposuction, radiofrequency, topical aminophylline, and retinol are other available modalities for the treatment of cellulite. These modalities have advantages and disadvantages, and most require multiple treatments.

One goal of most noninvasive cellulite treatments is to eliminate the fat protruding into the dermis and modify the connective tissue that permits these fat herniations. Mesotherapy has been shown to temporarily reduce these fat protrusions and flatten the dermal-epidermal interface. However, the improvement lasts only a few months because the adipocytes regrow into the dermis. Subcision, an invasive treatment, is another option.

A tribopedic hypodermic needle is inserted into the skin, and the sharp edges of the needle are moved back and forth to break the strands of connective tissue that secure the fat herniations to the underlying muscle layer. Although this treatment frees the skin surface, making the skin appear even and smooth, it does not alter the pockets of fat that penetrate the dermis. Therefore, the broken strands eventually reconnect to the dermis and muscle in the same fashion.

This study evaluates the efficacy, safety, and duration of clinical benefit associated with a pulsed laser that delivers 1440-nm energy to the dermal-hypodermal interface for the treatment of cellulite (CelluLaze, Cynosure, Inc., Westford, Massachusetts). Other energy-based devices emit light that must penetrate the upper layers of skin to reach the lower layers, and the skin may be cooled during treatment. With this system, however, energy does not penetrate the upper layers, because it is delivered internally with a fiber, thus making it possible to (1) break the hypodermal septa by thermal subcision, (2) thermally denature the adipocytes that protrude into the dermis, (3) thicken and tighten the skin by stimulating synthesis of new collagen at the dermal-hypodermal junction, and (4) selectively melt hypodermal adipocytes in the risen areas of the skin.

**METHODS**

**Treatment Protocol**

Ten healthy women with moderate-to-severe cellulite on their thighs (lateral, posterior, or both) enrolled in a prospective study conducted during 2009-2010 at the author’s private plastic surgery clinic and approved by an independent Institutional Review Board (Plantation, Florida). All patients provided signed informed consent.

Medical histories were reviewed, and participants underwent a preoperative physical examination and chemistry test panel. Exclusion criteria included previous treatments (surgical and nonsurgical) for cellulite; a history of thrombophlebitis, acute infections, heart failure, or keloid formation; recent antiplatelet, anticoagulant, thrombolytic, vitamin E, or anti-inflammatory therapy; intolerance to anesthesia or photosensitive medications; pregnancy, planned pregnancy, or lactation; and inability to maintain a diet and exercise routine during the study period.

One day before treatment, patients were weighed, photographed, and given oral antibiotics (500mg Keflex; Eli Lilly and Company, Indianapolis, Indiana). Patients were also instructed to continue antibiotics for seven days after treatment. Skin thickness (ultrasound) measurements, elasticity measurements, and three-dimensional photography were also conducted. Cellulite was evaluated with the patient in a standing position. On the day of surgery, dimples and raised areas were delineated with surgical markers of different colors to help the treating physician locate these areas with the patient in a supine position during treatment.
Participants received a single treatment with the CelluLaze system, with the power setting at 8 to 10 W and pulse frequency at 40 Hz. Energy was delivered to the subdermal tissue through a 600-µm “side-firing” fiber (SideLight 3D, Cynosure, Inc.) enclosed in a 1-mm cannula and extending 1 to 2 mm beyond the distal end of the cannula. Skin surface temperature was monitored with a thermal camera (ThermaCAM E45, FLIR, Niceville, Florida). Surface temperatures reached 40°C and 42°C during treatment. Delivered energy ranged from 300 J for raised areas and dimples measuring 3 × 3 cm to 600 J for raised areas and dimples measuring 5 × 5 cm. If necessary, an ice pack was placed to cool the skin in the surgical field. A temperature-sensing cannula (ThermaGuide, Cynosure, Inc.) attached to the laser cannula monitored and maintained an average subdermal temperature below 47°C.

The side-firing fiber (Figure 1) is designed to deliver roughly half its laser energy normal to the fiber axis while the remaining energy moves forward along the fiber axis. This design utilizes the high water and lipid absorption of the 1440-nm pulsed laser to form a transient bubble on the distal tip, which then creates an air-glass interface in the tissue and deflects the beam. This feature permits more targeted delivery of laser energy to the structures of interest. An accelerometer (SmartSense A, Cynosure, Inc.) attached to the laser hand piece ensured uniform delivery of energy during treatment by causing the energy level to decrease (if the motion of the hand piece slowed) or increase (if the hand piece was moved more rapidly); if the hand piece stopped moving, energy delivery ceased within 0.2 seconds.

