

Fisioter Bras 2020;21(1);77-85

<https://doi.org/10.33233/fb.v21i1.2820>

ORIGINAL ARTICLE

Effects of multi-directional oscillatory vibration in the treatment of cellulite and body remodeling

Efeitos da terapia vibro-oscilatória multidirecional no tratamento da celulite e remodelamento corporal

Fabiele Chierogato*, Caroline Nogueira da Silva**, Tania Maria Carvalho***, Clovis Grecco**, Renata Gomes Moreira**, Renata Michelini Guidi, PT****, Luis Fernando Girola**, José Ricardo de Souza**, Débora Aparecida Oliveira Modena, PT, M.Sc.*****

Esthetician, Postgraduate in MBA Derma functional, Aesthetic and Cosmetic Center for Study and Advanced Training Ibramed (CEFAI), Brazil, **Study Group in Applied Technology to Health, IBRAMED, Amparo/SP, Brazil, *MD, Gynecologist, Universidade Estadual de Campinas (UNICAMP), Campinas/SP, Brazil, ****Master of Electric Engineering of University of Campinas (Unicamp), Brazil, *****Student in Electrical Engineering of University of Campinas (Unicamp), Study Group in Applied Technology to Health, IBRAMED, Amparo/SP, *****Doctoral Student in Science of Surgery of University of Campinas (UNICAMP), Study Group in Applied Technology to Health, IBRAMED, Amparo/SP*

Received: March 19, 2019, accepted: January 27, 2020.

Corresponding author: Débora Aparecida Oliveira Modena, Av. Dr. Carlos Burgos, 2800, 13901-080 Amparo SP

Fabiele Chierogato: fabiele@ibramed.com.br

Caroline Nogueira da Silva: c.silva@ibramed.com.br

Tania Maria Carvalho: drataniamariacarvalho@gmail.com

Clovis Grecco: clovis.grecco@alumni.usp.br

Renata Gomes Moreira: r.moreira@ibramed.com

Renata Michelini Guidi: renata@ibramed.com.br

Luis Fernando Girola: l.girola@ibramed.com.br

José Ricardo de Souza: re_guidi@yahoo.com.br

Débora Aparecida Oliveira Modena: de_modena@yahoo.com.br

Abstract

Introduction: Several technologies have been developed and optimized for the treatment of unaesthetic disorders. Among them is the oscillatory vibration therapy, a novel form of treatment based on the mechanical and physiological fundamentals of the vibration platform. **Objective:** The present study evaluated the efficacy of the oscillatory vibration therapy in the improvement of body contour remodeling and in the aspect of cellulite in women. **Methods:** This is a prospective longitudinal comparative study, in which the following evaluation tools are used: anthropometry, perimetry, adipometry, evaluation of skin viscoelasticity with Cutometer®, evaluation of the thickness of the hypodermis with diagnostic ultrasound and analysis of severity of cellulite (CSS). The evaluations occurred at the start and 1 week after the end of ten oscillatory vibration therapy. The results were analyzing using a paired student's t-test with interval confidence of 95% (P-Value <0.05). **Results:** Thirty women took part in the research, with age of 33 ± 9 years, weight of 62 ± 11 kg, height of 1.66 ± 0.06 m, BMI of 22 ± 2 kg/m². The measurements of perimetry, adipometry, analysis of subcutaneous tissue thickness by means of diagnostic ultrasound and analysis of skin viscoelasticity did not present significant alterations. However, the CSS variable of the right gluteus (7.3 ± 1.8 to $5.8 \pm 1.6 \leq 0.0001$), left gluteus (7.2 ± 1.9 to $5.8 \pm 1.6 = 0.0001$), right thigh (6.9 ± 1.9 to $5.6 \pm 1.4 = 0.0004$), left thigh (6.9 ± 1.9 to $5.6 \pm 1.3 = 0.0004$) and Celluqol® (59 ± 16 to $49 \pm 16 = 0.022$) presented significant difference. **Conclusion:** The multi-directional oscillatory vibration therapy is an effective and efficient therapy for the treatment of cellulite; however, for the treatment of body remodeling, it must be further evaluated and studied.

