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Original Article

Low Level Laser Therapy versus Radiofrequency on Cellulite after Liposuction

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Abstract

Background: Cellulite is a painless skin condition involving esthetic concerns with dimpling and denting of the skin surface. It is a common condition occurring in about 80%-90% of post-pubertal women of all races.

Purpose: The aim of this study was to compare the effects of low-level laser therapy and radiofrequency on cellulite after liposuction.

Materials and Methods: Fifty female patients were equally classified into two treatment groups each of 25 patients; group (1) treated by Low Level Laser Therapy (LLL) and group (2) treated by radiofrequency (RF). For Low level laser therapy; patients were subjected to green 532 nm diode and abdominal exercise for 2 months, 3 sessions per week, 2-3 days apart. Unipolar radiofrequency was applied to the other group in addition to abdominal exercise for 2 months, 3 sessions per week, 2-3 days apart. Assessment by photo-numeric cellulite severity scale was performed before sessions and after 2 months of treatment.

Results: The effectiveness of treatments analysis between both groups revealed that; LLLT group (1); 16 patients (64%) had effective treatment and 9 cases (36%) had no effect. In RF group (2); 8 patients (32%) had effective therapy and 17 cases (68%) had no effect. The outcomes for cellulite scale and cellulite severity assessment revealed that; comparison between groups (LLLT) and (RF) showed a non-significant difference before treatment. Both groups showed highly significant differences after treatment compared to before treatment, however, group (LLLT) was more significant than group (RF).

Conclusion: Both treatment modalities LLLT and RF, had significant effects on cellulite after liposuction and provided significant improvement in all variables (photo numeric cellulite severity scale), in addition, LLLT was more effective than RF.

Keywords: **Low Level Laser Therapy; Radiofrequency; Cellulite; Liposuction.**

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Introduction:

Cellulite is a painless skin condition involving esthetic concerns with dimpling and denting of the skin surface, giving it an orange peel appearance. It is a common condition occurring in about 80%-90% of post-pubertal women of all races, almost all women think that they have cellulite at some time in their lives. It is seldom related to obesity and methods of fat reduction don't work well for the condition. It occurs mostly in areas with greater fat storage like the thigh, buttocks, and abdomen. It is also known as ganoid lipodystrophy, edemato-fibrosclerotic panniculopathy, or nodular liposclerosis. The treatment remains a challenge, with several topical treatments, life-style modifications, noninvasive device-based treatment, intralesional and surgical modalities having been tried **(1)**.

The most frequent risk factors contributing to cellulite formation are hormonal factors, genetic predisposition, inadequate diets, inactivity, excess body fat, smoking, postural disorders, and wearing tight clothes that cause external compression on body parts. The incidence of cellulite is about 85%–98% in women **(2)**. Menopause also worsen the condition due to increased vascular permeability and poor blood vessel tone, dermal atrophy in the affected areas, the alteration in subcutaneous septa, hypoxia, increased lipogenesis, and inflammation have all been postulated as contributory factors, and they may be responsible together **(1)**.

Liposuction most commonly causes changes in the cutaneous surface, which have the same appearance as the skin depression of cellulite. These depressed lesions cause secondary cellulite or exacerbate the grade of cellulite (3). It is currently the most performed aesthetic plastic surgery worldwide: just such as any surgical procedure, it stands its own risks and complications such as contour irregularities, infection, hypoesthesia, edema ecchymosis, seroma, hematoma, skin discoloration **(4)**.

Treatment of cellulite involves targeting various steps and pathways postulated in the etiopathogenesis. Although combination therapies have been tried, still there is no effective treatment **(1)**. Various kinds of non-invasive body contouring methods, including cryo-lipolysis, radiofrequency (RF), LLLT and high-intensity focused ultrasound (HIFU), are available for reducing the volume of subcutaneous adipose tissue or cellulite **(5-7)**.

Each procedure has distinct mechanisms for stimulating apoptosis or necrosis of adipose tissue **(6)**.

