

Impact of Ozone Dosimetry on Abdominal Subcutaneous Fat Reduction: A Randomized Controlled Study

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Abstract

The aim of the study was to evaluate the safety and efficacy of a volume-controlled ozone generator at different dosages in localized abdominal adiposity. A single-center controlled and randomized clinical trial was carried out. Female participants were recruited and 110 were randomized into 4 groups: Sham Group (SG): participants received treatment with the ozone equipment turned off; Intervention groups: participants received ozone treatment at doses of 20 (G20), 30 (G30) and 40 µg/mL (G40). Interventions were carried out at 24 pre-established points in the abdominal region, twice a week for a period of 4 weeks, totaling 8 sessions. The main results show that the G20, G30 and G40 groups showed a reduction in abdominal circumference in the periods of 15 and 30 days after treatment, a lower GAIS score and an improvement in the treatment satisfaction score in both periods evaluated. However, G40 showed lower adipose tissue thickness in both experimental periods. No serious adverse effects were reported. Thus, it can be suggested that the controlled volume ozone generator used in the present study proved to be a safe and potentially promising modality in the treatment of localized adiposity, with emphasis on the highest dose.

Keywords: Ozone; Ozone Therapy; Body Contouring; Localized Adiposity

Introduction

Subcutaneous adipose tissue morphologically presents a cluster of fat cells intertwined with thin fibrous collagen septa [1,2]. The cytoplasm of the white adipocyte is occupied by a large and single droplet of lipid, which serves as an energy reservoir, regulating several endocrine functions and responsible for the spherical shape of adipocytes. Based on the amount of lipids stored, the volume of white adipocytes fluctuates greatly throughout life [3,4].

The continuous imbalance between caloric intake (hypercaloric diet) associated with limited energy expenditure (physical inactivity) leads to the gradual accumulation of subcutaneous adipose tissue. Since excess energy is not used by the body, excess lipids are stored in the form of triglycerides, causing hypertrophy of pre-existing adipocytes and, often, adipocyte hyperplasia that involves the proliferation of adipocyte precursors (pre-adipocytes). The association of these somatized adipogenic phenomena with a reduced lipolytic response leads to the accumulation of subcutaneous adipose tissue in different locations of the body [2]. It is important to emphasize that as adipose tissue increases, adipocytes and macrophages synthesize several pro-inflammatory proteins, known as adipokines or adipocytokines, which are directly related to an inflammatory and oxidative process in adipose tissue, a state that can cause significant metabolic disorders, in addition to health risks [1].

Aspects related to social well-being should not be underestimated, since the accumulation of subcutaneous adipose tissue is considered aesthetically unpleasant and distressing for many and can result in loss of self-esteem, body image dissatisfaction, anxiety or even social inhibition [5].

Regarding dermatological and aesthetic medicine, the search for improvements in body contouring has encouraged technological and innovative advances in minimally invasive and non-invasive procedures. Traditionally, treatments available to reduce localized adiposity were limited options, often involving invasive surgical procedures with associated downtime and risks [6]. However, new treatment methods that are emerging promise to improve body contouring with minimal invasiveness and promising clinical efficacy [7-11].

Ozone (O₃) therapy has received considerable attention in the areas of dermatology and aesthetics. It was demonstrated that the technology can be used to treat skin problems, particularly difficult-to-heal wounds, dermatitis, acne, psoriasis, mycoses and other conditions [12-14]. Furthermore, in recent years, interest in applying therapy to reduce subcutaneous adipose tissue has increased considerably, as it is a minimally invasive, well-tolerated and low-cost procedure. Despite its widespread use in common clinical practice, the mechanisms of action of the gas are still being understood [15-18].

Therefore, although ozone therapy is widely used in common clinical practice, some issues related to the use of this technique in the treatment of localized adiposity are still not well understood. In particular, there is a lack of studies in the literature investigating the effect of ozone therapy at different doses in the treatment of localized adiposity. Given this, the hypothesis arises that the gas could have the potential to reduce the thickness of adipose tissue, thus favoring body remodeling. Thus, the objective of the present study was to verify the clinical implications of ozone therapy at different doses in the treatment of localized abdominal adiposity, through a randomized controlled clinical trial.

Methodology

Type and Location of Study

This is a controlled, randomized clinical trial with a quantitative and qualitative approach. The study was carried out at the Physiotherapy Clinic of Centro Universitário da Faculdades Associadas de Ensino - UNIFAE - São João da Boa Vista - SP, Brazil. The study was submitted to the Human Local Ethics Committee of Centro Universitário da Faculdades Associadas de Ensino - UNIFAE via Plataforma Brasil and the Brazilian Registry of Clinical Trials (Rebec). After approval (protocol 4.962.021 – Annex I). The recruitment of participants was carried out through advertising on digital media, that is, social networks (Instagram and Facebook). Participants were informed about the procedures to be carried out during the study, that is, the treatments, number of sessions and other information pertinent to the study and subsequently signed an Informed Consent Form.

