

# SYNERGISTIC EFFECTS OF COMBINED THERAPY: ELECTROSTIMULATION WITH INFRARED LIGHT AND ULTRASOUND FOR CELLULITE

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## Annotation

*Cellulite, the problem of dimpled appearance of the skin that is present in 80-90 % of post-pubertal women and considerably affects quality of life. A wide range of products and treatments for cellulite reduction is available, however, there is a lack of research what is effect of electrostimulation with infrared and ultrasound on cellulite effected skin.*

**Key words:** elektrostimulation, infrared, ultrasound, stage III cellulite.

## Introduction

Cellulite is a descriptive term used to characterize the cosmetically distressing, altered (eg, dimpled, padded, peau d'orange) topography of skin. Cellulite is multifactorial, with sexual dimorphism of subcutaneous connective tissue, the effects of localized increases in tissue tension, and local circulatory and inflammatory abnormalities all thought to play an important role (Canela et al., 2018). Cellulite as skin condition is most commonly found on the posterolateral thighs, buttocks, and abdomen. It is often identified by a dimpled or orange-peel appearance of the skin's surface. Cellulite is a multifactorial condition that is present in 80–90 % of post-pubertal women (Luebberding et al., 2015). Cellulite may worsen during high estrogen states, including pregnancy, nursing, and chronic use of oral contraceptives. Although diet, exercise, and lifestyle, however, do not appear to be associated with its development, weight gain and obesity can worsen the appearance of existing cellulite (Friedmann et al., 2017). Even though it is not a life-threatening clinical condition, cellulite affects most women's psychosocial sphere because it is directly and inexorably related to the physical appearance, self-esteem, and, consequently to the well-being perception and social acceptance. Thus, the main reason to look for a treatment for cellulite is its esthetic appearance (Pérez Atamoros et al., 2018). There are four stages of cellulite:

- Stage I - the changes are caused by venous and lymphatic stasis only visible in bruising; this phase begins with the accumulation of fat in the adipocyte, and they are still prominent.
- Stage II - adipocytes compressing blood vessels, which blood flows through are reduced; at this stage a swelling can be a symptom occurring as the irregular protuberant surface of the skin, there is also the characteristic drop in the flexibility changes that can be obtained by compression of a skin fold.
- Stage III - at this stage circulatory disorders get worse around accumulated adipocytes they begin to accumulate deposits of collagen and ground substance of connective tissue, which results in fibrosis of certain parts of the subcutaneous tissue, the skin has an uneven corrugated surface, there are lumps and swelling, the changes are already visible without skin compression.
- Stage IV - collagen deposits begin to transform into hard nodules that compressing blood vessels and nerves, they cause pain, skin is wrinkled with visible and palpable hardenings; changes can rest, and the visibility is increased muscle tension at (Baryluk et al., 2017).

Based on the consistency of skin, cellulite is usually classified into four general types: hard, soft, edematous and mixed (Bauer et al., 2018).

Nowadays, there are several noninvasive and minimally invasive technologies to improve the appearance of skin and subcutaneous fat, such as radiofrequency, cryolipolysis, manual massage, carboxytherapy and high-intensity focused ultrasound, among others (Canela et al., 2018). Nonfocused ultrasound and electrical stimulation are therapeutic modalities commonly used in physiotherapy practice and, when used simultaneously, they are called Combined Therapy. The combination of electrical stimulation and ultrasound can be more effective than each of them used separately. Therapeutic ultrasound is characterized by mechanical vibrations of high frequency – above 20 kHz – and it can be a potent modality to promote biological effects (Canela et al., 2018). Electrostimulation current is characterized by an alternating medium frequency wave modulated in low frequency, and it can be indicated for various purposes, including muscle strengthening, pain control, circulation promotion and edema control (Choi, Lee, 2016). Heat generated by infrared light on the skin implies an increase in microcirculation, lymphatic drainage, and collagen synthesis. The process of collagen denaturalization induces its contraction, thickening, and later skin tightening (Pérez Atamoros et al., 2018).