All procedures were carried out by a single surgeon (B.E.D.). Only one thigh of each patient was treated. The untreated thigh acted as a control because of the inherent intrasubject variability in cellulite severity. The target area was divided into square sectors (5 × 5 cm; see Figure 2), and each sector was treated individually. Incision areas were given topical lidocaine (if necessary) and cleaned with povidone-iodine antiseptic (Betadine) before infusion of tumescent lidocaine solution. Two to four 1-mm incisions were made with a trocar or blade under standard-of-care conditions for introducing the laser cannula. In sum, 50 to 80 mL of the tumescent anesthesia mixture (50 mL of 1% lidocaine [without epinephrine], 1 mg epinephrine per liter of warm normal saline, and 12 mL of 8.4% sodium bicarbonate) was infused into each sector, to a maximum total volume of 1 L. The laser cannula was then inserted through one of the incisions close to the target area. A red aiming beam from a He:Ne laser source permitted the physician to visualize the tip of the fiber during treatment. The cannula was gently positioned below the skin surface. At this stage, the procedure was divided into three steps, with the fiber in the down, horizontal, and up positions. The fiber was placed in the down position (1-2 cm beneath the skin) to melt the excess hypodermal fat, in order to minimize its
expansion into the dermis and reduce the irregularity of the dermal-hypodermal interface (Figure 3). Once in place, the cannula-fiber unit was moved back and forth in a fanlike pattern until the delivered energy totaled 300 to 600 J (again, depending on the dimensions of the risen areas in the sector undergoing treatment). When all selected raised sectors were treated, the fiber position was changed to horizontal to direct the side-firing energy parallel to the skin surface (rather than perpendicular). In this step, energy was delivered only to areas premarked as dimples when patients were standing. Each sector containing dimples or cellulitic dimpling was retreated with the horizontal fiber moving in the same fanlike pattern and in the same plane. This step was carried out to thermally subcize the septal tissue strands connecting the dermal and muscle layers (Figure 4). The end point in this second step was the loss of resistance as the cannula passed through the tissue, indicating that the septa no longer connected the dermal and muscle layers. The fiber was then set at up and positioned 2 to 3 mm below the skin surface, just under the dermal-hypodermal interface. All sectors were then uniformly treated to smooth the dermal-hypodermal layer, increase skin elasticity, and stimulate collagen remodeling to increase dermal layer thickness during the months after treatment (Figure 5). Total time (including pretreatment and posttreatment care) was approximately 90 minutes, depending on the area treated.

When laser treatment was completed, the liquefied adipocytes were removed by gently squeezing the incision-point tissue. A rolled-up towel or medical roller was sometimes utilized to facilitate the process. Standard pressure dressings were applied to the treated areas, and participants were instructed to wear a compression garment for the next two to three weeks.

**Posttreatment Analysis**

Treatment efficacy was assessed with high-resolution digital photography, subjective patient and physician evaluations, and measured changes in skin elasticity and thickness. Photographs (Nikon D80, Nikon Inc., Garden City, New York) were obtained at baseline and at one, three, six and 12 months after treatment under standardized conditions of lighting, magnification, background, exposure time, and position. Surface images were further analyzed with Vectra 3D imaging software from Canfield Scientific, Inc. (Fairfield, New Jersey). Posttreatment evaluations were made at one week and one, three, six and 12 months. At the one, three, six and 12-month follow-up visits, physician and patients both rated the posttreatment evaluation results on a questionnaire form.

Skin elasticity was assessed with a device (DermaLab Elasticity Module, Cortex Technology, Hadsund, Denmark) equipped with a suction cup probe. When the probe was attached to the skin with light adhesive, negative pressure drew the skin first to a lower level and then to a higher level. The skin experienced tensile mechanical stress as this occurred. The negative pressure difference between the upper and lower levels provided a measure of skin elasticity. Skin elasticity at each time point was determined by calculating the skin-tightening indices ($Y$) according to the following equation:

$$Y = \alpha (\Delta p / \Delta x),$$

where $\alpha$ is a fixed system constant based on the geometry of the detecting suction probe, $\Delta p$ is the difference in negative pressure (in millimeters of mercury) between the upper and lower level, and $\Delta x$ is the distance between
the upper and lower detectors (in millimeters). Because $\Delta x$ is constant, $\Delta p$ is a direct measurement of the skin-tightening index. If the skin-tightening index was higher at one month than at baseline, skin elasticity had increased during the one-month period.

