

Effectiveness of adaptive cryothermogenesis for abdominal fat reduction assessed by bioimpedance.

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Abstract: Localized fat is defined as a regional accumulation of adipose tissue in various parts of the body, with higher and lower incidences depending on the individual's genetics, with the largest areas of fat concentration being the abdomen, thighs, hips, subscapular and pre-axillary regions. This study presents the evaluation of 5 volunteers with excess abdominal fat through bioimpedance, showing a decrease in white fat and an increase in beige/ or brown fat. For this, resources such as cryolipolysis by exposure and association with electrolipolysis, as well as excitatory current, were used. The paired Wilcoxon test was applied to compare the medians before and after the intervention. The results showed a significant reduction in fat metrics and subcutaneous fat (%). **Objective:** The objective of this research is to evaluate the ability of cryolipolysis associated with electrolipolysis and Russian current electrostimulation to reduce adipose tissue and increase lean mass index. The evaluation of the data will be carried out through bioimpedance performed before and after the treatment.

Keywords: obesity, bioimpedance, localized fat, cryolipolysis, electrolipolysis

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I. Introduction

Currently, there is a development of Science and Technology in all areas of society. This development also occurs in the cosmetic and technological equipment industry, a market that has shown extraordinary growth in recent decades, highlighting the pursuit of beauty.

In this pursuit of beauty, localized fat is one of the main obstacles to achieving the desired standard, thus the demand for supply and demand for aesthetic treatments is increasing more and more.

The accumulation of adipose tissue in specific anatomical regions continues to be a challenge in both metabolic regulation and aesthetic approaches. Lipogenesis, an anabolic process regulated by enzymes, converts excess energy substrates, such as glucose and free fatty acids, into triglycerides stored in the cytoplasm of adipocytes. This mechanism, intensified by physical inactivity and hormonal imbalances, culminates in regional hypertrophy of adipose tissue, often resistant to isolated caloric restriction or moderate aerobic activity (Lima; Vieira, 2017). Although often overlooked as aesthetic imperfections, these accumulations impact energy homeostasis and endocrine-metabolic function (Ruiz-Silva, 2025).

1.1 Adipose Tissue

For many years, adipose tissue was considered an important organ for energy storage, where excess energy is converted into triglyceride molecules under the action of the hormone insulin, while in restriction, energy stores are mobilized under the influence of catecholamines and other lipolytic hormones.1,2 article on adipokines

This tissue is basically composed of lipids derived from fatty acids, and the best way to store them is in the form of triglycerides (Borges, 2016).

It is an active, dynamic, complex, and metabolically important organ for the body, where it performs physiological functions that act in body homeostasis. In addition, this tissue is composed of cells called adipocytes, which have components such as pre-adipocytes, connective tissue, nerve fibers, immune cells, blood vessels, lymphoid nodules, and fibroblasts (Fonseca-Alanis et al., 2007).

It is classified as specialized connective tissue, composed of two important cell types and a complex extracellular matrix. This tissue has some functions such as energy storage, endocrine and immune functions (FARMER, 2009; GUIMARÃES et al., 2007; MOULIN et al., 2009; WAJCHENBERG et al., 2009).

In humans, two types of adipose tissue are found: white adipose tissue and brown adipose tissue, and they have different characteristics. (FONSECA-ALANIZ, et al, 2007;).

White tissue stores multiple lipid droplets that it later transforms into a single particle with triglycerides that occupies the central portion of the cell, displacing the cytoplasm, nucleus, and organelles to the periphery. Its main function is the storage of energy in the form of triglycerides and the secretion of hormones such as adipokines (FONSECA-ALANIZ, et al, 2007;).

Brown tissue, on the other hand, is characterized by heat production and regulation of body temperature, being found in newborns and in small quantities in adults near the neck and chest (FARMER, 2009;).

The brown tissue cell stores lipid droplets of various sizes, has abundant cytoplasm, a spherical nucleus, and many mitochondria. Its coloration occurs due to the concentration of cytochrome. Oxidase present in mitochondria. (FONSECA-ALANIZ, et al., 2007). Its primary function is non-shivering thermogenesis, that is, the production of heat from the oxidation of fatty acids, without muscle contraction.

Beige adipose tissue has cells with intermediate characteristics, with significant therapeutic potential, usually arising within white adipose tissue in response to cold stimuli or certain hormones, or also to physical exercise, being known as "browning," which gives the tissue the capacity for thermogenesis.