Keywords: vibration platform, vibration, cellulite, body contour, aesthetic medicine.

Resumo

Introdução: Várias tecnologias vêm sendo desenvolvidas e otimizadas para o tratamento das afecções inestéticas. Dentre elas está a terapia vibro-oscilatória, uma nova forma de tratamento baseada na fundamentação mecânica e fisiológica da plataforma vibratória. **Objetivo:** O presente estudo avaliou a eficácia da terapia vibro-oscilatória para melhora do remodelamento corporal e aspecto de celulite em mulheres. **Métodos:** Trata-se de um estudo clínico longitudinal prospectivo e comparativo, no qual se utilizaram as seguintes ferramentas de avaliação: antropometria, perímetria, adipometria, avaliação da viscoelasticidade da pele com Cutometer®, avaliação da espessura da hipoderme com ultrassom diagnóstico e análise da escala de severidade da celulite (CSS). As avaliações ocorreram no início e após 1 semana de término das dez sessões da terapia vibro-oscilatória. As análises estatísticas foram realizadas com o software Bioestat 5.0, utilizando o teste de normalidade de Lilliefor ($P\text{-Value} > 0,05$), teste paramétrico e teste T-Student da amostra pareada. **Resultados:** Trinta mulheres participaram da pesquisa, com média de idade de 33 ± 9 anos, peso médio de 62 ± 11 kg, altura média de $1,66 \pm 0,06$ metros, IMC médio de 22 ± 2 kg/m². As medidas de perímetria, adipometria, análise da espessura do tecido subcutâneo por meio de ultrassom diagnóstico e análise da viscoelasticidade da pele não apresentaram alterações significativas. Entretanto as variáveis de CSS glúteo direito ($7,3 \pm 1,8$ para $5,8 \pm 1,6 \leq 0,0001$), glúteo esquerdo ($7,2 \pm 1,9$ para $5,8 \pm 1,6 = 0,0001$), coxa direita ($6,9 \pm 1,9$ para $5,6 \pm 1,4 = 0,0004$), coxa esquerda ($6,9 \pm 1,9$ para $5,6 \pm 1,3 = 0,0004$) e Celluqol® (59 ± 16 para $49 \pm 16 = 0,022$), apresentaram diferença significativa. **Conclusão:** A terapia vibro-oscilatória multidirecional é uma terapia efetiva e eficaz para o tratamento da celulite, porém para o tratamento de remodelamento corporal ela deve ser mais bem avaliada e estudada.

Palavras-chave: plataforma vibratória, vibração, celulite, contorno corporal, medicina estética.

Introduction

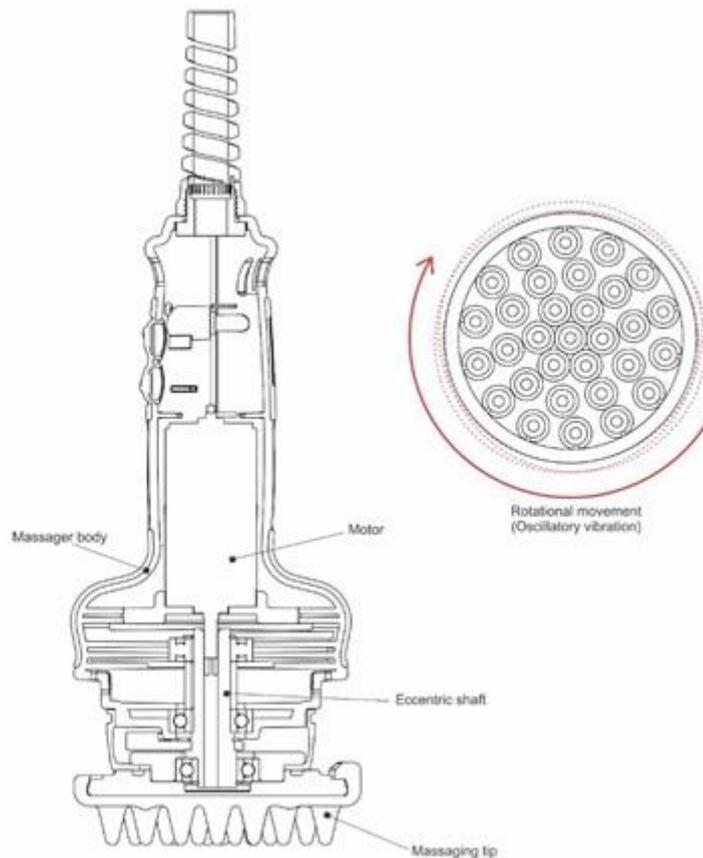
The range of products with approaches for the treatment of unaesthetic disorders is extremely wide: varying from non-invasive techniques, such as cosmetic products, diets with or without nutritional supplements, manual massages associated with electrotherapy resources to invasive forms, such as liposuction [1,2].

