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ORIGINAL RESEARCH REPORT

Evaluation of a long pulsed 1064-nm Nd:YAG laser for improvement in appearance of cellulite

ANNE TRUITT[1], LAILA ELKEEB[1], ARISA ORTIZ[1], NAZANIN SAEDI[1], AGUSTINA ECHAGUE[2] & KRISTEN M. KELLY[1]

[1]*Department of Dermatology, University of California, Irvine School of Medicine, Irvine, CA, USA, and* [2]*Candela Corporation, Wayland, MA, USA*

Abstract

Background: Cellulite is a common, unwanted condition, which is challenging to treat. *Objectives*: The objective of this investigation was to evaluate safety and effectiveness of a long-pulsed 1064 Nd:YAG laser as a method for improvement in cellulite appearance and to evaluate parameter selection. *Materials and methods*: Twenty-two female subjects with posterior leg cellulite were randomly assigned to treatment of left or right thigh with higher energy treatment with cryogen spray cooling (CSC) (10-mm spot size; 50 J/cm^2; 50-ms pulse duration and CSC settings of 30-ms duration with a 20-ms delay) or lower energy treatment with no CSC (10 mm; 20 J/cm^2; 50 ms). Subjects received three treatments at 4 weeks intervals. Digital photographs and circumference measurements were taken pre-treatment and up to 6 months post-treatment. *Results*: Nineteen subjects completed three treatments and 16 subjects completed 6-month follow-up. Circumference measurements pre- and post-treatment were not significantly different. Blinded evaluators noted mild improvement in three of seven subjects in high energy group and moderate improvement in two of nine subjects in low energy group. *Conclusion*: Multiple passes with a long-pulsed 1064 Nd:YAG achieved mild or moderate improvement in some subjects as rated by blinded evaluators.

Key Words: *laser and light sources, cellulite*

Introduction

Many people, especially women, are bothered by cellulite. This condition is difficult to treat and there are few procedures, which achieve desired improvement. With a rising demand for cellulite reduction, new non-invasive technologies are becoming increasingly popular.

Cellulite is commonly found in the thighs and buttocks of post-pubertal women and has an unclear etiology. One of the leading hypotheses of the physiology of cellulite is altered connective tissue septae (1), possibly due to hormonal influences. Altered septae could allow for subcutaneous fat herniations producing the commonly described cottage-cheese appearance of cellulite.

Several treatment modalities have been used for cellulite; however, few are consistently effective. Treatments include endermologie, subcision, bipolar and unipolar radiofrequency, ultrasound and lasers (2). The authors know of three Federal Drug Administration (FDA)-cleared non-ablative lasers for the temporary improvement of cellulite: Velasmooth/Velashape that combines laser (3), radio frequency and vacuum (Syneron Medical Ltd, Yokneam, Israel), Smoothshape that combines laser and mechanical vacuum (Eleme Medical Ltd., Merrimack, NH, USA) and Triactive (3), which combines low-energy diode laser, contact cooling, suction and massage (Cynosure, Inc., Westford, MA, USA). These devices are designed so that they are only used for treatment of cellulite or temporary reduction in thigh circumference. Liposuction has been used to attempt to improve appearance of cellulite. However, this procedure is better suited for removal of fat in localized areas. CoolSculpting (Zeltiq, Pleasanton, CA) is cleared by the FDA for non-invasive removal of

Correspondence: Kristen Kelly, MD, Associate Professor of Dermatology and Surgery, Department of Dermatology, University of California, Irvine, Medical Sciences C, C-340, Irvine, CA 92697-2400, USA. E-mail: annetruitt@aol.com

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localised areas of fat, for example 'love handles' (4). It is not intended for cellulite improvement or for treatment of large areas such as the thighs.

It would be useful for clinicians if a laser with multiple indications could be used for improvement of cellulite. One such device is a long-pulsed 1064-nm neodymium yttrium aluminium garnet (Nd:YAG) laser cleared by the FDA for treatment of unwanted hair, vascular lesions, benign pigmented lesions and rhytids. Many clinicians have these devices in their office and utilise them for the FDA-cleared purposes. This device also has the ability to deliver thermal energy to the dermis that could initiate a wound healing response and thus induce new collagen production (5–7). It has been hypothesised that a thicker layer of collagen could compress fat herniations associated with cellulite, improving the appearance. Key et al. (8) proposed use of this laser for skin tightening. Based on this work, we hypothesised that a multiple pass 1064-nm Nd:YAG laser treatment could be performed to deliver heat to tissue and create a tissue remodelling response.