Radiofrequency generates heat in different tissues by transforming energy through three basic mechanisms from electromagnetic field **(8)**.

The purpose of this study was to compare the effects of low-level laser therapy and radiofrequency on cellulite after liposuction

Materials and Methods:

This was a comparative randomized study, where, 50 female patients with cellulite after liposuction were recruited and included up on the following criteria; Adult female patients (>18 years) with cellulite (grade1-2) after liposuction were included. However, patients who had any contraindication for both therapies used, those with cardiovascular disease, liver or renal disease, malignancy, metal, or electronic implants, autoimmune diseases, injury to treatment areas as well as pregnancy, postpartum period, breastfeeding were excluded. The fifty participants were randomly classified into two equal treatment groups each of 25 patients; group (1) treated by LLLT and group (2) treated by (RF) in a non-blind manner.

The study was conducted in the gynecological and obstetric hospital port said, at the period from June 2023 to June 2024 after approval by Ethical Committee, Faculty of Physical Therapy, Cairo University. Written consents were taken from the participants that explained the aims, methods, benefits, and potential risks of the procedures in a simple way according to the declaration of Helsinki.

Baseline data was collected from all patient's study start, regarding, age, length, weight, body

mass index and cellulite grades and distribution. Patients were randomly distributed into two equal groups. Group (LLLT) included 25 patients having cellulite, treated with low level (light) laser therapy (LLLT) using green 532 nm diode and abdominal exercise for 2 months, 3 sessions per week, 2-3 days apart. Group (RF) included 25 patients having cellulite, treated by unipolar radiofrequency and abdominal exercise for 2 months, 3 sessions per week, 2-3 days apart. For both groups: the front and back of hips, thighs, and waist were exposed for 15mins (30 min total) during each session.

Treatment Procedures

1. Low Level Laser treatment:

The LLLT device used in this study (Erchonia1 GL Scanner; Erchonia Corporation, McKinney, TX; GLS) utilizes six 532-nm green diodes or five 635-nm red diodes. Four mounted diodes in the scanner device were positioned 120^{o} apart from one another and titled at a 30^{o} angle. The remaining two diodes were positioned 4″ from the center and tilted at a 15^{o} angle. Internal mechanics of the GLS collected the laser light emitted from each diode and processes it through a proprietary lens which redirects the beam with a line refractor. The refracted light of each diode is bent into a random, spiraling pattern that is independent of the other diodes. The overlapping patterns of light ensure total coverage of the treatment area. The target area is approximately 8″ x 10″ in. (80 in. ^{2} or approximately 516 cm^{2}). Each diode has a mean power output of 17 mW and the total output of the six diodes is 102 mW **(9)**.

2. *Radiofrequency treatment:*

Each subject received four 30-min treatments with the Emsculpt Neo (BTL Industries Inc., Boston, MA) device simultaneously delivering HIFEM+RF energies through a single applicator. Two specific applicator types were used, the large applicators for broad treatment areas and small applicators for curved treatment areas.

Once positioned, the applicator remained fixed through the duration of therapy due to the flexible tape. The magnetic field intensity (0%–100%) was adjusted according to the subject's tolerability, and the intensity of radiofrequency energy was set to 100% from the start. Patients were regularly asked about the therapy comfort throughout the treatment administration, and the energy settings were adjusted accordingly. Consecutive treatment with the Emsculpt Neo device delivering simultaneous RF+TPE followed. The intensity of radiofrequency energy was initially set at a lower level (40%–50% of maximum output) and further adjusted up to 85% according to the patient feedback. The TPE pressure was set at 4-bar throughout the therapy. The applicator tip was kept in a constant circular motion over the treatment area, where conductive cream was applied to maintain good contact with the skin throughout the treatment duration. Each subject received four weekly treatments that lasted up to 20 min, depending on the treated area **(10)**.