Furthermore, adipose tissue can be defined according to its location in the body as subcutaneous or visceral. According to Fonseca-Alaniz and collaborators (2007), visceral tissue is the fat deposit near or inside the organs of the abdominal cavity; in this case, it plays an important role in the pathogenesis of cardiovascular diseases, through the production and secretion of various post- Inflammatory factors such as TNF alpha and IL-6 (FONSECA-ALANIZ, et al, 2007)

In adulthood, adipose tissue does not increase quantitatively, but rather there is an increase in cell size, that is, the adipocyte, which can lead to the appearance of localized fat, which is more prevalent in the abdominal region.

It is also worth remembering that these cells synthesize and secrete proteins called adipokines, which are proteins capable of acting in various physiological and pathophysiological processes, and their production can be regulated by inflammatory stimuli and by conditions of hypertrophy and hyperplasia of adipocytes when found in cases of obesity and metabolic syndrome (BASTARD et al, 2006; GREENBERG; OBIN, 2006; GUIMARAES et al, 2007; KARMIRIS et al, 2006).

These cells are also capable of secreting chemokines such as MCP1 (chemoattractant protein for monocytes 1) favoring the recruitment of macrophages to adipose tissue. BASTARD et al, 2006; GREENBERG; OBIN, 2006; GUIMARAES et al, 2007; KARMIRIS et al, 2006).

Adipocytes exhibit characteristics similar to the immune system, involving the production of pro-inflammatory, anti-inflammatory mediators and the complement system (BASTARD et al, 2006; MOULIN et al, 2009).

The vascular stromal fraction delimits the non-adipocyte portion of the tissue and is crucial for its function; it includes pre-adipocytes, macrophages, fibroblasts, lymphocytes, and endothelial cells.

Pre-adipocytes are mesenchymal cells that differentiate into mature adipocytes. Macrophages are cells of the immune system. In lean individuals, M2 macrophages, which are anti-inflammatory, predominate, while in individuals with obesity, there is an increase in macrophages M1 Pro-inflammatory, contributing to the state of low-grade chronic inflammation.

The other cells that compose it are essential for structural integrity, immune function, and tissue vascularization.

Regarding endocrine function, adipose tissue is considered an active endocrine organ, secreting various bioactive molecules such as adipokines. The most significant are: leptin, the "satiety hormone," adiponectin, a protective molecule that increases insulin sensitivity, and resistin, which is associated with insulin resistance and inflammation.

The identification of leptin, a hormone secreted by adipocytes, shows an effect on the CNS and endocrine function, participating in energy control, as well as appetite.

Leptin is a type of adipocytokine produced exclusively by adipose tissue, more specifically by mature adipocytes (BASTARD et al, 2006). It is composed of 167 amino acids, meaning it is a protein that is mainly expressed in white adipose tissue, with its highest production occurring in subcutaneous tissue. It is characterized by pro- or anti-inflammatory properties (KAMIRIS et al, 2006).

One of the first genetic pieces of evidence about this protein is its importance as a regulator of energy balance in humans.

It is also observed that resistance to this protein can lead to cases of obesity.

This protein interacts with different central neuroendocrine systems involved in the control of food intake, including neuropeptide Y (NPY), which is synthesized in the arcuate nucleus of the hypothalamus and is a potent stimulator of food intake.

It is observed that both leptin deficiency and resistance cause overexpression of this peptide, leading to hyperphagia in obesity.

Several studies demonstrate that leptin promotes the oxidation of triacylglycerols in adipose tissue and reduces fat accumulation by inhibiting lipogenesis and stimulating lipolysis.

This protein can also exert a hypoglycemic effect, resulting from greater peripheral glucose utilization and increased insulin sensitivity. (article on adipokines)

Bastard et al. (2006) describe that this protein is an important marker of body fat mass, showing a direct association with BMI.

The balance of these adipokines is altered in obesity, resulting in a pro-inflammatory state and insulin resistance.

Regarding expansion, adipose tissue can be hypertrophic, when there is an increase in the size of adipocytes, which can lead to metabolic dysfunction and inflammation. Or hyperplasia, which involves an increase in the number of adipocytes through the differentiation of pre-adipocytes, being considered the healthiest mode of expansion and with the best metabolic profile.