The demand for this type of treatment and aesthetic surgery has been increasing exponentially; year after year young individuals, men and women, set out in search of their ideal body. To keep up with this growth, technology has been advancing to fulfill the expectations of the population and innovating, with new treatment methods in different fields of health and aesthetic medicine [1,2].

Several technologies are being developed and optimized for the treatment of aesthetic disorders. One of these technologies is the multi-directional oscillatory vibration therapy, based on the mechanical and physiological fundamentals of the vibration platform, or whole-body vibration (WBV). On the platform, the vibration will run through the whole body, and thus stimulate physiological events, such as the activation of blood flow, muscle activation and rebalance; consequently, there is improvement in strength gains, resistance and power in healthy individuals and even in individuals with some types of musculoskeletal dysfunction [2-4].

Following this principle, multi-directional oscillatory vibration therapy was developed to represent a low-cost mechanical massage technique, whose objective is to assist the therapist during the aesthetic procedure, potentializing the effect of the therapist's hands, decreasing the treatment time, and acting with safety and efficiency.

The equipment uses a mechanical system which consists of a disc-shaped body, coupled to a motorized axis that moves in a multi-directional and oscillatory manner, through an eccentric axis, executing back and forth movements around a certain balanced position. The equipment engine is in the applicator, and the multi-directional oscillatory vibration is transmitted to the treatment area through a multipoint tip fixated onto the disc (Figure 1).



Source: Author

Figure 1 - *Internal mechanical system of the applicator.*

The therapist must move the applicator continuously in a semi-circular direction; therefore, the oscillatory vibration has effect on the treatment area. It is necessary to adjust the frequency of cycles per second for each therapeutic objective and always respect the acute response of the skin during the treatment.

The objective of this study is to evaluate the efficacy of the multi-directional oscillatory vibration treatment developed to act in the fields of aesthetic medicine, aiming to improve body contour and the appearance of cellulite.

Methods

This is a prospective longitudinal and comparative clinical study approved by the local committee of ethics in research and registered in Clinical Trials: NCT03312946. All the individuals were recruited at the (CEFAI) - Ibramed Center for Advanced Studies and signed a previous consent form.

The main eligibility criteria were: women between 18 and 55 years of age; body mass index (BMI) of up to 29.9; non-smokers; without previous conditions; with light, moderate and severe degrees of cellulite severity according to the Cellulite Severity Scale (CSS) [5] in the gluteus and posterior thigh areas and localized fat in the abdomen and flanks areas. The main criteria of ineligibility were that the participants had received other treatment for cellulite less than 30 days before the study, male gender, suffering from dermatitis and dermatosis, fragility of the blood capillary, history of deep venous thrombosis (DVT) neoplasia, having implanted cardiac pacemakers or other implanted electronic devices.