Assessment Procedure:

Photo-numeric cellulite severity scale was used as a tool of assessment for cellulite. The assessment was conducted two times; before treatment and after 2 months of treatment. Photonumeric cellulite severity scale **(Hexsel et al., 2011)**:

The scale includes (**Figure 1**):

A. Number of evident depressions.

B. Depth of depression.

C. Morphological appearance of skin surface alterations.

D. Grade of laxity, flaccidity, or sagging skin.

E. Classification scale by Norberger and Muller:

- Stage I: No dimpling while the patient is standing or lying down but the pinch test reveals.
- Stage II: ‘Orange peel’ dimpling appears spontaneously when standing up, but not when lying down.
- Stage III: ‘Orange peel’ dimpling appears spontaneously both when standing up and lying down.

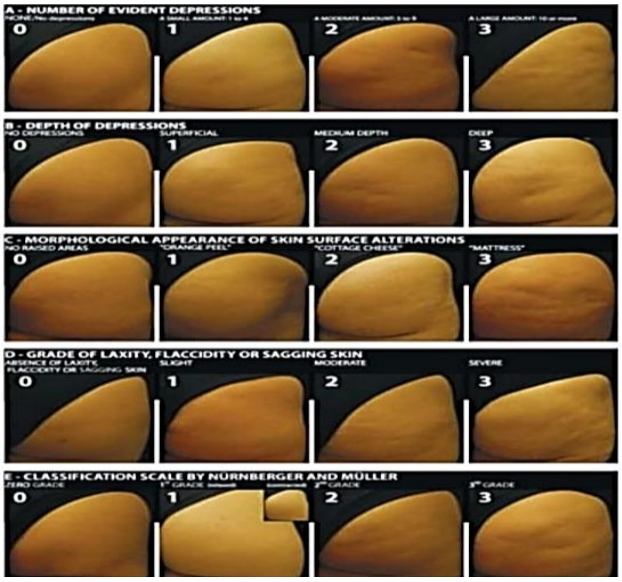

Figure 1. A guided validated photo numeric cellulite severity scale.

Statistical Analysis

Patient's demographic and measuring scale data were collected and analyzed by the SPSS software V 24 for Windows. Normal distribution of data was tested using one-sample Kolmogorov-Smirnov test. Qualitative data were expressed as frequencies and percent. Continuous variables (quantitative data) were expressed as means ± SDs (standard deviations) for normally distributed data. The parametric data were compared between groups using unpaired t-tests. While non parametric data was compared using Chi-square test. Within-group parametric results were compared using paired t test. A result was considered significant if the p ≤0.05.

Results:

Patient' demographic data:

The mean age was 30.72 ± 4.43 (range: 25-39) years in group (1) and 31.28 ± 4.77 (Range: 25-40) years in group (2). Anthropometric measures, cesarean section, grade of cellulites and cellulite distribution were similar in both groups (p >0.05), all are shown in **table 1.**

Photo numeric cellulite severity scale (Figure 2,3)

Effectiveness:

In LLLT group (1); 16 patients (64%) had effective treatment and 9 cases (36%) had no effect. In RF group (2); 8 patients (32%) had effective therapy and 17 cases (68%) had no effect. LLLT group (1) had more effective therapy than RF group (2) with a statistically highly significant difference (p <0.001), as shown in **Table 2.**

Figure 2. Sample photos of a woman with cellulite in the abdomen (up) and thigh (below): the left side before therapy and the right side after 8 sessions of LLLT (group 1)

Figure 3. Sample photos of a woman with cellulite in the thigh: the left side before therapy and the right side after 8 sessions of radiotherapy (group 2).

Scale score outcome measure:

Comparison between groups (1) & (2) showed an insignificant difference before treatment, while group (1) showed a significant reduction in cellulite than group (2) after treatment (p

=0.018). Both groups showed highly significant differences after treatment compared to before treatment, however, group (1) was more significant than group (2) (p =0.011, 0.039, respectively), as shown in **Table 3.**

Cellulite severity:

Comparison between groups (1) & (2) showed an insignificant difference before treatment, while group (1) showed a significant improvement than group (2) after treatment (p =0.016), as shown in **Table 4.**

Table 1. Demographics and characteristics of the two studied groups.