Sample

The inclusion criteria adopted were: female; age range from 20 to 50 years; with a body mass index considered eutrophic and/or overweight; hyperplasia of superficial subcutaneous adipose tissue (abdominal skin folds greater than 2 cm); non smokers; consent to participate in the study and sign the informed consent form. The exclusion criteria were: having carried out any aesthetic procedure in the area in the last 3 months; having undergone abdominoplasty or liposuction surgeries; being on a diet to reduce measurements; having used medications or dietary supplements in the last 90 days, the aim of which is to reduce measurements and/or body weight, which could affect lipid metabolism, appetite or nutrient absorption; G6PD deficiency; pregnant or lactating women; who have metabolic dysfunctions such as diabetes and thyroid disorders or cardiovascular changes such as hypertension, heart failure, arrhythmia, thrombosis, use of a pacemaker or other implanted electronic device; hematological disorders such as anemia, hemophilia, bleeding disorders; kidney problems; dermatological disorders at the treatment site; history of previous oncological disease; cognitive deficits in addition to refusal to sign the informed consent form. Furthermore, criteria for discontinuity were established: withdrawal of participants; two consecutive absences; use of some aesthetic resource during the study; pregnancy throughout the study; present any disorder/infection that requires the use of anti-inflammatory drugs or antibiotics throughout the study.

Study Design and Randomization

Participants were randomly distributed into 4 groups, as described below:

Sham Group (SG): participants received treatment with the equipment turned off.

Intervention Group 1 (G20): participants received treatment with ozone therapy at a dose of 20 µg/ml;
 Intervention Group 2 (G30): participants received treatment with ozone therapy at a dose of 30 µg/ml;
 Intervention Group 3 (G40): participants received treatment with ozone therapy at a dose of 40 µg/ml.

The randomization process was conducted by a researcher, not involved in the experiment, through a simple draw in a computer program, creating a random table of numbers. The numbers were placed in opaque envelopes corresponding to the groups (SG, G20, G30 and G40). Assessment and reassessment were carried out by a researcher blind to the experimental groups. Patients were also unaware of the type of treatment (Sham or interventions). The sample size was calculated using the GPower 3.0.10 program with parameters: effect size of 0.25, observed power of 0.75 and $\alpha = 5\%$.

Experimental Design

The experimental design of this study consisted of the initial assessment through an anamnesis form that included personal data, medical history, lifestyle habits, type of diet and history of aesthetic procedures, carried out by a properly trained and qualified healthcare professional. Then, all participants underwent anthropometric assessment, bioimpedance, abdominal circumference, adipometry, adipose tissue thickness, photographic recording, assessment of patient satisfaction and adverse effects. Assessments were carried out one week before the first treatment session (A1) and reassessments were carried out 15 (A2) and 30 (A3) days after the last session. Participants underwent 8 treatment sessions, twice a week over a period of 4 weeks. It is worth noting that the evaluations and reevaluations were always carried out by the same evaluator, in the morning and the participants were instructed not to change their skin care routine throughout the experimental period.

Assessments

Anthropometrics and bioimpedance

To determine body weight, lean mass and amount of fat, bioimpedance analysis (InBody 120) was performed and height was obtained using a stadiometer. The participant was instructed to position herself, keeping her body upright, feet fully coupled to the sensors located at the base of the scale, arms straight and thumbs coupled to the sensors on the rod.

Abdominal circumference

Abdominal circumference (perimetry) was measured using a measuring tape. Measurement was performed on the abdominal circumference respecting the horizontal lines, the first being located 5 cm above the umbilical line, the second exactly on the umbilical scar line and the third 5 cm below the umbilical line. Data were expressed as the average of the 3 measurements in cm.

Adipometry

To analyze abdominal skinfolds, a clinical plicometer (CESCORF) was used. Measurements were carried out at 4 points, namely: 5 cm above the umbilical scar and 5 cm in relation to the linea alba on the right and left side (points 1 and 2) and also, 5 cm below the umbilical scar and 5 cm in relation to the linea alba on the right and left side (point 1 and 2). Three consecutive measurements were taken to assign an average as the final value, referring to skinfold thickness (mm).

Abdominal adipose tissue thickness

To evaluate the thickness of abdominal adipose tissue, diagnostic imaging ultrasound equipment (SonoStar SS-9) was used, with a linear transducer (frequency 7.50 MHz) to create panoramic images. The analysis points were marked with the patient standing. The points for capturing the thickness are standardized as shown in Fig. 3. Next, the patient was arranged in the supine position, a thin layer of neutral conductive gel (RMC) was applied and analyses with the punctual technique were performed.

Photographic records

All participants were photographed with a digital camera (Canon EOS Rebel T3I, Canon USA Inc., Melville, NY, USA) fixed to a tripod in order to guarantee image reproduction at other moments of the study. The height of the tripod (in 105 cm), standard lighting, without external light interference and black clothing were standardized. The participant was positioned 70 cm from the back wall and 2 meters from the tripod to guarantee framing and enable reproduction both among participants and at other moments of the study. The photos were evaluated using the Global Aesthetic Improvement Scale (GAIS). A score ranging from 1 (much better) to 5 (much worse) was assigned to each side of the abdomen by two blind and properly trained evaluators.