Data collection was carried out by a specialized physiotherapist, with the use of the following evaluation tools: anthropometry as weight (kg) and height (m²) with the mechanical stadiometer (model 110 CH; Welmy, SP, Brazil), and calculated using the BMI (kg/m²). For the body circumference evaluation, a perimetry was carried out using a measuring tape (RCM®) around the waist area, umbilical line, gluteus (the reference point being 5 cm lower and lateral to the anatomical region of the greater trochanter of the femur) and thighs: gluteus fold, medial fold

(5 cm lower in relation to the gluteus fold) and distal fold (15 cm lower in relation to the gluteus fold).

To evaluate the thickness of the skinfold an abdominal adipometry was carried out with the adipometer (CESCORF®) in the infra-abdominal area (two fingers below the umbilical line in the longitudinal direction) and supra-umbilical area, two fingers above the umbilical line, transversal axis).

For the evaluation of cellulite, the Cellulite Severity Scale (CSS) was used, which covers and classifies with punctuations from 0 to 3 the different aspects of cellulite, such as: number of depressions, depth, morphological aspect, degree of flaccidity, and the cellulite gradation according to Nürnberger & Müller. The sum of the punctuations of each of these aspects generates the classification, which can be light (1 to 5), moderate (6 to 10) or severe (11-15) [5].

For the evaluation of skin elasticity, the Cutometer® MPA 580 (Courage-Khazaka, Germany) was used. The analysis of the thickness of the subcutaneous tissue was performed by an ultrasonographer physician, using the diagnostic ultrasound equipment with the frequency of 6-18 MHz (MyLab™ 25 Gold, Esaote, Italy) with software VPan (Esaote, Italy), in both evaluations, points marked by the evaluator in the abdomen, flanks, gluteus and posterior of thighs were analyzed [6].

Before and after the treatment, the Celluqol® questionnaire was applied, which evaluates how much cellulite affects the quality of life and the lifestyle of women. The questionnaire is composed of questions regarding the choice of clothes, diet, recreation and physical activities, relationship with the partner, feelings and changes in daily habits. Each question is ranked from 1, when the individual does not feel disturbed by having cellulite, until 5, when the fact of having cellulite disturbs the individual all the time. The result of Celluqol® is the sum of all the points of each question. The final reevaluation of the participants was carried out seven days after the end of the treatment [7].

Procedure

At the beginning of each session, a body exfoliation was performed in the treatment area with physical exfoliant, and after that a cosmeceutical, known as Creme Para Massagem Modellata (Anvisa nº 25351.185215/2018-70) was applied to help in the sliding of the equipment tip. The Modellata® equipment (Ibramed-Indústria Brasileira de Equipamentos Eletromédicos EIRELI- Brazil) was used, in continuous mode, with frequency of 60 cycles per second (cps), and the application was carried out in the abdomen area, flanks, gluteus and posterior of thigh and the application technique followed was suggested by the equipment manufacturer. The application time in each area was based on the skin response of each patient; that is, at any sign of hyperemia in the entire treatment area the therapy in the area was finalized. However, when the patient did not present tissue hyperemia, the average treatment time was fifty minutes. All the participants received 10 sessions, performed twice a week.

Statistical analysis

Statistical analyzes were performed with Bioestat 5.0 software (Sociedade Civil Mamirauá, Amazonas, Brazil). The Lilliefors normality test ($P > 0.05$) was performed and does not show deviation from normality. After assessing the normality of data distribution, a parametric test was applied to detect significant difference at 0.05 level. All data were expressed as mean \pm standard deviation and differences between mean values were compared with paired student's t-test.

Results

Thirty women started and completed the treatment. They presented the average ages of 33 ± 9 years, weight of 62 ± 11 kg, height of 1.66 ± 0.06 m, and BMI of 22 ± 2 kg/m². There was no alteration in weight and BMI after the treatment.

The measurements of perimetry, adipometry, analysis of thickness of subcutaneous tissue by diagnostic ultrasound and analysis of viscoelasticity of skin by Cutometer® did not present significant alterations ($P < 0.05$) as seen in tables I and II.