Data	Group LLLT (n = 25) Mean ± SD		Group RF (n = 25) Mean ± SD		p-value
Age (years)	30.72 ± 4.43		31.28 ± 4.77		0.924
Weight (kg)	77.88 ± 6.69		75.20 ± 3.56		0.537
Height (cm)	157.24 ± 3.24		159.48 ± 3.65		0.873
BMI (kg/m2)	24.8 ± 2.26		23.6 ± 1.18		0.617
Cesarean section:	**No.**	**%**	**No.**	**%**	**P/χ2**
Primary	9	36	9	36	1.000
Repeated	16	36	16	36	1.000
Cellulite grade:					
Grade (1)	8	32	10	40	0.062
Grade (2)	17	68	15	60	0.118
Cellulite distribution					
Abdomen	5	20	13	53	0.000*
Thigh	20	80	12	48	0.001*

SD: Standard deviation, t: t-test, χ^2: Chi-square test, *p <0.05: Statistically significant.

Table2. Treatment effect in the two treatment groups.

Treatment outcome	Group (LLLT)		Group (RF)		P/χ2
	No.	**%**	**No.**	**%**	
Effective	16	64.0	8	32.0	0.001*
No effect	9	36.0	17	68.0	0.000*
Total	25	100	25	100	

χ^2: Chi-square test, *p <0.05: highly significant.

Table 3. Comparison of outcomes in the two studied groups by Photo-numeric Cellulite Severity Scale before and after treatment.

PN-CSS before & after treatment	Group (LLLT)	Group (RF)	Significance	
			t	**P**
Before: Range	5.2 – 13.9	5.5 – 12.8	0.041	0.794
Mean ±SD	8.17 ± 3.01	8.02 ± 2.93		
After: Range	1.8 – 13.2	2.37 – 12.7	1.405	0.018*
Mean ±SD	5.26 ± 1.44	6.74 ± 1.68		
% of change	2.91	1.28	5.538	0.001*
t-test	1.621	1.012		
P value	0.011*	0.039*		

t = unpaired t-test, *p < 0.001: highly significant, PN-CSS: photo-numeric cellulite severity scale.

Table 4. Subjective analysis by Photo-numeric Cellulite Severity Scale in the two studied groups before and after treatment.

PN-CSS before & after treatment	Group (LLLT)		Group (RF)		Significance	
	No.	%	No.	%	F	P
Before: - Mild	0	0.0	0	0.0	0.000	1.000
- Moderate	14	56.0	14	56.0		
- Severe	11	44.0	11	44.0		
After: - Mild	9	36.0	3	12.0	3.212	0.016*
- Moderate	11	44.0	14	56.0		
- Severe	5	20.0	8	32.0		

F: Fisher exact test, *p < 0.001: highly significant, PN-CSS: photo-numeric cellulite severity scale.

Discussion:

Liposuction most commonly causes changes in the cutaneous surface, which have the same appearance as the skin depression of cellulite. These depressed lesions cause secondary cellulite or exacerbate the grade of cellulite **(3)**. Many agents/devices targeting various steps/pathways implicated in the etiopathogenesis of cellulite are available to help treat or diminish cellulite appearance, including topical agents, oral treatments, massage, energy-based devices as radiofrequency (RF), laser or light therapy, and acoustic wave therapy), subcision, and injectable treatments **(17).**

The purpose of this study was to compare the effect of low-level laser and radiofrequency on cellulite after liposuction. Fifty patients who underwent liposuction were precipitated according to our inclusion and exclusion criteria and participated in this study. It is clear from the research results that there is an improvement in both groups but the significant improvement in LLLT group (1) had more effective therapy than RF group (2) with a statistically highly significant difference ($p < 0.001$).