Skin thickness in each sector was measured with a 20-MHz high-frequency ultrasound probe (DermaScan C, Cortex Technology). Ultrasound images of the dermis (bright) and hypodermis (black) were taken at baseline and at one, three, six and 12 months.

Significance of body weight and body mass index (BMI) changes before treatment and at the one-year follow-up evaluation was determined by the Wilcoxon signed rank test, with $p < .05$ as the cutoff level. Significance of skin thickness and elasticity increases compared to baseline were evaluated by a paired t-test, with $p < .01$ as the cutoff level.

Table 1. Mean Percentage Increases in Skin Thickness and Elasticity at 1, 3, 6, and 12 Months

<table>
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Results

The mean age of the patients was 47 ± 5.4 years. They were Caucasian ($n = eight$) and Hispanic ($n = two$), with Fitzpatrick skin types II ($n = nine$) and III ($n = one$). Median pretreatment body weight and body mass index were 156.1 lbs ± 18.2 (interquartile range, a measure of dispersion; 70.80 ± 8.3 kg) and 25.0 ± 2.45, respectively. Body weight was recorded pretreatment and at each follow-up point. Median body weight and BMI values did not differ significantly before treatment and at the one-year follow-up evaluation for patients who completed the one-year study ($n = six$).

Skin Thickness

All participants achieved an increase in skin thickness compared to baseline. Mean increases were significant ($p < .01$) at each time point (Table 1). In one patient, skin thickness increased to 48% at one month, 44% at three months, and 32% at six months. Skin thickness increases reached a minimum at six months and increased to the one-month value at 12 months (Figure 6). Increased dermal thickness was also shown by ultrasound (Figure 7).

Skin Elasticity

All patients except one achieved an increase in skin elasticity at each time point. The exception (Participant 8)
achieved a 14% reduction in elasticity at six months and an increase at all other time points. Increases were significant (Table 1). Elasticity increased up to 47% at one month, 64% at three months, and 73% at six months. Mean increases in elasticity are shown in Figure 8.

**Efficacy and Safety**

Subjective physician and patient evaluations were favorable for both safety and efficacy of the procedure.

**Physician evaluation.** Firmness, overall cellulite reduction, skin texture, and overall improvement at one year were graded by the author on a five-point scale for seven participants with one-year data (0, worse; 1, poor; 2, moderate; 3, good; 4, excellent). Mean scores were 3.4 for firmness, overall reduction, and overall improvement and 3.9 for skin texture. Swelling was graded on a four-point scale, and the mean score was 0.0. Mean scores for cellulite reduction, skin texture, and patient satisfaction at three months, six months, and one year are shown in Figure 9. Scores at one year were roughly equal to or greater than those at three and six months, indicating that treatment benefit as perceived by the physician persisted at least one year.

**Patient evaluation.** Prolonged discomfort, bruising, swelling, and numbness were evaluated by seven patients at one year on a scale from 0 to 3. Mean scores were low and ranged from 0.0 to 0.3 for each parameter. All issues resolved within three months. Overall firmness was rated higher, at 2.0. As shown in Figure 10, overall reduction of cellulite was rated as 3.2, skin texture improvement as 3.0, and patient satisfaction as 3.7 at one year; all these parameters were scored on a scale of 0 to 4. For reduction of cellulite and skin texture, scores at one year were roughly equal to those at three and six months, whereas patient satisfaction reached a maximum at one year. These results suggest that treatment benefit, as perceived by patients, persisted at least one year.

Clinical results are shown in Figures 11-17.

**DISCUSSION**

This study suggests that a single treatment with the 1440-nm pulsed laser safely improves the appearance of cellulite and that the improvement persists for at least one year. The side-firing fiber enabled the laser operator to treat three structural features of cellulite: (1) the uneven dermal-hypodermal interface, by melting the hypodermal fat to prevent its expansion into the dermis; (2) the connective tissue strands (septa) connecting the dermal and muscle layers, by thermally subcizing them; and (3) the dermal layer, by heating to increase its thickness, tighten the skin, and stimulate collagen remodeling. This interpretation is supported by objective measurements of skin thickness and
elastici ty, subjective physician and patient evaluations, and clinical photographs before and after treatment.