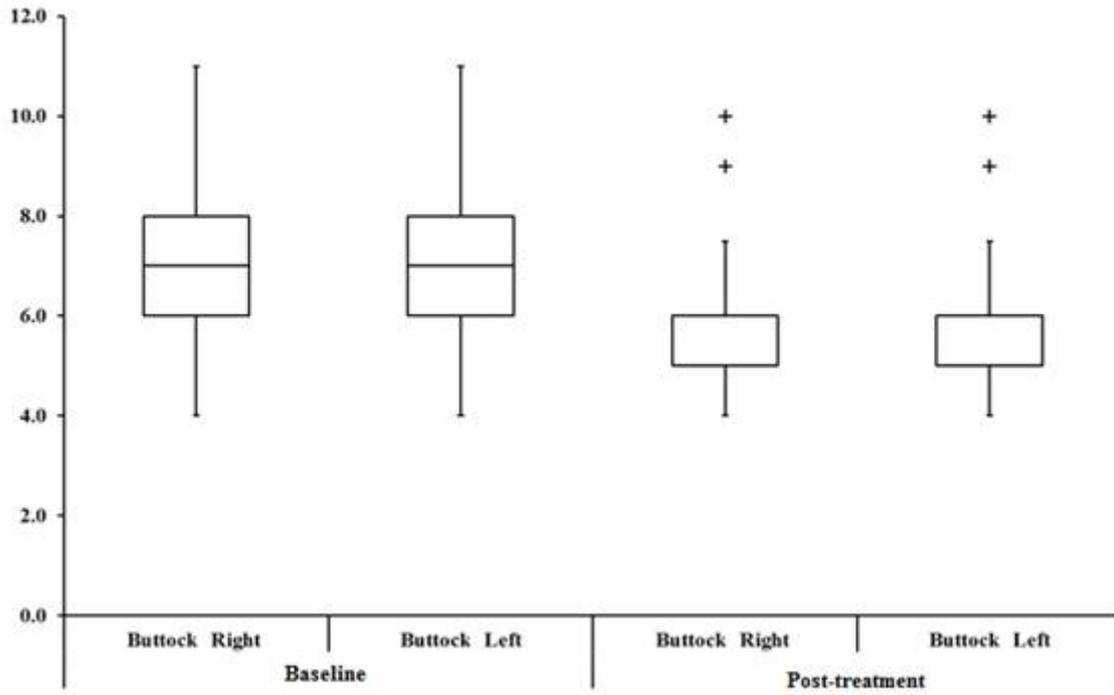
Table I - Analysis of the measurements by perimetry, adipometry and diagnostic ultrasound.

Variables	Baseline		Post-treatment		P-value
	Average	SD	Average	SD	
Perimetry (cm²)					
Waist	79	6	77	6	0,398
Abdomen	88	7	86	6	0,279
Hip	105	7	104	8	0,546
Proximal thigh	61	5	60	5	0,406
Medial thigh	52	5	52	4	0,628
Distal thigh	43	3	43	3	0,589
Adipometry (mm)					
Supra iliac	2,5	0,9	2,3	0,7	0,28
Upper abdomen	2,7	1	2,4	0,8	0,166
Lower abdomen	3,2	0,9	2,9	0,9	0,283
Diagnostic ultrasound (mm)					
Upper abdomen	14	5	14	5	0,902
Lower abdomen	15	4	16	4	0,906
Right flank	28	9	25	6	0,196
Left flank	28	9	28	6	0,754
Right buttock	24	4	22	4	0,164
Left buttock	24	4	23	4	0,425
Right culote	28	6	27	5	0,790
Left culote	27	7	27	5	0,431
Right posterior thigh	9	4	9	3	0,709
Left posterior thigh	9	4	9	4	0,922