1.2 Electrolipolysis

It is a technology also known as electrolipophoresis, which uses low or medium frequency electrical currents (generally between 1 and 4000 Hz) for the treatment of localized fat and gynoid lipodystrophy. This technique can be used percutaneously (with the use of acupuncture needles inserted into the adipose tissue) or transcutaneously (with surface electrodes).

According to Soriano et al., it is a current characterized by the application of specific low-frequency microcurrents, which act directly at the level of adipocytes and accumulated lipids, promoting their destruction and favoring their elimination.

In other words, the objective of this technique is to induce the process called lipolysis, which is characterized as the "breakdown" of triglyceride molecules into fatty acids and glycerol, subsequently facilitating their elimination.

In this technique, the application to inflamed adipose tissue, as occurs for example after cryolipolysis, compensates for the bioelectricity that is diminished in hypoxic and inflamed tissue (Ruiz-Silva, 2006; 2016; Xu, 2021; Coy, 2022), generating ATP and mitogenesis. This current generates a constant intensity, increasing the electrical flow, dissociating the water molecule, and hydrogen and hydroxyl ions are formed around both electrodes. The hydrogen that leads to the creation of ATP, it follows that, as a residual effect after the microcurrent stimulator is switched off, ATP production continues at the site. However, this energy formation through ATP is observed according to Mitchell's theory (Cheng, 1985; Ruiz-Silva, 2016).

This form of microcurrent exerts "hormone-like effects," norepinephrine secretion in the postganglionic sympathetic neuron of the nervous system and in the G protein of the cell membrane (Al-Tubaikh 2018). Norepinephrine secretion increases by binding to the β_3 -adrenergic receptor (β_3 -AR), which in turn converts ATP to cAMP in adipocytes (Noites, 2017). MCT induces lipolysis after stimulation of the postganglionic sympathetic neuron (Piras, 2021; Vilarinho et al. 2022).

It presents the Joule effect, which occurs due to the increase in temperature produced in this process, contributing to vasodilation.

Lamination and consequent increase in local blood flow. In this way, it promotes a local cellular metabolic stimulus, facilitating calorie burning and improving cellular trophism.

The other effect of this current is the electrolytic effect; from the generated electric field, an ionic movement occurs that brings about changes in the membrane polarity. In this way, the cell tends to maintain the normal membrane electrical potential, and this activity promotes energy expenditure.

The presence of the circulatory effect produced by the current assists in the drainage of the area, due to the stimulation of the subcutaneous connective tissue.

With the presentation of the neurohormonal effect, the technique presents significant amounts of glycerol in the urine, which does not occur under normal conditions. This is explained by the activation of lipolysis, which, produced in conjunction with all the effects described, also results in an increase in local catabolism, which clinically translates into a reduction of adipose tissue.

It is observed that the technique provides lipolysis through stimulation of the sympathetic nervous system, resulting in the release of catecholamines, which activates adrenergic receptors, releases adenylate cyclase, and transforms adenosine triphosphate into cyclic adenosine monophosphate. In this way, the triglyceride lipase enzyme activates the lipolytic action, which hydrolyzes the triglycerides. The release of fatty acids and glycerol are the consequences of these actions, and upon entering the bloodstream, the fatty acids are transported to the cells to be used as an energy substrate. (article 04)

1.3 Cryolipolysis

It consists of a technique that uses low temperatures (around -5 to -15° C) to eliminate localized fat (MENDES et al., 2014).

The technique, by placing the organism at these temperatures (-5°C and -15°C), promotes a cascade of cellular events, including vasoconstriction, followed by vasodilation, increased tissue oxygenation, and anti-inflammatory stimulation of M2 macrophages (IKEDA et al., 2020).

With the application of cryolipolysis, the multiplication of healthy mitochondria is activated without the predominance of survival factors with anti-apoptotic proteins. This occurs through the mobile cryolipolysis system,

generating the activation of the MICOS cristae organization system, through the translocation of MIC19 and translocation receptors of the outer membrane (RUIZ-SILVA, 2023; MARTINS, RUIZ-SILVA, 2021; RUIZ-SILVA, 2024; YAU, 2020).

This cooling generates controlled thermal shock with subsequent reactive hyperemia and activation of cellular stress proteins (HSP70), impacting specific apoptotic pathways. This thermal stimulus also contributes to the modulation of mitochondrial metabolism, activation of PERK/OGT and a possible increase in UCP1 expression, typical of beige adipose tissue (JIANG et al., 2017).