Previous modalities have demonstrated limited efficacy and duration because they address only one or two of the multiple structural features of cellulite. The Endermologie device mechanically mobilizes subcutaneous fat and improves lymphatic drainage, but it does not address the septa, denature subcutaneous fat, tighten skin, or stimulate

Figure 11. The left lateral thigh of a 37-year-old woman treated with the 1440-nm laser. The dotted line encloses the treatment area at (A) baseline, (B) three months, (C) six months, and (D) one year after treatment.

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Figure 12. The left posterior thigh of a 47-year-old woman treated with the 1440-nm laser. The dotted line encloses the treatment area at (A) baseline, (B) three months, (C) six months, and (D) one year after treatment.
collagen remodeling, thus explaining why the effects are temporary and up to 15 sessions are recommended. The VelaSmooth system may stretch the connective tissue surrounding the fat, but stretched connective tissue will eventually regain its unstretched orientation, which may explain why the duration of clinical effects is short and

Figure 13. The right lateral thigh of a 46-year-old woman treated with the 1440-nm laser. The dotted line encloses the treatment area at (A) baseline, (B) three months, (C) six months, and (D) one year after treatment.
repeat treatments are required. These limitations apply to all devices that rely completely or in part on mechanical manipulation of tissue. Laser energy applied to the skin surface stimulates blood and lymphatic flow and neovascularization, but the energy must penetrate the upper layers of skin to reach the lower layers, and the skin must be cooled during treatment, thus limiting its effect on collagen, fat, and connective tissue. The device studied here overcomes these limitations by introducing laser energy into the lower layers of skin so that the energy is directed against the specific causes of cellulite. This three-pronged approach explains the much-greater duration of effect compared to other modalities and the necessity of only a single treatment.

Heating the dermal layer with the laser fiber in the up position had several effects. One was to smooth the dermal-hypodermal interface by disrupting herniated fat in the dermal layer. Ultrasound images at baseline and one, three, six, and 12 months show the rapid improvement in smoothness of the interface at one month and demonstrate that most of the benefit persists for at least one year. Resolution of the uneven interface is attributed to thermal destruction of the intruding adipocytes. Another effect was to stimulate collagen deposition and remodeling, which increased the dermal thickness and skin elasticity. Ultrasound and elasticity measurement showed that skin thickness and elasticity increased at one month and persisted for at least one year. One belief is that a thicker and more elastic dermis helps flatten the skin and smooth the surface, thereby improving the appearance of cellulite.

The increase in thickness reached a minimum at six months. This may be due to the posttreatment edema, which slightly inflates the dermis and affects the thickness measurement. Edema was resolved after six months; however, the deposition and reorganization of new collagen was still in process at one year, so the dermis was thicker at six months. An elasticity measurement device showed that posttreatment elasticity continued to increase for at least one year.

Figure 14. Untextured before/after surface data based on Vectra 3D Analysis (Canfield Scientific Inc., Fairfield, New Jersey) are spatially registered for consistent evaluation of changes in surface geometry. Treatment areas are enclosed by four green dots (pretreatment, left; one-year posttreatment, right). The posttreatment image shows clear improvement (smoothing) in the skin surface of the thigh.
Ultrasound has been recommended to evaluate the efficacy of cellulite treatments.\textsuperscript{12} In one study, ultrasound cross-sectional images were used to monitor the effectiveness of cellulite treatment by revealing changes in the smoothness of the dermal-hypodermal interface over time.\textsuperscript{6} In that protocol, patients received three treatments per week during the three-month study period, and ultrasound images before and after massage treatment showed a reduction in irregularity of the interface. When the treatments stopped, the dermal-hypodermal interface gradually became more irregular over several months, indicating that massage provided only temporary benefits.

Cellulite is associated with a high percentage of fibrous septae perpendicular to the skin surface.\textsuperscript{8,11} This condition creates dimples and bumps in the skin (raised areas) in patients with cellulite (especially, women) due to fat retention within the fibrous septal compartments.\textsuperscript{11} In this study, the laser cannula was moved back and forth with the fiber in the horizontal position to reduce dimples and raised areas on the skin. The coagulation caused by the heat, as distributed by the laser fiber moving in the hypodermis, stimulated collagen deposition in a more horizontal pattern over time, thereby reducing the likelihood of cellulite recurrence.