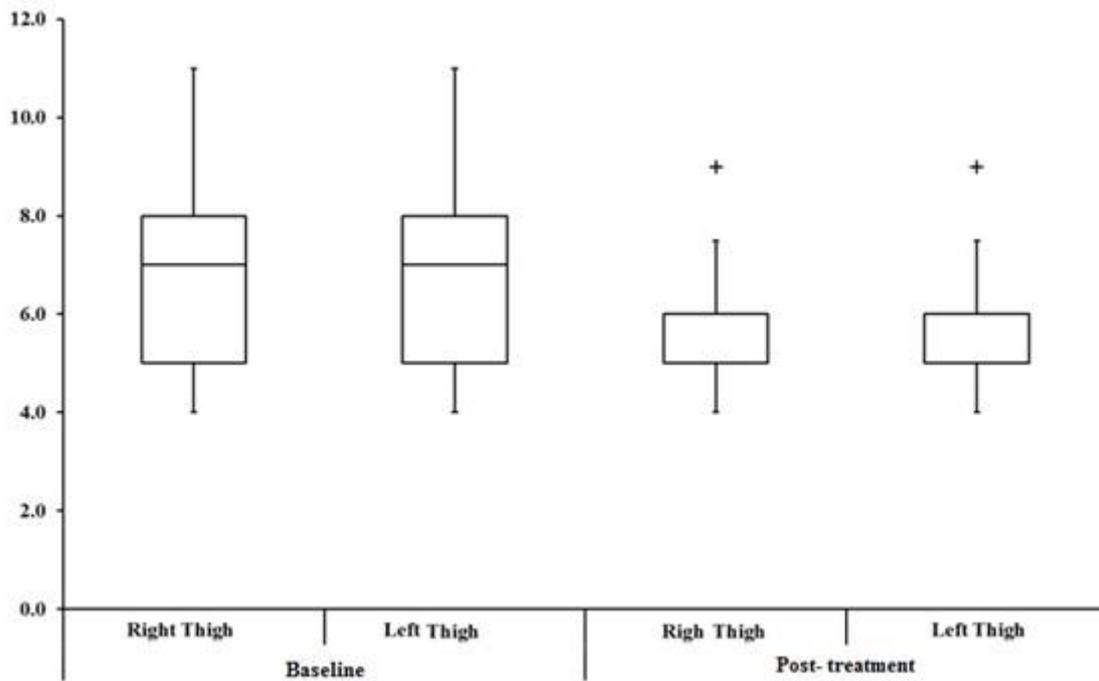
Table II - Analysis of the measurements by Cutometer®.

Variables	Baseline		Post-treatment		P-value
	Average	SD	Average	SD	
Cutometer (mm)					
Abdomen					
R0	0,633	0,073	0,619	0,067	0,418
R2	0,891	0,077	0,919	0,064	0,127
R6	0,266	0,050	0,283	0,064	0,266
Flanks					
R0	0,464	0,079	0,432	0,070	0,108
R2	0,912	0,063	0,938	0,056	0,099
R6	0,536	0,183	0,590	0,323	0,429
Buttocks					
R0	0,574	0,075	0,554	0,070	0,306
R2	0,903	0,056	0,918	0,055	0,288
R6	0,320	0,060	0,317	0,075	0,890
Culotes					
R0	0,471	0,076	0,452	0,069	0,306
R2	0,917	0,061	0,943	0,057	0,096
R6	0,501	0,113	0,482	0,010	0,358
Posterior thighs					
R0	0,407	0,053	0,397	0,056	0,497
R2	0,922	0,059	0,930	0,068	0,648
R6	0,553	0,120	0,576	0,195	0,577