Our results were consistent with **Manuskiatti and colleagues et al. (18)** evaluated the effects of a TriPollar RF technology on abdomen and thigh circumferences and cellulite appearance in 39 female subjects with cellulite grade 2 (Nurnberger-Muller scale). The subjects received eight treatment sessions, seven days apart, without any change in their physical activity and diet. Four weeks after the last treatment session, the study showed a significant circumference reduction in the abdomen and thigh regions. Nevertheless, there was no significant reduction in buttocks and arms. In addition, the study showed that TriPollar RF improved the appearance of cellulite. For assessing treatment procedure's outcomes, circumference measurements of the treated region were done along with taking real-time scanning images and measuring skin elasticity. The cellulite condition was evaluated in each patient according to the Nurnberger-Muller scale.

Del Pino et al. (19) assessed the effects of applying unipolar RF [the Accent RF System (Alma Lasers Inc)] on subcutaneous fat of the buttocks and thighs of 26 female subjects (ages 18 to 50 years) with visible cellulite (grade 1 to 3). Two treatment sessions, two weeks apart, were considered. They used real-time scanning image ultrasound to measure the distance between the dermis and the camper's fascia, and their findings showed that controlled tissue heating with RF could reduce the thickness between the dermis and fascia. The average reduction in thigh and buttocks was 2.64 and 1.8 mm, respectively. Understanding the effect of treatment sessions on changes in skin texture and clothing leads to patient satisfaction with the procedure and was assessed by the studying group.

Our results agreed with **van der Lugt et al. (20**) revealed that RF could improve upper thigh cellulite in females aged 24 - 58 years, and the positive effects remained at least for six months after treatment. They applied a unipolar, volumetric RF device (frequency between 0.6

and 2.4 MHz) for 12 sessions, one week apart. All of the fifty female subjects (with homogenous cellulite depositions) showed considerable amelioration in buttock skin conditions, which was completely noticeable by real-time scanning ultrasound image and comparing the distance between stratum corneum and Camper's fascia and from the stratum corneum to the muscle, before and two weeks after treatment sessions. Most of the patients were satisfied with the treatment. However, two months after the last session, a slight return was seen in the favorable treatment results. Another study in New Jersey revealed that utilization of unipolar RF (Alma Lasers, Buffalo Grove, IL) improved upper thigh cellulite in females. All the subjects were over the age of 30 years with upper thigh cellulite (grade 3 to 4, according to the Nurnberger-Muller scale). Their thigh circumference decreased 2.45 cm on average after six sessions of treatment, one week apart. However, there were no significant changes in body weight and blood lipids after the treatment **(21**).

Sadick and Mulholland (22), reported their experience on the use of RF energies in order to treat cellulite in 35 female subjects. Each patient received 8 to 16 treatment sessions one week apart and target zones were thighs and/or buttocks. Subjects were instructed to continue their normal lifestyle (including diet and fluid consumption). After eight treatment sessions, the mean reduction in circumference was 2.03 cm.Our findings agreed with **Araujo et al. (23)** confirmed that up to 96% of former studies obtained positive outcomes with RF. These data were collected by before and after exposure pictures, patient questionnaires, biopsy, etc. Satisfaction for subcutaneous fat reduction with RF was approximately 71 - 97%, according to patients' self-reported data.

Low-level laser therapy is another noninvasive method for reducing adipose tissue and received FDA clearance in 2010. Before that, LLLT was widely used for treating other problems such as neurologic, ophthalmic, dental, and dermatologic diseases. Although there is some evidence that shows the effects of LLLT on reducing fat in combination with liposuction, the evidence for the effects of this method as a stand-alone procedure, is not sufficient. Applying LLLT for fat removal has no observable consequence on surrounding tissues and does not increase tissue temperature. Moreover, it takes time to show its effect on the treated zone **(24)**.

Using LLLT for fat reduction and body contouring is based on experiences, which showed that applying 635-nm laser leads to deflation of tiny temporary openings within the membrane of adipose cells and releasing fats into the interstitial space. The result of these changes is a reduction of unwanted fat. However, the openings have no destructive effect on body cells but let lipids enter the interstitial space and excrete from the body. It seems that the mechanism mentioned above is the consequence of the photoexcitation process of cytochrome c oxidase in mitochondria's respiratory chain **(24)**.