Only a limited number of studies on synergistic effects of combined therapy of electrostimulation with infrared light and ultrasound on cellulite affected skin have been published in the international literature.

*The research aim:* to determine the efficacy of electrostimulation with infrared light and ultrasound in treatment of cellulite on the thighs, circumference reduction and the safety profiles.

## **Research Methodology**

### *Subjects*

The study involved four healthy women, aged 25 to 35 years. The subjects were enrolled in the study on acceptance to participate. The inclusion criterion was the presence of the stage III solid cellulite. The exclusion criteria were pregnancy, a history of edema, obesity, only mild cellulite, concomitant cellulite treatments; inflammatory or infectious skin diseases, in the treatment areas, neoplasm; significant varicose veins on the lower extremities, history of deep venous thromboses, having an artificial cardiac pacemaker, or any other disease diagnosed at the time of the initial interview. All patients gave a written informed consent prior to study participation.

### *Treatment protocol*

It was used for the study *BODY SHAPE UP SYSTEM* (Technology SRL, Milano, Italy), whose mechanism of action is based on electrostimulation, ultrasound and infrared light.

Treatments were performed every other day, three times a week for a total of 10 sessions. Each woman was treated with a combined electrostimulation infrared and ultrasound apparatus by the same well-trained technician for 40 min. No specific diet or exercise plans were given to the patients, but they were advised to drink 1.5–2 l of water per day.

Cellulite stage was assessed in the subjects with a “Callegari soft plus” instrument using a cellulite measurement program that measures moisture level, cellulite stage, and water retention level in relation to changes in body temperature. The initial measurement was performed prior to the course of procedures to assess the client’s suitability for the study. Other measurements were performed after 5 and 10 procedures using a centimeter strip. Measured: widest point of thighs (under buttocks fold), middle of thighs, lower thighs (above knee joint), before every treatment visit. Each measurement point was recorded at baseline to ensure that subsequent measurements were obtained at the same location. All subjects completed the treatment protocol and attended every follow-up visits.

### *Questionnaires*

The results of the study were also subjectively evaluated by the subjects by completing a questionnaire in which the tolerance of the procedures and the satisfaction with the treatment were assessed. The level of tolerance was marked from 1 to 4 (1 - intolerable, 2 - tolerable, 3 - comfortable, 4 - very comfortable), the level of satisfaction procedure was also marked from 1 to 4 (1 - dissatisfied, 2 - indifferent, 3 - satisfied and 4- very satisfied).

## **Research Results**

Before the course of procedures, the water retention level of three subjects (A1, A2, B2) was 3, one (B1) – 2 (Table 1). After 5 procedures, the water retention level of three women (A1, A2, B1) did not change, one (B2) - decreased by one scale unit. After the entire course of procedures, the water retention stage of study A1 decreased to 2, A2 remained unchanged, B1 did not change, and B2 decreased to 2.

Table 1

Level of water retention in the skin before the course of procedures, after 5 and after 10 procedures

	Before	After 5	After 10
A1	3	3	2
A2	3	3	3
B1	2	2	2
B2	3	2	2

Assessing the changes in circumference before, after 5, and after 10 procedures, changes are observed in all cases (Table 2, Table 3).