Treatment Satisfaction

Participant satisfaction with the treatment was assessed at the end of the study using a 5-point Likert scale. Participants were asked to rate their level of satisfaction regarding the overall change in body shape at the conclusion of the phase by recording a rating on a 5-point scale: 1 - very satisfied, 2- satisfied, 3- neither satisfied nor dissatisfied, 4- somewhat satisfied, 5- not at all satisfied.

Adverse effects

The adverse effects of treatments were assessed by observing the following symptoms: presence of discomfort, pain (visual analogue scale - VAS), burning sensation, erythema, edema and ecchymosis. Follow-up was carried out immediately after treatments and for 3 consecutive days after treatments, via phone contact.

Interventions

Ozone treatment protocol

A portable ozone generator from Ibramed (Amparo, São Paulo) was used with an injector tip (Precision Glide BD hypodermic needle 13 x 0.30 mm - 30G1/2") and a device with a flow of 800 ml/min, concentration of 20, 30 and 40 µg/ml of ozone and a volume of 5 ml per point. The application of ozone was carried out at 24 pre-established points in the abdominal region in horizontal lines, equidistant at 5 cm from the umbilical line, 5 cm above and 5 cm below the umbilical line. A subcutaneous technique was used with an angle of 90°C in relation to the skin surface, twice a week over a period of 4 weeks, totaling 8 sessions.

It is noteworthy that for the application of ozone, the skin in the treatment region was cleaned (70% alcohol) before each session. During treatments, participants were arranged in the supine position and a template of application points was always used in order to guarantee standardization in all treatment sessions.

Statistical Analysis

Data were statistically imposed using descriptive techniques, in the form of means and standard deviations. The Shapiro-Wilk normality test was used for all variables. For anthropometric assessments, bioimpedance, body perimetry, adipometry, adipose tissue thickness and photographic records, Two Way ANOVA tests with Sidak post hoc were used. To analyze patient satisfaction with treatment, in cases where there was a normal distribution of the sample, comparisons between groups were made using One Way ANOVA with Tukey post hoc. In non-parametric cases, the Kruskal-Wallis test with Dunn's post hoc test was adopted. All analyses were performed using GraphPad Prism software, version 6.01 (GraphPad Software, San Diego CA, USA). For statistical analysis statistics, a significance level of 5% ($p \leq 0.05$) was used.

Results

Flow Diagram

To carry out this study, 141 participants were recruited. Of these, 110 participants were selected to participate, according to the inclusion criteria and randomized into 4 groups: SG, G20, G30 and G40. During the experimental period, 2 volunteers were excluded because they missed 2 consecutive sessions, as shown in the flow diagram (Fig. 1).

Participants had an average age of 41.04 (SG), 40.69 (G20), 40.10 (G30) and 40.78 (G40). BMI was 27.10 (SG); 27.08 (G20), 27.87 (G30) and 27.89 kg/m² (G40). Regarding the level of activity, 69.23% (SG), 66.66% (G20), 67.87% (G30) and 67.85% (G40) had active IPAQ. It was not possible to observe a statistical difference in the parameters evaluated. Table 1 represents the demographic and anthropometric data of the participants.

Bioimpedance

The results regarding weight (Kg), lean mass (Kg) and fat mass (Kg) are represented in Table 2. No statistically significant difference was observed between body composition parameters, as well as when comparing experimental groups and evaluation periods.

Adipometry

Fig. 2 represents the adipometry assessment values of the different experimental groups in the periods of A1, A2 and A3. No statistical differences were observed in the evaluation of the experimental periods (A1, A2 and A3), as well as in the comparison between the experimental groups (SG, G20, G30 and G40).

Abdominal Circumference

The results of the abdominal circumference analysis of the different experimental groups and different evaluation periods (A1, A2 and A3) are shown in Fig. 3. In the evaluation between the experimental periods, a significant reduction in abdominal circumference was observed in periods A2 and A3 when compared to A1 in groups G20, G30 and G40 ($p < 0.0001$). When comparing the experimental groups G20, G30 and G40 in relation to the SG, a reduction in abdominal circumference was observed in the experimental periods of A2 and A3.

Abdominal Adipose Tissue Thickness

Fig. 4 represents the abdominal thickness values of the different experimental groups in assessments A1, A2 and A3. In the evaluation between the experimental periods, a reduction in thickness was observed between A2 and A3 when compared to A1 ($p < 0.001$) in the G40 group. In the evaluation between the groups, it was possible to observe that there was a significant reduction in adipose tissue in G40 when compared to SG in the periods of A2 ($p = 0.0043$) and A3 ($p = 0.0035$) and when compared to G20 in the experimental period A3 ($p = 0.0032$).

Improved Overall Aesthetics

Fig. 5 shows the analysis of the improvement in global aesthetics achieved through the GAIS score. In the semi-quantitative analysis, a reduction in the GAIS score was observed in the G20, G30 and G40 groups when compared to the SG in the A2 and A3 periods. No statistical differences were observed between the treated groups.

Treatment Satisfaction

Assessments regarding patient satisfaction after treatment are shown in Fig. 6. It was observed that the G20, G30 and G40 groups presented the lowest scores when compared to the SG.