Studies conducted by Dr. Lee between 2013 and 2016 demonstrated that exposure to cold and exercise increases levels of the hormone irisin (produced by muscle) and FGF21 (produced by brown fat), and that, in the laboratory, irisin and FGF21 can differentiate cells into beige adipose tissue cells over a period of six days (Loap, 2018). These two hormones, irisin and FGF21, are the main signals to stimulate energy expenditure in the laboratory. Recent research suggests that there is an inverse association between BMI and plasma irisin concentrations in individuals with morbid obesity.

Apoptosis (hypoxia and reperfusion) is observed in the cryolipolysis technique, with a decrease shown over a long period, with loss recorded over a long period (Avram, 2009; Coleman, 2009; González, 2019; Jaliman, 2013; Manstein, 2008; 2009; Nelson, 2015; Pugliese, 2020; Zelickson, 2009).

Loap, in a publication, brought to light the concept of weight loss with cryoexposure, based on the hypothesis of transformation of white adipose tissue into brown adipose tissue, which dates back more than a century (Loap, 2018). The use of cold exposure increases energy and calorie expenditure through thermogenesis and fat metabolism (Loap, 2018).

The best results from cryoexposure are achieved by freezing as many areas as possible simultaneously and stimulating the receptors of the sympathetic nervous system through electrolipolysis or electrostimulation to induce the expression of Zfp516 through sympathetic stimulation by cold (contraction).

Zfp516 binds to PGC1 α and Cox promoter regions, promoting transcriptional activation (Dempersmier, 2015).

Optimization of results can be observed with the association of cryolipolysis with microcurrents, since the reduction of adipose tissue is energy-dependent and can be achieved by reducing fat stores (lipolysis) or by the permanent removal of adipocytes, necrosis and apoptosis (Ruiz-Silva, 2023).

Lipid-rich tissues are more sensitive to cold injury than other tissues, making it possible to injure subcutaneous adipocytes,

while avoiding damage to the underlying epidermis and dermis, presenting an effective way to treat excess adipose tissue located in the subcutaneous tissue.

The cryolipolysis technique, when applied, causes several metabolic changes due to low temperatures, which leads to the activation of the sympathetic nervous system (SNS). This system generates the transmission of nerve impulses to the hypothalamus for heat conservation and production, stimulates vasoconstriction and piloerection, causing a metabolic increase in the area of application.

Low temperatures stimulate metabolism to utilize the energy reserves contained within adipocytes, promoting a lysis of triglycerides, releasing fatty acids and glycerol to be used as an energy source, resulting in a reduction in adipocyte volume and a decrease in localized fat.

This exposure to cold increases the body's need to produce heat in order to promote homeothermy. This occurs through the release of hormones by the hypothalamus that induce the use of free fatty acids as energy substrates in the mitochondria, promoting an increase in energy metabolism. Thus, when panniculitis occurs, the body reacts by causing an anti-inflammatory response, resulting in the elimination of damaged cells.

This controlled and localized cooling of the adipocyte, for a period of 50 to 120 minutes, causes localized cold panniculitis, adipocyte death by apoptosis, and consequently a decrease in the localized subcutaneous adipose tissue (MENDES et al., 2014).

Apoptosis involves a series of morphological changes in the cell that leads to its inactivation and fragmentation, without leaking contents into the extracellular environment. Then the cellular debris is phagocytosed by tissue macrophages without damage to other cells in the body (OLSEN DE ALMEIDA et al., 2015).

Intense cold promotes a structural change in lipids, assuming a shape known as fractal (BRAZ et al., 2017). In this shape, the lipids are no longer recognized by the body and are seen as a foreign body inside the adipose cells. From this, the organism develops an inflammatory response in an attempt to eliminate the cells containing fat in the fractal state. Because it is a slow response, the body takes about 90 days to eliminate this fat (BRAZ et al., 2017).

BORGES and SCORZA (2016) state that this inflammation induces the action of adipokines, which are proteins secreted by adipose tissue. There are adipokines that have an immunological function, among which tumor necrosis factor (TNF- α) stands out. This factor is produced by adipocytes in response to infectious or inflammatory stimuli.

TNF-alpha would then be responsible for triggering apoptosis of adipocytes, which is fundamental for the reduction of localized fat. Reperfusion has the ability to produce a matrix of oxygen free radicals, which can trigger the loss of adipose tissue.