Destruction of conjunctive septa was the basis for the subcision procedure shown to smooth cellulite-affected skin in a 232-patient study.\textsuperscript{19} Although patient satisfaction in that study was high, all patients experienced pain, bruising, and hemosiderosis that persisted for up to 10 months. Ninety percent of patients had bruises that were painful for a maximum of four months, and 14\% reported “an excessive elevation of the treated areas.” Hemosiderosis-induced hyperpigmentation that lasted for two to 10 months was also observed in all treated patients.

Unlike subcision, the 1440-nm laser energy ruptures the conjunctival septa thermally rather than mechanically.
A mechanical rupture eventually heals, and the fibers reconnect the upper dermal and lower muscle in the same fashion. Heat, however, not only disconnects the septa but also stimulates the development of collagen in an anatomical area that may form a scarlike splint between the upper and lower portions of the septa and, thus, a more horizontal reconnection.

Adverse effects with the 1440-nm laser procedure were limited to discomfort, bruising, swelling, and numbness, the severity of which was mild and the resolution of which was complete within three months for all patients. Treatment-induced burns were not observed in this study, because temperature was monitored in real time with a thermal camera on the skin surface and internally during treatment. The treatment end point was the number of joules of energy delivered rather than the skin surface temperature. Clinical outcomes and the minimal adverse effects suggest that 32 to 68 J/cm² (800 to 1700 J per square sector [5 × 5 cm]) is a reasonable energy density to achieve efficacy while minimizing damage to vascular/lymphatic structures and hardening of fatty tissue.

Several procedural cautions must be emphasized. First, the treatment end point is the number of joules of energy delivered to the tissue, rather than the skin surface temperature. Second, the appropriate energy per unit area is 32 to 68 J/cm²; additional energy may cause tissue hardening secondary to fat necrosis and seroma. Third, the temperature-monitoring device should never be set higher than 47°C. Last, each patient should be evaluated immediately after treatment for complications.

The strengths of this study are the objective and subjective data showing the persistence of clinical benefit for up to one year. The objective measurements of skin thickness and elasticity, along with the patient photographs, provide

Figure 16. Surface data based on Vectra 3D Analysis (Canfield Scientific Inc., Fairfield, New Jersey) allow clinical evaluators to optimize their perspectives of the target area by rotating and zooming the models in much the same manner that one clinically assesses the patient, by physically moving oneself or the patient. However, unlike clinical assessment with the patient, comparison of multiple time points may be accomplished with registered and synchronized three-dimensional data. Presented here is an example of how a change in perspective enhances appreciation of a feature (pretreatment, left; one-year posttreatment, right).
conclusive evidence of the efficacy of the 1440-nm pulsed laser for the treatment of cellulite. Limitations of this preliminary study include the small number of patients. The encouraging results of the present study warrant future studies with more patients and cellulite of greater severity to further optimize treatment parameters.

**CONCLUSIONS**

A single treatment with the 1440-nm pulsed laser improved the appearance of cellulite in this preliminary study of 10 patients. Mean skin thickness and skin elasticity were shown by objective measurements to increase significantly at one, three, six, and 12 months. Subjective physician and patient evaluations indicated improvement, high patient satisfaction, and minimal adverse effects. Improvement persisted for at least one year.

**Disclosures**

Dr. DiBernardo is a paid research and training consultant to Cynosure, Inc. (the manufacturer of the product discussed in this article).

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Commentary on: Treatment of Cellulite Using a 1440-nm Pulsed Laser With One-Year Follow-Up: Preliminary Report

A. Jay Burns, MD

In my opinion, there are four holy grails of cosmetic surgery that the baby boomer generation has been actively pursuing over the last 20 years: noninvasive skin tightening, localized noninvasive fat reduction, stretch mark improvement, and treatment of cellulite. In his study, Dr. DiBernardo introduces an interesting, novel, and promising new approach to the last of these goals.

As the author points out, his study is limited by a small number of patients (10). However, this study is well designed as a prospective controlled model. The clear strengths of the study include the full year of follow-up, the clearly-demonstrated photographic improvement, and the objective measurements of skin elasticity and thickness.

One of the most confusing areas of laser surgery is the area of optimal wavelength utilization. Anderson et al outlined the optimal wavelengths for fat absorption. However, that study actually outlined fat absorption from external laser radiation and did not examine the effectiveness of absorption when the laser was fired into the hypodermis in direct contact with the fat itself. Many wavelengths are utilized in the melting of fat (eg, 920 nm, 975 nm, 1064 nm, 1320 nm, and 1440 nm), and the characteristics of each are beyond the scope of this commentary. However, the 1440-nm wavelength—the one administered in Dr. DiBernardo’s study—has the greatest absolute absorption of water and fat among the wavelengths listed. Therefore, when the laser is fired directly in the hypodermis, the heat generated from absorption of the wavelength occurs very close to the tip of the fiber. As such, the wavelength is effective in heating collagen, which is precisely how it is utilized in this study.