Adverse Effects

Adverse effects observed throughout treatment, such as: discomfort, pain, burning, erythema, edema and ecchymosis in all groups evaluated. Pain and burning were more reported in groups G30 and G40. All events were transient and disappeared in less than a day in all groups.

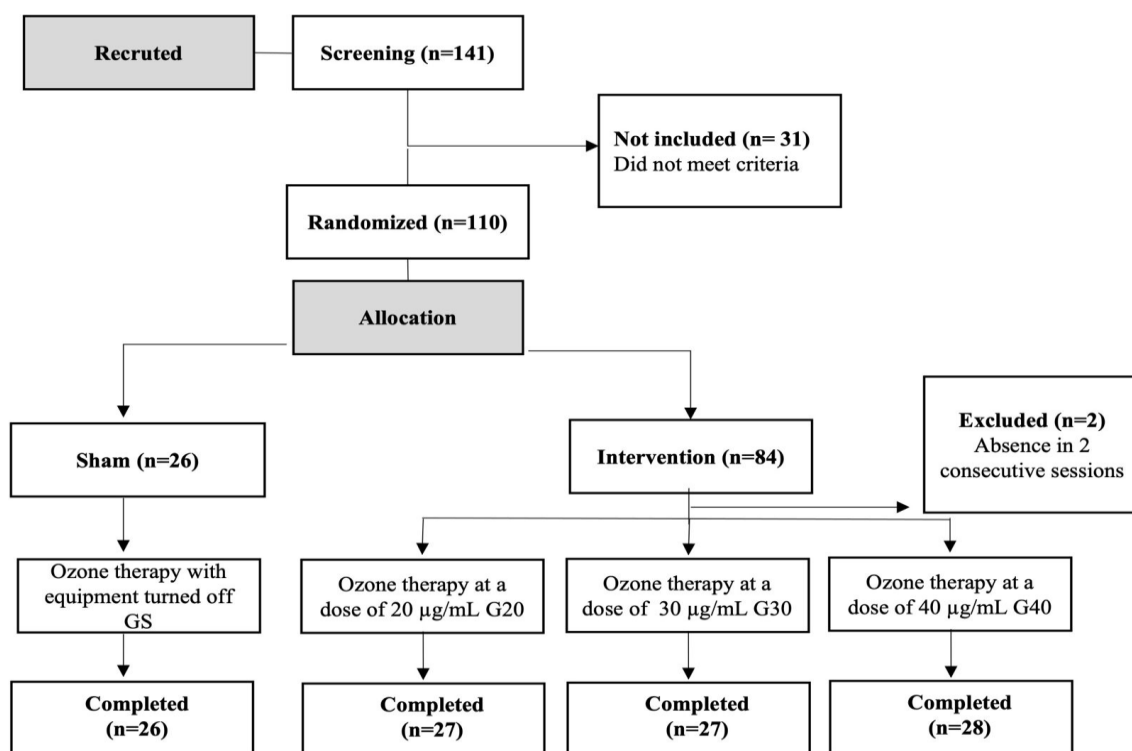


Figure 1: Flow diagram of recruited volunteers.