The objective of this investigation was to evaluate safety and effectiveness of the long-pulsed 1064-nm Nd:YAG laser as a method for improvement in appearance of cellulite and to evaluate parameter selection for this indication.

Material and methods

This randomised prospective study was approved by the University of California, Irvine Institutional Review Board for the protection of human subjects. Full inclusion and exclusion criteria are listed in Table I. Briefly, subjects were eligible for enrolment if they were female, post-pubertal, Fitzpatrick skin types I–IV and had cellulite on both thighs at stage 2–3 per the Nurnberger–Muller Scale (Table II). Subjects were excluded if they had undergone liposuction or other surgical procedures (including mesotherapy) to remove fat from their thighs during the past year or had severe cellulite with pain or tenderness.

Laser treatments

Subjects were randomly assigned to treatment of the left or right thigh with the contralateral untreated thigh serving as control. Each subject was also randomized to a higher energy treatment with cryogen spray cooling (CSC) for epidermal protection (high fluence/cooling group) or a lower energy setting without CSC (low fluence/no cooling group). Three or four (depending on thigh size) rectangular treatment areas were marked out on the skin. Topical or oral anaesthetics were not used. Treatment was completed on one of these treatment areas before moving on to the next. Three to five passes were performed on each area. For the high fluence/cooling group, the laser settings were: 10-mm spot size; 50 J/cm^2; pulse duration of 50 ms and CSC settings of 30-ms duration with a 20-ms delay (30/20). Single laser pulses were delivered. For the low fluence/no cooling group, the laser settings were: 10-mm spot size; 20 J/cm^2; pulse duration of 50 ms and no cooling. Double stack pulsing was performed for each spot in the low fluence/no cooling group. Three treatments were performed at 4-week intervals. Subjects were evaluated for up to 6 months post-treatment.

Table I. Study criteria.

Inclusion Cristeria	
1.	Individuals, male or female, greater than 40 wars of age.
2.	Moderate skin laxity in the arms, legs, abdomen, or neck.
3.	Subject is not overweight Body Mass Index (B.MI.) is = 27.
4.	Subject has Rtzpatrick skin phototype I-IV'.
5.	Subject is willing to participate in studyand adhere to follow-up schedule.
6.	Subject is able to read and comprehend English.
7.	Subject has completed Informed Consent Form.
Exclusion Criteria	
1.	Subjects that have had liposucbon or other surgical procedures (including mesotherapy) to re move fa tin the treatment are a during the past year.
2.	Subject is overweight (BMI > 27).
3.	Subject has known photosensitivityor history of ingesting medications known to induce photosensitivityin the previous 3 monms.
4.	Subject has a personal or family historyof keloid formation or scarring.
5.	Subject is pregnant orlactating.
6.	Subject has a history of uncontrolled diabetes and or requiresmedication which mayinterfere with the study.
7.	Subjects with a known historyof neuropathy.
8.	Subjects with a known historyof a coagulopathy.
9.	Subject is unable or unwilling to complywim me study requirements
10.	Subject has pacemaker or metallic implants.
11.	Subject has Fitqatrick skin type V and VI.
12.	Subject is mentally incompetent or a prisoner

Table II. Nurnberger–Muller scale.

Srage 0:	No dimpling. Pinch test "folds and furrows." no mattress like i appearance.
Stage 1:	No dimpling. Pinch test reveals mattress like appearance.
Stage 2:	Dimpling spontaneously standing.
Stage 3:	Dimpling ^ontaneously standing and lying down.

Measurements/evaluations and statistics

Prior to initiation of treatment, standardised pictures and bilateral thigh circumference measurements were taken.

During each treatment, the subject was evaluated by the investigator for purpura, oedema, erythema and blistering. Each subject was asked to rate their pain level on a scale of 0–10, with 10 being the maximum.

The pictures were evaluated by dermatologists. The blinded evaluators were not told, which leg was treated prior to their assessment. Each evaluator reviewed both thighs, determined which thigh they thought had been treated, and then graded improvement of presumed treated thigh. The grading scale and scoring used by these evaluators is as follows: no improvement (0%), mild improvement (1–25%), moderate improvement (26–50%), significant improvement (51–75%) and excellent improvement (76–100%).

At follow-up visits, subjects were also given an assessment survey to evaluate their satisfaction with the procedure, to estimate their overall improvement and to assess their likelihood of undergoing the treatment again. The scale for this survey was rated 1–5 (1 = not satisfied, 2 = little satisfied, 3 = somewhat satisfied, 4 = satisfied, 5 = very satisfied).