Table 2

Changes in right thigh circumference before the course of procedures, after 5 and after 10 procedures

	The widest place			Middle			The narrowest place		
	Before	After 5	After 10	Before	After 5	After 10	Before	After 5	After 10
A1	59,20	59,20	58,90	51,90	51,90	51,50	42,80	42,80	42,40
A2	68,30	68,30	67,90	60,80	61,00	60,50	53,20	53,10	52,80
B1	56,30	56,30	55,10	48,30	48,30	47,00	37,60	37,50	36,40
B2	66,80	66,40	65,30	60,00	59,90	58,80	58,50	58,00	57,00

Assessing the changes in the widest part of the left thigh, it can be seen that the decrease decreased by 0.3 cm for study A1, by 0.4 cm for study A2, by 1.2 cm for study B1, and decreased by 1.5 cm for study B2. Assessing the changes in the mid-thigh circumference, it can be seen that for study A1 the circumference decreased by 0.4 cm, A2 - by 0.3 cm, for study B1 - by 1.3 cm, and B2 decreased by 1.2 cm. Assessing the changes in the narrowest right thigh, it was found that the circumference decreased by 0.4 cm for subjects A1, A2, for B1 decreased by 1.3 cm, for study B2 - by 1.5 cm. Thus, the largest positive changes were observed for the B2 study.

Table 3

Changes in left thigh circumference before the course of procedures, after 5 and after 10 procedures

	The widest place			Middle			The narrowest place		
	Before	After 5	After 10	Before	After 5	After 10	Before	After 5	After 10
A1	59,20	59,20	58,80	52,40	52,40	52,00	43,00	43,00	42,70
A2	68,20	68,20	67,80	61,10	61,10	60,90	53,20	53,20	53,00
B1	56,90	57,00	55,60	48,60	48,50	45,50	37,50	37,40	36,30
B2	66,80	66,60	66,00	60,20	60,00	59,40	58,60	58,30	58,00

Assessing the circumference of the left leg, it can be seen that after the course of procedures, the widest point for A1 and A2 subjects decreased by 0.4 cm, B1 - decreased by 1.3 cm, and B2 - decreased by 0.7 cm. Assessing the left middle part of the leg, it was observed that the circumference of A1 decreased by 0.4, A2 - by 0.2 cm, and B1 studies decreased by 1.1 cm, B2 - by 0.8 cm. The narrowest part of the left thigh decreased by 0.3 cm for A1 subjects, by 0.2 cm for A2 and by 1.2 for B1, and by 0.6 cm for B2 subjects. Thus, the largest positive changes in left leg circumference were observed in B2 study.

Before the course of procedures, all subjects had cellulite stage III, after 5 procedures stage did not change. After 10 procedures, the cellulite stage of three subjects did not change, one - changed to II (Table 4).

Table 4

Changes in cellulite stage before procedures, after 5 and after 10 procedures

	Before	After 5	After 10
A1	3	3	2
A2	3	3	3
B1	3	3	3
B2	3	3	3

After evaluating the level of tolerance of the performed procedure (Table 5), subjects A1 and B1 indicated that the procedure was comfortable, and A2 and B2 rated it as very comfortable. Assessing the level of satisfaction with the procedure (Table 5), subjects A1 and A2 indicated that the procedure was satisfied, while B1 and B2 rated it as very satisfied. Such results showed that the procedure is tolerable, does not cause unpleasant sensations and gives quite good results.

Table 5

Subjects' tolerance and satisfaction with treatment

	Tolerance level	Satisfaction level
A1	3	3
A2	4	3
B1	3	4
B2	4	4

### Discussion

Cellulite is related to collagen and elastic tissue degeneration in dermis and hypodermis associated with fat deposition (Canela et al., 2018). This disorder, which bothers women to such a high extent, however, is not easy to be treated (Hexsel et al., 2017; Modena, 2019; Bauer et al., 2020). Although there are many methods of treatment, there is still no perfect way to eliminate the cellulite (Wanitphakdeedecha et al., 2015; Alomairi et al., 2018). Despite multiple therapeutic approaches that attempt to treat cellulite, no procedures have been proven successful long term. Topical agents, injectable treatments, and energy-based devices can ameliorate the appearance of cellulite, sometimes to a satisfactory degree, but never eradicate cellulite because this involves extensive tissue remodeling (Sadic, 2019). Consequently, until the present moment there is no revolutionary therapy that will bring the cure for cellulite (Modena, 2019; Writers, 2015).