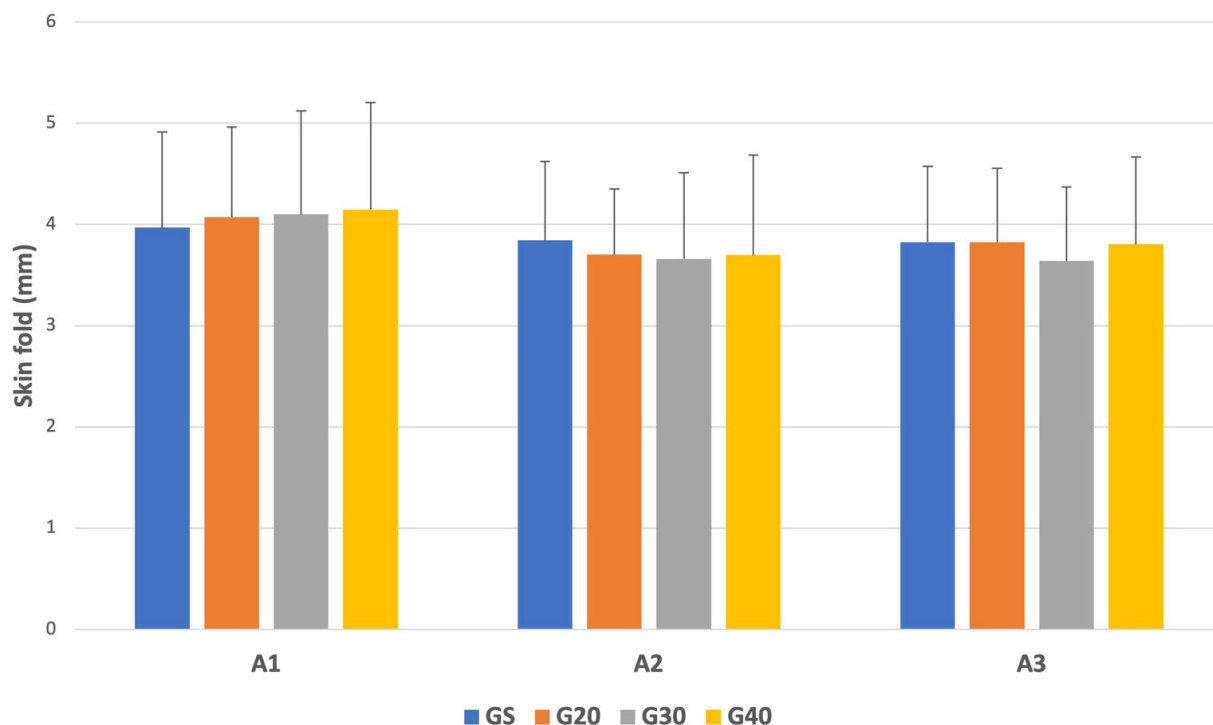


Figure 2: Representative figure of adipometry assessment values. Sham Group (SG): participants received treatment with the equipment turned off; Intervention Group where participants received treatment with ozone therapy at a dose of 20 $\mu\text{g/ml}$ (G20); 30 $\mu\text{g/ml}$ (G30); 40 $\mu\text{g/ml}$ (G40).

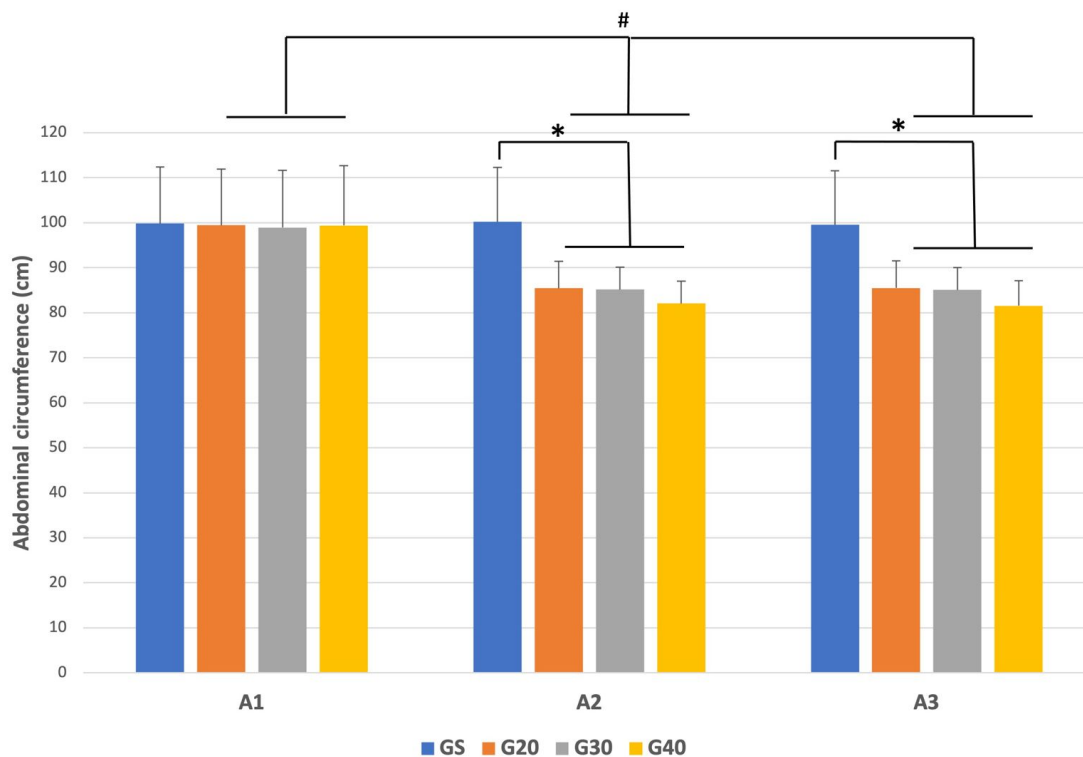


Figure 3: Representative figure of abdominal circumference assessment values. Sham Group (SG): participants received treatment with the equipment turned off; Intervention Group where participants received treatment with ozone therapy at a dose of 20 $\mu\text{g/ml}$ (G20); 30 $\mu\text{g/ml}$ (G30); 40 $\mu\text{g/ml}$ (G40).