A unique feature of this study is the directional application of the laser energy. Instead of coming from the end of the tip, it exits from the side near the tip. This side-firing fiber is placed just under the dermis and pointed down over the fat bulges to melt/reduce these areas. In a second stage, the fiber is turned upward 90° so that the energy is placed adjacent to the tight fibrous septae, firing parallel to the skin and theoretically releasing tight fibrous septae through heat destruction. Finally, the fiber is turned so that laser energy is directed up toward the dermis to tighten the skin. Note that melting the fat through heat most assuredly occurs with other wavelengths and is not singular to the one applied in this study. All wavelengths can melt fat nonselectively by creating char on the tip of the fiber. If this occurs, the fat can melt by sheer heat alone.

Dr. DiBernardo postulates that the fibrous septae are released by heat destruction with the 1440-nm laser as well. The high absorption in water places the effective treatment range right at the tip of the fiber, so it does become more precise in theory and is therefore an excellent theoretical and practical choice to accomplish the task of breaking up these fibrous bands. There is no evidence to explain why the bands do not regenerate as seen in the Orentreich and Orentreich study, in which these septae were divided sharply with cold steel. The author proposes that a wide scar band from diffuse treatment of the area yields a fibrous splint parallel to the undersurface of the dermis and perpendicular to the band itself. Again, this theory is presently pure conjecture. The mechanism is yet to be determined, but the author offers logical and reasonable theories. From the long-term results shown in this study, some mechanism apparently exists to minimize the indentsions seen preoperatively. Melting fat and tightening of the dermis alone could largely influence the effectiveness of treatment. The relative importance of each of these three proposed mechanisms remains to be determined.

I have always been concerned with the application of heat by any mechanism to the subdermis in an effort to tighten the dermis. Such an approach clearly places the subdermal plexus in jeopardy. This concern is more than theoretical:

Dr. Burns is Assistant Professor of Plastic Surgery at the University of Texas Southwestern Medical School, Dallas, Texas.

Corresponding Author:
Dr. A. Jay Burns, 901 N. Central Expressway Suite 600 Dallas, TX 75231
E-mail: annette.langford@dpsi.org
several cases of burns have been reported with laser-assisted liposuction, in which the laser-generated heat is transmitted to the dermis from the hypodermis for the purpose of tightening. No reported burns occurred in this study, which could be a result of the small sample size. However, the author has taken advantage of some impressive safety systems. Slower fiber movement of the laser for any reason would cause greater energy to be delivered in a smaller area, as well as excess heat and potential morbidity. To combat that potential complication, the system utilized by Dr. DiBernardo contains a motion sensor on the laser that decreases laser energy or stops the laser from firing altogether with slower movement of the fiber. Furthermore, an elaborate thermoregulatory feedback system monitors heat at the tip of the fiber. The surgeon can set the laser to stop firing when a certain temperature is reached. This safety mechanism is critical—and mandatory, in my opinion—when applying a laser to heat the dermis from below. Although these improvements represent a clear advance in safety, it is unclear whether such features are enough to ensure adequate safety based on only 10 patients—but again, they are a clear advance, which is welcome and necessary.

Also, skin elasticity measurements are far from exact, given that variation in the location of the suction tip placement and the hydration of the patient can affect reliability of the measurements. However, the consistent improvement in skin elasticity shown in this study cannot be overlooked. This finding runs parallel to the strong evidence of dermal thickening shown throughout the longevity of follow-up.

In summary, the author’s clinical photographs show a clear improvement at 12 months. In fact, these results are the best that I have seen to date in the treatment of cellulite. This photographic evidence is supported by impressive objective measurements of improved dermal thickness and skin elasticity. A logical explanation has been proposed for the mechanism of action with this 1440-nm wavelength technology, although further data are warranted. For these reasons, I commend Dr. DiBernardo on an excellent study that should serve as a basis for further research into this new approach to cellulite, which shows great promise at this point. We may not have found the holy grail, but we may be getting closer.

**Disclosures**

The author declared no conflicts of interest with respect to the authorship and publication of this article.

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