Noninvasive and nonpharmacological body countering techniques are effective in the management of cellulite (Atamoros et al., 2018; Alomairi et al., 2018). There are a number of effective non-invasive anti-cellulite therapies in the scientific literature where combination therapy is more effective than each of them used separately (Wanitphakdeedecha et al., 2017; Canela et al., 2018; Atamoros et al., 2018). In our study case the synergistic effects of the combined therapy electrostimulation with infrared light and ultrasound methods are more effective than each of them used separately also.

Ultrasound can induce biological effects through heating that results from the absorption of ultrasonic energy and through nonthermal mechanisms that include ultrasonic cavitation, mechanical stress and other nonthermal processes. In cosmetic application, both thermal and nonthermal mechanisms within an ultrasonic field are used for the destruction of adipose tissue and contraction of collagen-based tissue – dermis (Mlosek et al., 2011; Miller et al., 2012). Experimental studies suggest that the absorption of ultrasonic energy can lead to changes in the cellular activity and in the structure of adipocytes, and it releases lipids in the blood circulation and extracellular space immediately after the treatment (Garcia, Schafer, 2013).

Phototherapy improves cellular activation which is an important factor for the treatment of cellulite. These positive effects can result in a further improvement of body aesthetics using infrared-LED (Paolillo et al., 2011). Infrared light penetrates deeper into the skin than other non-invasive treatments. When it penetrates at a deeper level, it jump-starts the production of collagen and circulation which improves the skin quality. Infrared light has shown positive results for body contouring and fat loss across several clinical studies. It is non-invasive and safe treatment to improve the looks and overall health (Bauer et al., 2018; Bauer et al., 2020).

The *BODY SHAPE SYSTEM* used in our study included ultrasound, electrostimulation, electrolysis, drainage, infrared light processes. The use of the equipment leads to visible results in reducing adipose tissue and cellulite and improves muscle and skin toning performance. Whereas cellulite is usually related to alterations of the microcirculation (Nkengne et al., 2013; Freire et al., 2019).

When evaluating anthropometric measurements the current study showed a slight decrease of the circumference of treated areas, but it should be kept in mind that this was the case for solid cellulite. In cases of edematous cellulite when slimming due to reducing the circumference of edema would decrease more (Godoy et al., 2012).

Another aspect of this study was the evaluation of the levels of tolerance and satisfaction with the treatment through self-questionnaires. The procedure was considered well tolerated. All participants were satisfied with the treatment outcome, the percentage of satisfaction level was high (50% satisfied, 50% very satisfied) after the treatment. No adverse reactions were observed. All the subjects would undergo the treatment again, they resumed normal activities immediately after each session of the treatment, without downtime, pain or discomfort.

However, some other authors conclude that anti-cellulite procedures may have side effects - pain, ecchymosis, or swelling (Alomairi, 2018; Canela et al., 2018).

According to many authors, in order to assess the effectiveness of anti cellulite treatment should be studies carried out on a large number of patients (Canela et al., 2018; Baryluk et al., 2017; Modena, 2019).

The current study has some limitations that must be considered when interpreting the results. The sample size is small, further studies using larger sample size should be performed to confirm these results. Another limitation is lack of follow-up to determine how long the beneficial effects of combined therapy electrostimulation with infrared light and ultrasound lasted.

Consequently combined therapy electrostimulation with infrared and ultrasound is efficient and safe treatment to improve cellulite appearance and reduce body circumferences.

### Conclusions

1. We conclude that the synergistic effects of the combined therapy electrostimulation with infrared and ultrasound might be a good option for cellulite treatment.
2. The therapy is good for cellulite affected thigh skin condition and circumference, but it is less effective in reducing the cellulite grade.
3. This combined noninvasive and nonpharmacological therapy is well-tolerated and safe.
4. Further studies with larger sample size should be performed to confirm these results.

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