1.4 Excitomotor Current: Russian Current

Lack of exercise and overeating can result in a significant increase in adipose tissue. Obesity constitutes a combination of an increased number of adipocytes and their lipid content; that is, the obese person has a greater number of fat cells and a much larger lipid volume than lean individuals (BORGES, 2016).

The Russian current equipment emits an alternating, medium-frequency, rectangular, balanced, and symmetrical excitomotor current that can be modulated in bursts with the promise of toning and strengthening muscles, improving dermal flaccidity, and promoting fat burning with weight loss. One advantage of its use is that by inhibiting fatigue in the central nervous system, it becomes possible to perform a greater number of repetitions and therefore greater energy consumption. (article 03)

For the body to use this fat, lipolysis must have occurred, that is, the functioning of this system breaks down the triglycerides on the surface of the fat droplet, the fatty acids. They are not metabolized or cross the adipocyte cell membrane to enter the capillary circulation. Once in the bloodstream, they bind to serum albumin, which acts as a carrier, and are transported by cells that use the energy substrate.

In this way, fatty acids diffuse into the circulation, being delivered to active tissues where they are removed from adipose tissue and transferred to the muscle (mainly slow-twitch fibers), where the fat is broken down and transformed into energy within the mitochondria to be used as fuel (BORGES, 2016).

It is observed that exercise increases the plasma concentration of epinephrine and other hormones, activating the beta receptors of adipocytes and stimulating lipolysis, thus breaking down triglycerides into fatty acids (BORGES, 2016).

Once in the plasma, fatty acids bind to albumin, and their quantity in the blood decreases as the intensity of exercise increases. (BORGES, 2016);

II. Materials And Methods

This prospective longitudinal study, which presented a quantitative approach to the data, through descriptive analysis of the before and after of the volunteer patients. Five volunteer patients with the same body phenotype were selected, meaning they all presented a concentration of fat in the abdominal region.

Data collection took place after agreement and authorization through the signing of the Informed Consent Form (ICF) by the volunteers, in which they stated that they were aware of the treatment protocol, possible risks and expected benefits, ensuring their complete freedom to participate or not in the research without any reprisals.

The variables BMI (body mass index), perimeter (abdominal circumference), umbilical waist circumference, lower umbilical waist circumference, and weight were evaluated using bioimpedance. The measurements were assessed in a transverse plane with the patient in an orthostatic position, positioning the tape on the patient's umbilical scar.

For the analysis of the results, the anamnesis form, bioimpedance, and measurements with a simple measuring tape were used. Images were taken using an Apple 14 Pro Max cell phone. These images were taken before the procedure, with the volunteers in anterior, posterior, right profile, and left profile positions. The distance maintained for each image was 150 centimeters.

The treatment protocol developed began with nutritional assessment and bioimpedance analysis. The device used was the Omronn, where the volunteers were instructed to fast for 2 hours, not consume caffeine, not perform intense physical activity, and not use body creams so as not to interfere with the examination.

Perimetry consists of measuring the abdominal circumference in an orthostatic position with the aid of an inelastic measuring tape at 3 points: 2.58 cm above the umbilical scar, on the line of the umbilical scar, and 2.5 cm below the umbilical scar. The treatment protocol consisted of 1 session of localized static cryolipolysis for 2 hours, with perfusion performed 80 minutes. After 15 days, auxiliary electrolipolysis protocols were introduced, lasting 1 hour (frequency of 10 Hz) followed by 40 minutes of Russian current (carrier frequency of 2500 Hz, frequency

modulated at 30 Hz, active cycle 50% synchronized mode in the same region with the parameters rise 4 seconds, on 4 seconds, decay 2 seconds and off 1 second). These were performed over 2 weeks for a total of 4 sessions. The procedure is completely non-invasive and therefore the volunteers can return to their ADLs (activities of daily living) immediately.

Bioimpedance:

A resource used for evaluation, it shows the reduction in measurements due to loss of localized adiposity, as well as the percentage of body fat, water, and weight of organs and bones.

It is an evaluative method that determines the quantity of body mass and water quickly and accurately, being non-invasive, portable, easy to handle, with good reproducibility and therefore viable for clinical practice and studies. Through a single frequency (50 kHz), or multi-frequency (frequency from 5 to 1000 kHz), the equipment fires an imperceptible electrical current through the body via two pairs of electrodes. Because fat cells have a lot of resistance to electrical current, it becomes possible to determine the amount of abdominal fat using the formula (TBW = $6.69 + 0.34573 \times \text{height}^2 / 100 + 0.17065 \times \text{weight} - 0.11 \times \text{age} + 2.66 \times \text{sex}$).