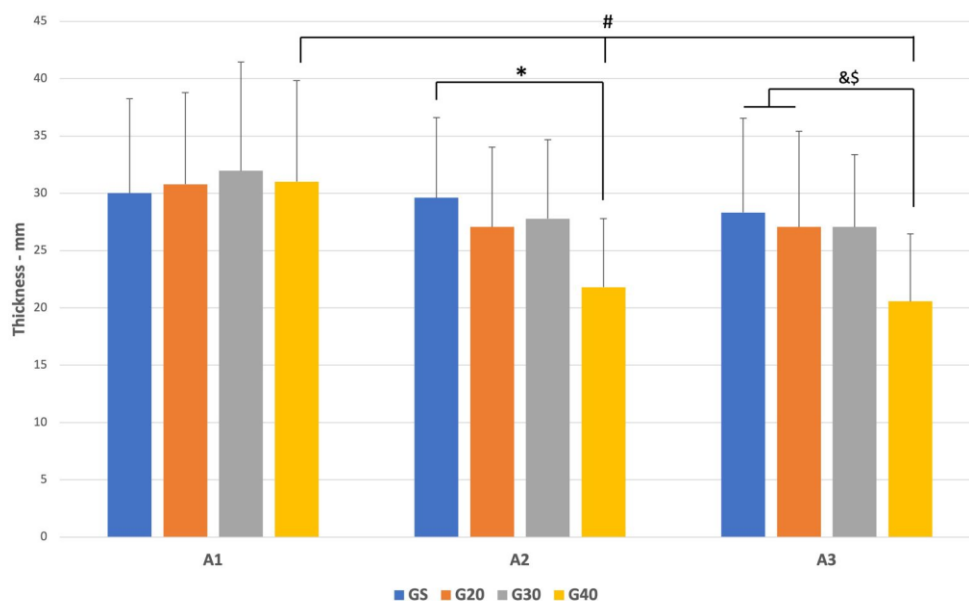


Figure 4: Representative figure of abdominal adipose tissue thickness assessment values. Sham Group (SG): participants received treatment with the equipment turned off; Intervention Group where participants received treatment with ozone therapy at a dose of 20 $\mu\text{g/ml}$ (G20); 30 $\mu\text{g/ml}$ (G30); 40 $\mu\text{g/ml}$ (G40).

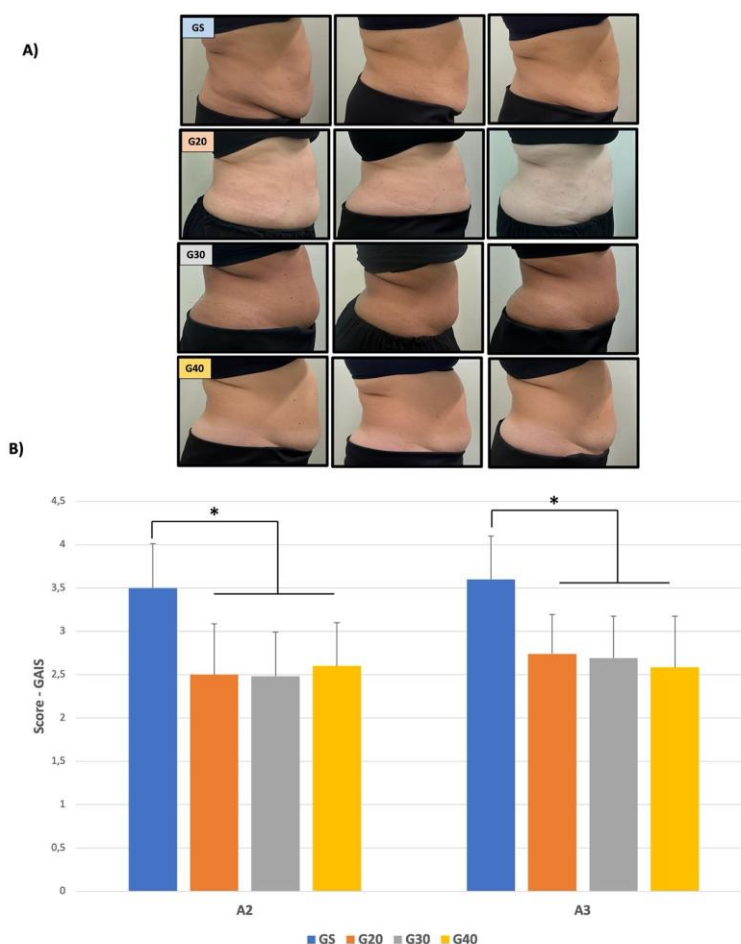


Figure 5: Representative figure of global aesthetics assessment values. A) Representative photomicrographs used for GAIS analysis. B) Semi-quantitative analysis of GAIS. Sham Group (SG): participants received treatment with the equipment turned off; Intervention Group where participants received treatment with ozone therapy at a dose of 20 $\mu\text{g/ml}$ (G20); 30 $\mu\text{g/ml}$ (G30); 40 $\mu\text{g/ml}$ (G40).

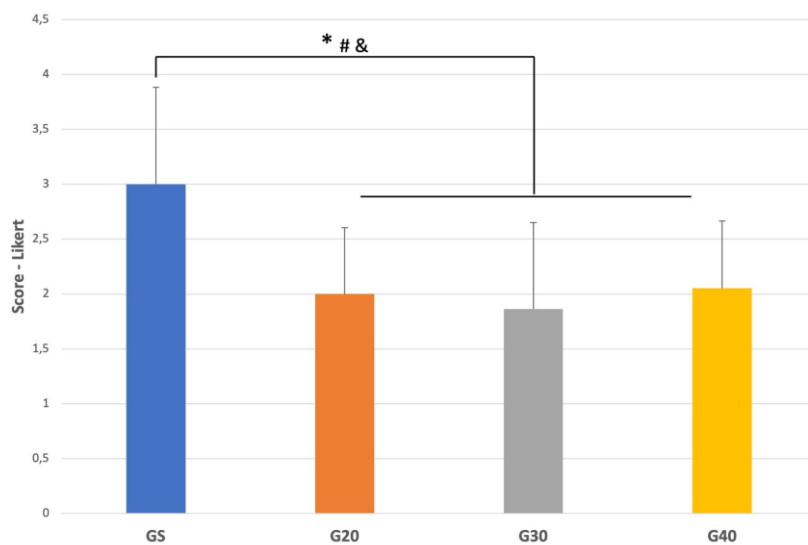


Figure 6: Patient Satisfaction assessment values. Sham Group (SG): participants received treatment with the equipment turned off; Intervention Group where participants received treatment with ozone therapy at a dose of 20 $\mu\text{g/ml}$ (G20); 30 $\mu\text{g/ml}$ (G30); 40 $\mu\text{g/ml}$ (G40).