Thermal camera (ThermaCAMTM Model S65 manufactured by FLIR Systems, Inc.) and handheld temperature monitor measurements were taken mid-way through the study as an exploratory endpoint to evaluate tissue heat generation with various parameters offered by the laser. Comparisons were made between different spot sizes: 18-mm spot size (20 J/cm^2; pulse duration of 50 ms; no CSC; single pulses) versus 10-mm spot size (24 J/cm^2; pulse duration of 50 ms; no CSC; single pulses). To explore treatment with CSC versus no CSC, comparisons were made with 18-mm spot size; 20 J/cm^2; pulse duration of 50 ms; with and without 30 ms of cooling with a 20-ms delay; single pulses.

Results

Twenty-two subjects were enrolled in this study. Eleven subjects were randomised to the high fluence/cooling group and 11 subjects were randomised to the low fluence/no cooling group. Table III compares characteristics of the two groups. Age and body mass index were comparable between groups.

Table III. Comparison of characteristics of study group.

	High Fluence/ Cooling (n = 11)	Low Fluence/ No Cooling (n = 11)
Age in years		
-Average (range)	38(23–09)	36(27–47)
-Standard Deviation	9.38	as2
	p value of two groups 0.74	
Body Mass Index		
-Average (range)	23.3 (19–26)	23.9(20–26)
-Standard Deviation	228	176
	p value of two groups 0.47	
Skin Type (Fitzpatrick scale)		
-Average (range)	III ll–IV)	III (ll–IV)
-Standard Deviation	092	069
	p value of two groups 0.03	

The two groups did differ in terms of skin type with the lower fluence/no cooling group having more subjects with type IV skin type. Of the total 22 subjects, 19 subjects completed three treatments with a total of eight subjects in the high energy/cooling group and 11 subjects in the low energy/no cooling group. In case of the subjects who voluntary withdrew, discontinuation in the protocol was not related to treatment effects but due to relocations or an illness in the family.

There was no blistering, purpura or oedema noted during any treatments. All subjects experienced mild erythema during the procedure that resolved rapidly after completion of the treatment. There was no evidence of scarring or pigmentary change observed during any of the post-treatment assessments. Each subject reported the level of pain after each treatment, and the average pain level of three treatments was calculated for each subject. The variation in the pain level for each treatment was minimal with maximum difference being two. For the average pain level after three treatments, in the high fluence/cooling group, three subjects noted a pain level of 0–2, one subject with 3–5 and four subjects with a pain level of 6–8. In the low fluence/no cooling group, eight subjects noted a pain level of 0–2, one subject with 3–5 and two subjects with a pain level of 6–8.

Sixteen subjects continued through the 6-month follow-up visit (seven subjects in the high fluence/cooling and nine in the low fluence/no cooling group). Again, subject self-withdrawal was due to personal reasons and not due to any complication from treatment. The average weight of subjects was consistent from baseline to final follow-up at 139.5 and 140.7 pounds, respectively. Four subjects had weight changes greater than 10 pounds: −13.6, 12.6, 11.0 and 13.4 lbs. Four subjects did have

several inches reduction in treated thigh circumference; however, changes in circumference of treated and untreated thighs were similar and overall pre- and post-treatment measurement differences were not statistically significant (high fluence/cooling group ($p = 0.79$); low fluence/no cooling group ($p = 0.68$)).

These 16 subjects were scored by the blinded evaluators. Three of seven (43%) subjects in the high fluence/cooling group were graded as having mild improvement and two of the nine (22%) subjects in the low fluence/no cooling group were graded as having moderate improvement in the appearance of cellulite. Improvement was not noted in the other subjects.

Fifteen subjects completed the survey at the 6-month follow-up visit. Five (33%) subjects were either satisfied or very satisfied with the procedure, four (27%) subjects reported moderate or significant improvement of cellulite and four (27%) subjects would definitely undergo this treatment again. Figure 1 shows the treated thigh of a 40-year-old subject.

Thermal camera and hand-held temperature monitor measurements are reported in Figure 2 and Table IV. Heat generated increased with cumulative number of passes and with the use of a larger spot size. Using an 18-mm spot, the temperature elevated an average of $\pm$ 0.9 to 2°C with each cumulative pass from 35°C, at baseline to over 41°C after the fourth pass. The peak temperature achieved with the 10-mm spot was just over 37°C. The larger spot size produced a higher temperature increase. Higher temperature elevations were achieved without as compared to with cryogen spray cooling.