Our results agreed with **Jackson et al. (25)** reported that applying LLLT to reducing body fat could be effective on overall circumference. They assessed 67 overweight participants (BMI 25 nto 30 kg/m2), which underwent LLLT (635-nm light with 2.5 mW power) for two weeks (three treatment sessions each week). After treatment by LLLT (Zerona lipolaser was the first device that received FDA clearance), a total of 891-mm fat reduction was observed across waist, hips, and thighs. Maximum fat reduction was reported across the waist (2.66 cm). However, two weeks after the last treatment session, a 7.8-mm increase in circumferences was seen in three treated zones.

Jackson et al. (26) reported that treating 689 subjects with LLLT (12 treatment sessions within 14 days) leads to a 13.13-cm circumferential reduction in waist, hips, thighs, arms, knees, neck, and chest. Our finding agreed with **Caruso-Davis et al**. **(27)** used 635 - 680 nm LLLT (Meridian LAPEX 2000 lipolaser system, Meridian Medical Inc. Anyang, Korea) for reducing adipose tissue. Forty subjects with BMI

of < 30 kg/m2 participated in their experiment and received eight treatment sessions (half an hour for each session) within one month. The average fat reduction on waist circumference after the last treatment session was equal to 2.15 cm. There were two studies, which measured patient's satisfaction after the treatment procedure. In the study of **Nestor et al. (28)** satisfaction was reported up to 80% but in the research of **Lach et al. (29)** reduction of subcutaneous fat in normal weight women was nearly 32%.

Our results were in agreement with **Neira et al. (30**) who investigated the action of red laser (635 nm, 10 mw intensity) on human adipocytes taken from lipectomy samples. Transmission electron microscope (TEM) and scanning electron microscope (SEM) images revealed the formation of transient micro-pores in the cell membrane of the adipocytes. Subsequently, up to 99% of fat could be released from the adipocytes leading to complete deflation of adipocytes. Another proposed mechanism of action is based upon the activation of complement cascade which could induce adipocyte apoptosis leading to the release of lipids through transient pores. A red 630 nm laser was used in our selective laser combination to achieve this biochemical activity on adipocytes (**31)**. Our results were agreed with **Lach and Pap (32)** conducted another study among 25 subjects who underwent a series of treatments with infrared and red lasers, followed by massage. In total, 14 subjects showed a 5 to 35% reduction in fat thickness and improvement in the appearance of cellulite in the thighs at the end of the treatment period.

Brosseau et al. (33) investigated the action of 630 - 680 nm, 150 mW showering arrays, and single 40 mW diode laser irradiation sources on 311 participants. A total of 130 patients in groups of 6 and 12 sessions achieved average sustained losses of 6.55 and 11.04 cm, corresponding to an average girth reduction of 0.48 to 0.55 cm per session.Our results agreed with **Jalian and Avram (24)**, Using LLLT for fat reduction and body contouring is based on experiences, which showed that applying 635-nm laser leads to the deflation of tiny temporary openings within the membrane of adipose cells and releasing fats into the interstitial space. The result of these changes is a reduction of unwanted fat. However, the openings have no destructive effect on body cells but let lipids enter the interstitial space and excrete from the body. It seems that the mechanism mentioned above is the consequence of photo excitation process of cytochrome c oxidase in mitochondria's respiratory chain.

The results of our study confirm those of **Lach (29)** in which the combination of low-level, dual-wavelength laser with massage prototype provided significantly greater reduction in subcutaneous fat than massage alone, as shown by magnetic resonance imaging (MRI). **Sadick and Magro (34)**, also reported that 71.87% of treated subjects achieved a decrease in overall thigh circumference, which compares well with the 71.1% of similar subjects in our study. Sadick and Magro also reported that the greatest reduction in thigh circumference occurred at 4 weeks and that the decrease was immediately after treatment.

Conclusion:

Our results concluded that both treatment modalities LLLT and RF, had significant effects on cellulite after liposuction and provided significant improvement in all variables (photo numeric cellulite severity scale), in addition, LLLT was more effective than RF.

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