	Age (Years)	IMC (Kg/m^2)	IPAQ (ativo)
GS	41,04 $\pm$ 3	27,18 $\pm$ 3	69,23%
G20	40,69 $\pm$ 5	27,08 $\pm$ 4	66,66%
G30	40,10 $\pm$ 4	27,87 $\pm$ 5	67,87%
G40	40,78 $\pm$ 5	27,89 $\pm$ 4	67,85%

Table 1: Average demographic and anthropometric data.

Bioimpedance	Weight (Kg)	Muscle mass (Kg)	Fat mass (Kg)
GS			
A1	71,70 $\pm$ 6	22,77 $\pm$ 5	29,63 $\pm$ 4
A2	70,94 $\pm$ 6	23,56 $\pm$ 4	29,82 $\pm$ 4
A3	71,65 $\pm$ 6	23,56 $\pm$ 3	30,20 $\pm$ 3
G20			
A1	72,94 $\pm$ 8	24,58 $\pm$ 2	28,14 $\pm$ 6
A2	71,89 $\pm$ 7	24,75 $\pm$ 3	28,08 $\pm$ 7
A3	71,08 $\pm$ 8	24,63 $\pm$ 4	27,92 $\pm$ 7
G30			
A1	69,04 $\pm$ 7	23,61 $\pm$ 3	29,60 $\pm$ 3
A2	70,32 $\pm$ 8	23,86 $\pm$ 2	28,32 $\pm$ 4
A3	69,44 $\pm$ 7	23.90 $\pm$ 3	28,25 $\pm$ 4
G40			
A1	72,09 $\pm$ 5	24,55 $\pm$ 3	28,34 $\pm$ 5
A2	71,80 $\pm$ 7	25,01 $\pm$ 4	26,66 $\pm$ 4
A3	70,98 $\pm$ 6	25,38 $\pm$ 2	26,65 $\pm$ 4

Table 2: Bioimpedance data average.

Discussion

The increasing demand for non-invasive and minimally invasive procedures in dermatology and aesthetic medicine has led to significant advances, revolutionizing the way individuals seek to improve body appearance. This article investigates and compares the effects and safety of an innovative continuous-flow ozone therapy approach using different doses for the treatment of localized adiposity. The present discussion interprets the study findings, explores their clinical implications and discusses their significant potential in the field of aesthetic dermatology. The main findings demonstrated that participants who received ozone therapy treatment at all evaluated doses exhibited a reduction in abdominal circumference, improvement in overall aesthetics and enhanced patient satisfaction with the treatment at both evaluation periods, with minimal and transient adverse effects. However, only ozone therapy at the dose of 40 µg/mL resulted in a reduction in adipose tissue thickness at both experimental time points.

The growing demand for non-invasive aesthetic procedures significantly highlights the importance of developing therapeutic strategies capable of safely and effectively improving body contour [7,8,11,21]. Several treatment options for localized adiposity have been used in clinical practice and ozone therapy has recently been strongly recommended. Nevertheless, few studies have evaluated the impact of this technique on adipose tissue, with substantial variability in the application parameters used in clinical practice, thereby justifying the rationale for conducting this randomized controlled clinical trial [19,20].

Through anthropometric and circumference assessments, it was possible to identify that all participants recruited in the present study presented a mean BMI classified as overweight and a mean abdominal circumference above 90 cm. The literature demonstrates that, beyond the aesthetic concern (dissatisfaction with appearance), increased BMI and abdominal volume are directly associated with cardiometabolic risks and other related health disorders. An elevated abdominal circumference is defined as greater than 102 cm in men and greater than 88 cm in women, as observed in the participants included in the present study [22]. Therefore, the reduction of abdominal subcutaneous adipose tissue should be considered an important medical necessity.

As previously mentioned, as adipocytes increase in size, they become capable of synthesizing pro-inflammatory proteins (adipokines), which may induce excessive infiltration and activation of macrophages with pro-inflammatory phenotypes within adipose tissue. Consequently, adipose tissue accumulation may lead to the development of low- to moderate-grade inflammation associated with several health risks [23]. However, if such conditions persist for prolonged periods, this inflammatory state may lead to hyperglycemia, hyperinsulinemia, hypertriglyceridemia and glucose intolerance, which are characteristic features of insulin resistance syndrome and other metabolic disorders [1]. Data regarding abdominal circumference in the present study demonstrated that ozone therapy at all evaluated doses significantly reduced abdominal circumference at both 15 and 30 days after treatment, suggesting its promising application as a therapeutic strategy in metabolic healthcare.