Discussion

This approach has potential. Treatment was quick (15 minutes or less), was well tolerated and was performed with a laser already present in many offices. Most subjects reported no to moderate pain during treatment. Skin erythema was noted immediately post-treatment but resolved quickly. No other skin changes, specifically no blistering, pigmentary changes or scarring were observed.

The study design allowed for exploration of varying laser parameters to optimise efficacy, safety and subject comfort. The initial laser parameters for this study were selected based on reports from other physicians (5) and safety considerations (initially a small spot size was considered to be safer, especially with pulse stacking). However, as the study progressed and it was determined that the treatment was safe, we explored other settings with thermal camera measurements as described in the results section above. These measurements demonstrated that a larger spot size may be most efficacious and could be done safely.

The lack of change in circumference reduction was not unexpected, since treatment was to the posterior thigh only and not the entire circumference.

Subjects were surveyed about the procedure at the 6-month follow-up visits. There appeared to be

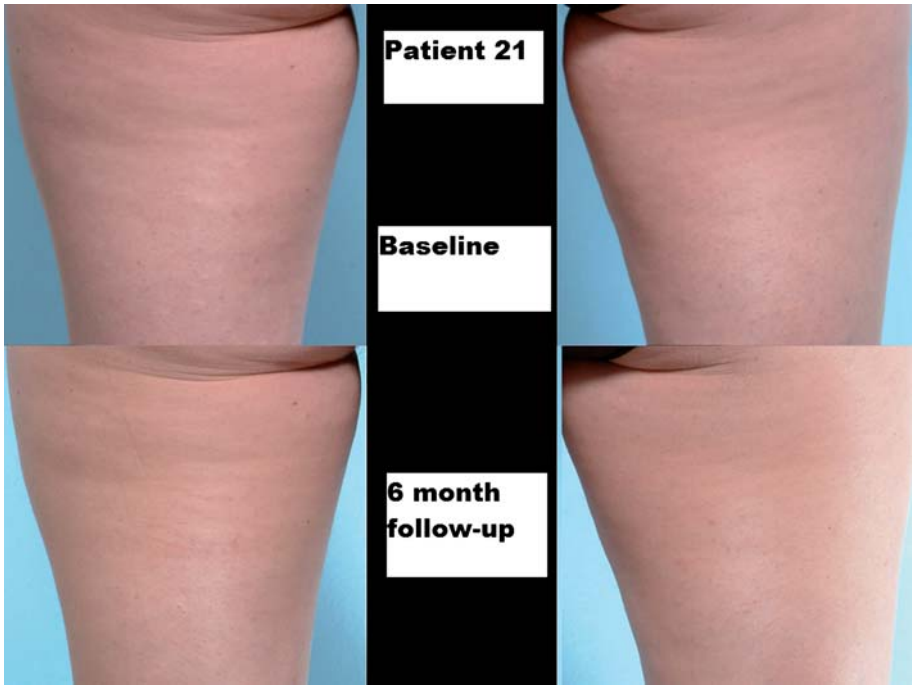
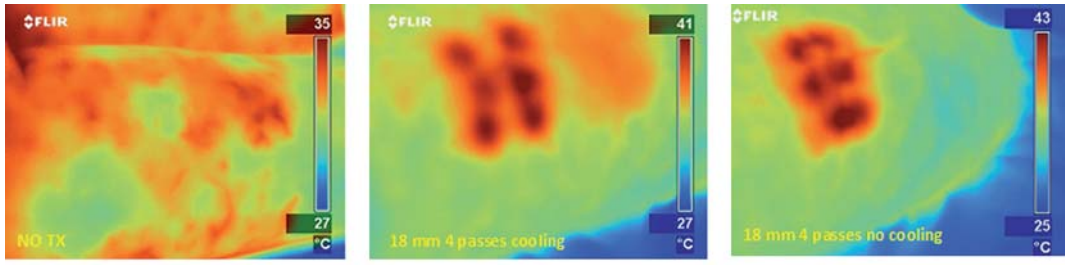


Figure 1. A 40-year-old female in low fluence/no cooling group who had left thigh treated (10-mm spot size; 20 J/cm^2; pulse duration of 50 ms and no cooling). Improvement was graded as moderate.