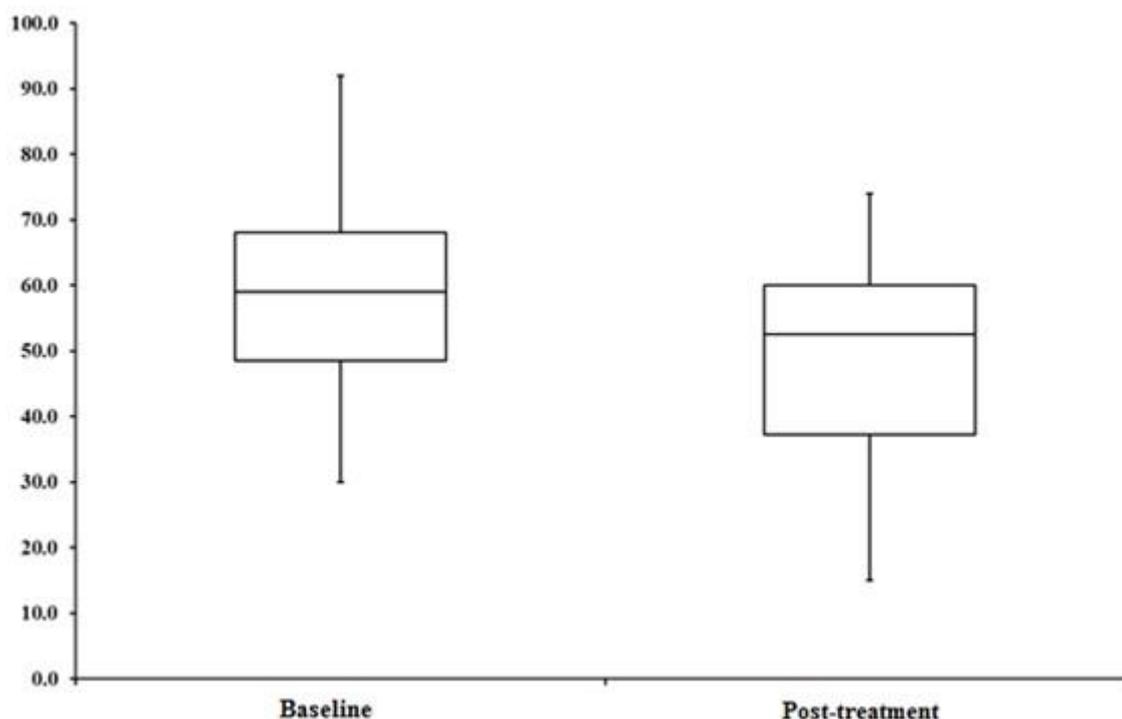
The CSS variables of right gluteus (7.3 ± 1.8 to $5.8 \pm 1.6 \leq 0.0001$), left gluteus (7.2 ± 1.9 to $5.8 \pm 1.6 = 0.0001$), right thigh (6.9 ± 1.9 to $5.6 \pm 1.4 = 0.0004$), left thigh (6.9 ± 1.9 to $5.6 \pm 1.3 = 0.0004$) and Celluqol® (59 ± 16 para $49 \pm 16 = 0.022$) presented significant differences as seen in the graphs below.



Graph 1 - CSS scale for gluteus.



Graph 2 - CSS scale for posterior of thigh.



Graph 3 - Celluqol® analysis.

Discussion

This is the first study to analyze the efficacy of multi-directional oscillatory vibration by means of a piece of equipment developed exclusively with that function. It is fair to say that the oscillatory vibration therapy is a technological advancement of the conventional manual massage and of the conventional vibration massage equipment currently present in the market, the first treatment methods for some types of aesthetic disorders.

The practice of conventional massage dates back thousands of years, and several studies have demonstrated its benefits and physiological effects are renowned in the scientific field [8,9].

Currently, new techniques and several electromedical devices for the treatment of aesthetic disorders such as localized fat and cellulite have been used, for instance: ultrasound, focused ultrasound, radiofrequency, carboxytherapy and, most recently, extracorporeal shockwave therapy [1,8,9].

The present study observes that the multi-directional oscillatory vibration obtained significant results in the improvement of the appearance of cellulite by the CSS scale analysis in gluteus and posterior of thighs, corroborating the result presented by Celluqol®, which showed significant difference in the improvement of quality of life and lifestyle of the volunteers.

According to Turati *et al.* [10], cellulite is defined as a metabolic disorder located in the subcutaneous tissue, generating morphologic alterations on the skin surface. To guarantee the efficacy of cellulite treatment, the stimulation of blood flow in a homogeneous manner is necessary and vital to aid in the reactivation of local metabolism [8-10].

Atamoros *et al.* [12] report that manual or mechanical massage with the aid of devices promotes lymphatic drainage and activation of microcirculation of the subcutaneous tissue, therefore decreasing the lipedema associated with the cellulite condition [11,12].