The beneficial effects of ozone therapy on adipose tissue reduction have been increasingly explored scientifically. It is believed that the action of O₃ occurs through its interaction with plasma membrane structures, particularly membrane polyunsaturated fatty acids [15]. Some hypotheses suggest that the dose-dependent oxidative stress produced by the gas and the subsequent generation of by-products (also known as ozonides) culminate in several biochemical and cellular events [24,25]. This ability to modulate cellular metabolism and induce different biological responses strongly depends on the dosimetry used. Furthermore, the same biological response induced by a specific dose may be further optimized or inhibited depending on the intensity of the oxidative stress generated [16-19].

Ozone doses above 20 µg/mL were selected because they are widely used in clinical practice for the treatment of localized adiposity and have demonstrated, *in-vitro*, the ability to reduce adipocyte viability and induce adipocyte necrosis [19,20]. In the present study, only the 40 µg/mL dose significantly reduced adipose tissue thickness, suggesting that ozone concentration is a key determinant of therapeutic efficacy. This finding is consistent with the mechanism proposed by Conti, et al., who demonstrated that mild cellular stress promotes reversible lipid extrusion through transient micropores in the plasma membrane, whereas more intense oxidative stress induces lipid peroxidation and adipocyte necrosis [26]. Accordingly, lower ozone doses may have induced sublethal stress, whereas the 40 µg/mL concentration generated sufficient oxidative damage to promote adipocyte death. The significant differences observed between the Sham and treated groups further support the potential of ozone therapy as an effective strategy for reducing subcutaneous fat with minimal metabolic risk.

Recently, Luccas, et al., investigated the same ozone concentrations in male participants and reported reductions in abdominal adiposity at all evaluated doses, with the greatest effect observed at 40 µg/mL, corroborating the findings of the present study [27]. Despite the well-established sex-related differences in adipose tissue distribution and metabolism, including the greater hypertrophic capacity and lower lipolytic responsiveness of female subcutaneous adipocytes compared with the more metabolically active male adipose tissue, both sexes responded more favorably to the highest ozone concentration [28,29]. However, adipose tissue reduction occurred earlier in men (15 days) than in women (30 days), suggesting that hormonal and metabolic factors may influence the rate of therapeutic response without compromising its overall efficacy.

The reduction in adipose tissue thickness was accompanied by improvements in body contour and overall aesthetic appearance, as confirmed by photographic assessments and reflected in high patient satisfaction. Considering the psychosocial impact of localized adiposity, these findings further emphasize the importance of patient-reported outcomes in evaluating treatment success [5]. Ozone therapy also offers several practical advantages, including its minimally invasive nature, short treatment duration (approximately 20 minutes), low cost and favorable safety profile. The ozone generator used in this study incorporates an automatic self-calibration system that improves dose accuracy and treatment reliability. Adverse events were mild and transient, consisting mainly of pain at the injection site, burning sensation, edema and minor ecchymosis, which are consistent with those commonly reported following minimally invasive aesthetic procedures. The present study has some limitations. Although the beneficial effects were maintained throughout the short-term follow-up, longer follow-up periods are necessary to determine the durability of the therapeutic outcomes. Furthermore, because this was a single-center study, future multicenter investigations including more diverse populations are warranted to improve the external validity of these findings [30].

Finally, although ozone therapy should not replace healthy lifestyle interventions, it may represent a valuable adjunctive strategy for body contouring by increasing patient motivation and promoting long-term adherence to healthy lifestyle behaviors.

Conclusion

The results of the present study indicate that ozone therapy in all dosages used proved to be a safe and promising treatment in the field of aesthetic dermatology. All dosages evaluated were able to reduce abdominal circumference, improve global aesthetics and patient satisfaction with the treatment. However, only ozone therapy at a dose of 40 µg/ml was effective in reducing adipose tissue thickness in both periods evaluated. No serious adverse effects were observed in this study. Thus, the present study supports the use of ozone therapy as an adjunct therapy in the treatment of localized abdominal adiposity. In a way that this option may be particularly relevant for patients seeking non-invasive therapies to improve body contouring.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Statement

The project did not meet the definition of human subject research under the preview of the IRB according to federal regulations and therefore was exempt.

Informed Consent Statement

Informed consent was obtained from all participants included in the study.

Authors' Contributions

MSc Fabiele Chieragato, graduation in aesthetics, experimental application of the technique and revision of the results. Graduate Degree Alexandre de Melo Giarretta, physiotherapist, protocol preparation and revision. Graduate Degree Giovana Carolina Gonçalves Lucas, physiotherapist experimental application of the technique and revision of the results. MSc Elisabete Loro de Oliveira Gonçalves, physiotherapist, experimental application of the technique and revision of the results. Dra. Vanessa Vilas Boas, physiotherapist, statistical data. PhD Patricia Brassolatti, physiotherapist, protocol preparation and revisions, publication of the study report. B.A. José Ricardo de Souza, Support with the development and production of equipment and study development. PhD Carla Rober Tim, physiotherapist, protocol preparation and revisions. PhD Lívia Assis, physiotherapist, protocol preparation and revisions.

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