The use of this examination is necessary to monitor the weight reduction of fat mass during a weight loss treatment.

Perimetry, on the other hand, is an evaluation method using an inelastic measuring tape to measure abdominal circumferences (supraumbilical, umbilical, and infraumbilical) that denotes changes in body fat after weight loss.

3. Location, period, and sample:

The patients involved in the study were sampled by convenience, totaling 5 female participants, aged between 20 and 48 years, who underwent the procedure at the Lilian Lucy clinic, located in the municipality of Maringá/PR, between August and September 2025.

III. Data analysis:

For data analysis, the R Core Team software (2025) was used, where summary tables of the measured metrics of the patients were constructed, graphs were created, and the non-parametric paired Wilcoxon test was performed to compare medians (before x after). The non-parametric test was chosen due to the small sample size (N = 5), and the paired method is recommended in this case, where there are measurements over time for the same patient. The significance level considered was ,

because due to the small sample size, it becomes unfeasible to demand high precision in the statistical tests.

IV. Results and Discussion

The cryolipolysis technique (destruction of adipocytes through exposure to cold) has demonstrated a safe and effective reduction of subcutaneous fat without affecting adjacent tissues.

In this study, we chose to evaluate the associated effects of the technique, using electrolipolysis and Russian current. Because although it is considered a safe technique, there are several studies associating other aesthetic techniques with cryolipolysis.

It is common to associate therapeutic techniques to enhance results, although there are few studies that demonstrate the efficacy and risks of these associations (Borges, 2016).

Triglycerides stored in adipose tissue constitute 98% of all the body's energy reserves. Before triglyceride molecules can be metabolized to obtain energy, they must be broken down into glycerol and fatty acid, a process called lipolysis. From this principle comes the growing use of electrolipolysis in order to promote the reduction of localized fat.

Weight metrics show a relatively lower average in the period after the procedures, but indicate a greater standard deviation, varying between 81.6 to 98.6 in the "before" measurements and 77.9 to 97.6 in the "after" measurements. Lean mass showed an average falling from 24.02 to 23.54, but with a practically constant standard deviation between the two stages, varying between 23 to 26.3 "before" and 22.2 to 25.7 "after". The average fat percentage decreased from 41.04 to 39.52, however, the standard deviation increased from 5.08 to 5.84, varying between 36.8 to 49.4 "before" and 34.4 to 49.3 "after". The visceral fat index showed an average of 10.6 in the first stage and 10.2 in the second, with a standard deviation increasing from 1.67 to 1.92, and varying between 9

and 13 “before” and between 8 and 13 “after”. The average subcutaneous fat percentage decreased from 35.8% to 34.52%, with a standard deviation increasing from 4.1 to 4.76, and varying between 32.5 to 42.7 “before” and 30.5 to 42.6 “after”. The average protein rate found shows a slight increase, from 8.96 to 9.06, with the standard deviation going from 0.36 to 0.42, and varying between 8.6 to 9.4 “before” and 8.5 to 9.5 “after” (Table 1).

Variable	(before – after)			
	Mean	Standard Deviation	Minimum	Maximum
WEIGHT	86.38 - 84.1	6.98 - 7.9	81.6 - 77.9	98.6 - 97.6
LEAN MASS	24.02 - 23.54	1.33 - 1.39	23 - 22.2	26.3 - 25.7
FAT	41.04 - 39.52	5.08 - 5.84	36.8 - 34.4	49.4 - 49.3
VISCERAL FAT INDEX	10.6 - 10.2	1.67 - 1.92	9 - 8	13 - 13
SUBCUTANEOUS FAT (%)	35.8 - 34.52	4.1 - 4.76	32.5 - 30.5	42.7 - 42.6
PROTEIN RATE	8.96 - 9.06	0.36 - 0.42	8.6 - 8.5	9.4 - 9.5

The boxplots compare body measurements before and after the studied intervention, indicating a slight reduction in median body weight after the intervention, as well as a more drastic reduction in lean mass after the procedures, in addition to greater variability. Fat also shows evidence of substantial reduction, without many changes in variability. The visceral fat index indicates a reduction in median values, in addition to showing greater variability due to the emergence of values lower than the second quartile. The percentage of subcutaneous fat shows a similar distribution to that of fat, with a reduction in median values, but without major changes in variability. Finally, the protein rate shows high variability in both periods, but indicates that there was an increase after the procedures performed (Figure 1).