As cited previously, multi-directional oscillatory vibration therapy is an enhancement of the technology of the vibration platform. Fuller *et al.* [13] demonstrated that exercise with vibration can increase blood perfusion of the skeletal muscle of the lower limbs. The correlation is that the increase of blood flow is directly related to the frequency and load of vibration [13].

Savoia *et al.* [14] evaluated the efficacy of the combination of Low-Level Laser Therapy (LLLT) with the vibration platform. Thirty-three individuals took part in the study, in which they received treatment interspersed, in the same session, with vibration platform in different frequencies and LLLT (635 nm), in total the therapy presented an average time of 23 to 28 minutes.

The objective of the study was to evaluate the application of the LLLT therapy combined with vibration therapy for the reduction of circumference in patients with localized fat and cellulite. The results suggested that the combination of therapies can stimulate increase in metabolism and consumption of energy.

The combination of therapies was essential, because the therapy with the vibration platform isolated is not able to induce lipolysis, provoking exclusively basic processes involved in the pathogenetic of cellulite and localized fat [14]. Furthermore, vibration is capable of stimulating the enzymatic processes involved in the metabolism and stimulating the endothelial functions and the muscles, due to the stimulation of the alpha motor neurons, thus resulting in an increase of muscle activity, increase in O₂ consumption and basal metabolic rate, which in a way potentialize the effects of the LLLT therapy [13,14].

Through the scientific knowledge of the physiological effects stemming from vibration, some devices have appeared, which use vibration therapy as a coadjuvant for other types of therapy, to potentialize the results.

As Adatto *et al.* [15] the authors used extracorporeal shockwave equipment which presented a handpiece with an oscillatory vibration therapy system at 35 Hz (Cellactor® SC1 (Storz Medical AG, Gerwilen, Switzerland) to improve the aspect of cellulite and body remodeling as an indirect effect. According to the authors, vibration is a tool, which can help in the result of the treatment, for when in direct contact with the tissue, stimulates metabolism, lymphatic flow, accelerates the elimination of residues and causes a relaxing effect on muscles and tissues, which contributes to long-lasting results, especially in body remodeling and cellulite.

Our results demonstrated a tendency of improvement of body modeling in relation to the variables of perimetry, adipometry and analysis of the thickness of subcutaneous tissue, as seen in table I, which shows a subtle improvement of the variables.

Maloney-Hinds *et al.* [16] compared the effects of the frequencies of 30 Hz and 50 Hz isolated and in the same session and observed that there was increase in blood flow at 5 minutes of treatment in both frequencies [16,17].

According to Pastouret *et al.* [18] vibration has its effects in blood circulation and indicates that the mechanical massage on the skin, induced by vibration, presents a positive effect in the superficial lymphatic system; a system which is essential in the physiopathology of cellulite.

In theory, the oscillatory vibration therapy accelerates blood flow and vasomotor activity, indirectly favoring lipolysis. The lymphatic vases in the tissue increase their drainage, returning the substances that compose the lymphatic to the venous system. Thus, it is known that the slow blood flow causes lipogenesis, whereas fast blood flow stimulates lipolysis; that is, fat degradation – an important factor for cellulite treatment [8,17,18].

As a hypothesis, it can be said that the present study demonstrated the effect of multi-directional oscillatory vibration therapy and its possible role in local blood flow with subsequent activation of metabolism, favoring the improvement in the aspect of cellulite in the gluteus and posterior of thigh areas.

Further studies must be carried out with multi-directional oscillatory vibration therapy with new evaluation tools, for it is believed that the therapy can cause non-lethal damage to the adipocytes and, with that, cause them to suffer an improvement in their distribution in the tissue, which promotes an improvement of body contour.

Conclusion

We conclude that oscillatory vibration therapy is effective and efficient for the treatment of cellulite, for the main role of oscillatory vibration therapy is the stimulation of local blood flow, and that is an essential factor to obtain satisfactory results in the treatment of cellulite.

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