Label	Value [°C]	Min	Max
NO TX	35.9	-	-
18 mm TX 4 passes/no cooling	43.4	22.7	43.4
18 mm TX 4 passes/ cooling	40.5	22.5	40.5

Figure 2. Thermal camera measurements comparing no treatment, treatment with an 18-mm spot with cooling (20 J/cm^2; pulse duration of 50 ms; 30 ms of cooling with a 20-ms delay; single pulses) and treatment with an 18-mm spot and no cooling (20 J/cm^2; pulse duration of 50 ms; no cryogen spray cooling; single pulses).

no clear correlation between the satisfaction of the procedure with the estimated improvement score and the likelihood of recommending the procedure. This discordance may be due to variation in individual subjects' expectation as well as the fact that there was no charge for study treatments.

Groups were statistically different in terms of skin type with the lower fluence/no cooling group having more subjects with skin type IV. Authors do not feel that this affected results, and the subjects of darker skin did not experience more discomfort.

Bousquet-Rouaud et al. evaluated the treatment of cellulite with the 1064-nm Nd:YAG laser by assessing ultrasound images of the dermis both pre- and post-treatment at 1- and 3-month follow-up (5). This study involved treatment of the posterior thigh in 12 subjects, and the parameters used were: 18 mm, 30 J/cm^2, 50 ms pulse duration and cryogen spray cooling of 30 ms. Their findings demonstrated an improvement in the density of the dermis, a reduction of dermal thickness (which is not consistent with the hypothesis that a thick layer of collagen may compress cellulite) and a slight improvement of the dimpling aspect of the posterior thighs in some subjects. They also reported that treatments were well tolerated. These authors provide further evidence that this laser is a potential alternative for improvement of cellulite.

As noted above, all treatments were well tolerated. It should be noted, however, that clinicians do need to be careful while choosing Nd:YAG lasers as treatment effects may be relatively deep and tissue injury could occur if alternative settings were used or if there were other variables such as significant vasculature in the area (veins were specifically avoided) or treatment of darker skin types.

Cellulite remains a challenging dermatologic condition to treat. Treatments such as endermology and mesotherapy have varied responses and may result in adverse effects (1,2). Velasmooth/Velashape, Smoothshape and TriActive (3) have been reported to improve cellulite but there is a lack of long term follow-up and these devices are only used for cellulite improvement. Overall, our treatments were easy to perform with a laser that is commonly found in clinician offices for other procedures, were well tolerated and demonstrated improvement in some, albeit not all subjects.

Conclusion

Multiple passes with a long-pulsed 1064-nm Nd:YAG achieved mild or moderate improvement in some subjects as rated by blinded evaluators. Treatments were well tolerated and no adverse effects occurred. Temperature measurements demonstrated heat generated increased with cumulative number of passes and was greater with a larger (18 mm) versus a smaller (10 mm) spot size. Further studies analysing the potential improvement with a larger spot size are suggested.

Table IV. Temperature changes with cumulative passes.

	Temperature 1st pass	Temperature 2nd pass	Temperature 3rd pass	Temperature 4th pass	SD
10 mm spot size	34.10	35.83	36.83	37.60	0.39
18 mm spot size	36.03	38.20	38.80	41.50	0.39
SP03 = Control	33.36	33.97	33.73	33.80	0.49

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

References

1. Avram M. Cellulite: A review of its physiology and treatment. J Cosmet Laser Ther. 2004;6:181–185.
2. Khan M, Victor F, Rao B, Sadick N. Treatment of cellulite; Part II: Advances and controversies. J Am Acad Dermatol. 2010:62:373–384.
3. Nootheti P, Magpantay A, Yosowitz G, Calderon S, Goldman MP. A single center, randomized, comparative, prospective clinical study to determine the efficacy of the Velasmooth system versus the TriActive system for the treatment of cellulite. Lasers Surg Med. 2006;38:908–912.
4. Nelson AA, Wasserman D, Avram MM. Cryoliploysis for reduction of excess adipose tissue. Semin Cutan Med Surg. 2009;28:244–249.
5. Bousquet-Rouand R, Bazan M, Chaintreuil J, Echague A. High-frequency ultrasound evaluation of cellulite treated with the 1064 nm Nd:YAG laser. J Cosemt Laser Ther. 2009;11: 34–44.
6. Goldberg D, Silapunt S. Histologic evaluation of a Q-switched Nd:YAG laser in the nonablative treatments of wrinkles. Dermatol Surg. 2001;21;744–746.
7. Dayan S, Vartanian A, Menaker G, Mobley SR, Dayan AN. Nonablative laser resurfacing using the long-pulse (1064-nm) Nd:YAG. Arch Facial Plast Surg. 2003;5; 310–315.
8. Key DJ. Single treatment skin tightening by radiofrequency and long-pulsed, 1064-nm Nd:YAG laser compared. Lasers Surg Med 2007;39:169–175.