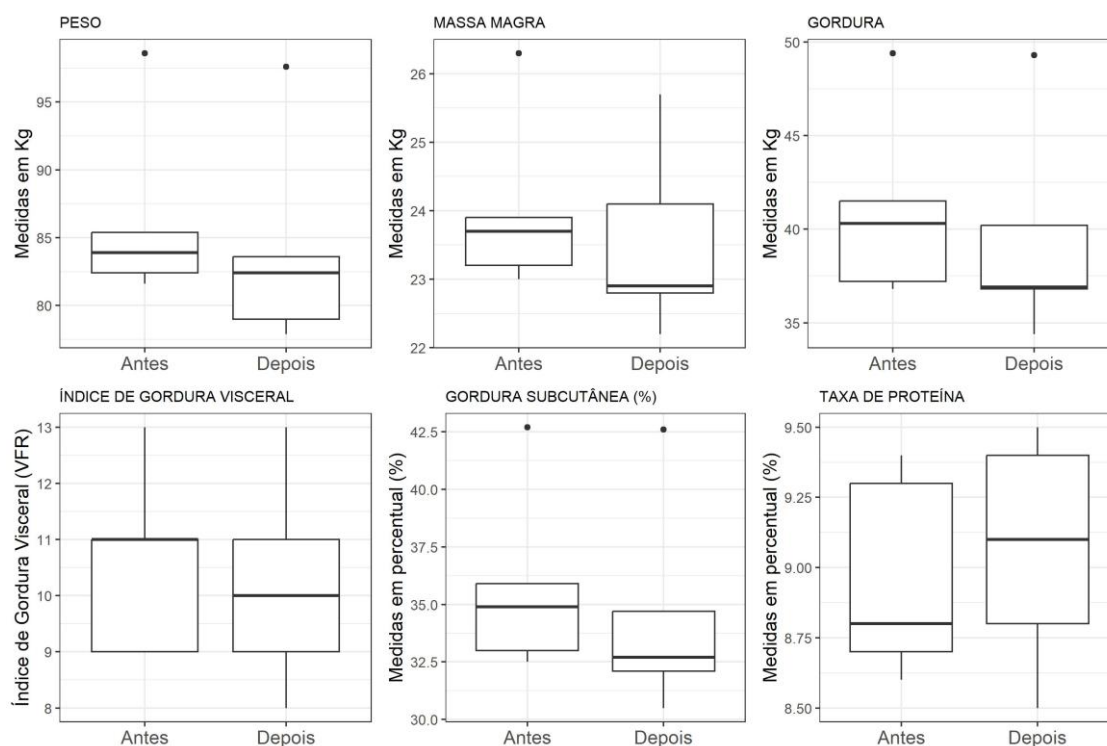


Figure 1: Boxplot of measurements before and after the patients

By comparing medians before x after, a significant difference is found in the measurements of fat and subcutaneous fat (%), and it is possible to say that, for these indicators, there was a significant reduction after the procedures performed, with the median fat decreasing from 40.3 to 36.9 and the percentage of subcutaneous fat decreasing from 34.9% to 32.7% (Table 2).

Table 2: Median comparison test between measurements before x after the patients

Variable	(before - after)	Statistic	p-value
	Median		
WEIGHT	83.9 - 82.4	10	0.1003
LEAN MASS	23.7 - 22.9	14	0.1040
FAT	40.3 - 36.9	15	0.0625
VISCERAL FAT INDEX	11 - 10	3	0.3457
SUBCUTANEOUS FAT (%)	34.9 - 32.7	15	0.0625
TAXA DE PROTEÍNA	8.8 - 9.1	1	0.2012

Note: Paired Wilcoxon test.

V. Conclusion

The combination of technologies in body aesthetic treatments allows for faster and more effective results, with fewer sessions and greater therapeutic safety. The combination of resources used showed effectiveness in reducing localized adiposity and body circumference.

The use of personalized protocols based on physiology and increasing the number of sessions may bring even more satisfactory results.

In addition to dietary monitoring and physical activity, these can also enhance the results.

Authors' participation

The second author contributed to the article's layout and corrections.

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