REVISTA CONTRIBUCIONES A LAS CIENCIAS SOCIALES

Evaluation of the efficacy of the combination of high intensity electromagnetic field and radiofrequency in promoting lipolysis

Avaliação da eficácia da combinação de campo eletromagnético de alta intensidade e radiofrequência na promoção da lipólise

Evaluación de la eficacia de la combinación de campo electromagnético de alta intensidad y radiofrecuencia para promover la lipólisis

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ABSTRACT
Introduction: The organization of skeletal muscle is complex, structured in distinct layers. This organization allows skeletal muscles to respond to electrical stimuli with precise and coordinated contractions. Muscle contraction occurs through responses to electrical stimuli sent by the brain

to the motor neurons in the muscle fiber, these stimuli can also be induced by technologies, one of which is the high intensity electromagnetic field, also known as the HIFEM current, leading to contractions considered to be supramaximal that cannot be achieved with normal contraction, resulting in muscle hypertrophy. Objective: This study aims to analyze the results of the combination of these technologies to reduce adipose tissue. Methods: This is a clinical, observational, cross-sectional study investigating the effectiveness of the combination of high-intensity electromagnetic field and radiofrequency technologies. The sample consisted of 6 volunteers. Conclusion: It is concluded that the combination of muscle contraction and radiofrequency technologies represents an innovative approach to fat burning, combining the efficiency of lipolysis promoted by muscle energy demand with the thermal effect of radiofrequency, reducing the thickness of the fat layer by 19.53%.

Keywords: radiofrequency therapy, magnetic field therapy, lipolysis, muscle contraction.

RESUMO

Introdução: A organização do músculo esquelético é complexa, estruturada em camadas distintas. Essa organização permite que os músculos esqueléticos respondam a estímulos elétricos com contrações precisas e coordenadas. A contração muscular ocorre por meio de respostas a estímulos elétricos enviados pelo cérebro aos neurônios motores na fibra muscular. Esses estímulos também podem ser induzidos por tecnologias, uma das quais é o campo eletromagnético de alta intensidade, também conhecido como corrente HIFEM, levando a contrações consideradas supramáximas que não podem ser alcançadas com a contração normal, resultando em hipertrofia muscular. Objetivo: O objetivo deste estudo é analisar os resultados da combinação dessas tecnologias para reduzir o tecido adiposo. Métodos: Este é um estudo clínico, observacional e transversal que investiga a eficácia da combinação das tecnologias de campo eletromagnético de alta intensidade e radiofrequência. A amostra foi composta por 6 voluntários. Conclusões: Conclui-se que a combinação das tecnologias de contração muscular e radiofrequência representa uma abordagem inovadora para a queima de gordura, combinando a eficiência da lipólise promovida pela demanda de energia muscular com o efeito térmico da radiofrequência, reduzindo a espessura da camada de gordura em 19,53%.

Palavras-chave: terapia por radiofrequência, terapia por campo magnético, lipólise, contração muscular.

RESUMEN

Introducción: La organización del músculo esquelético es compleja, estructurada en capas diferenciadas. Esta organización permite a los músculos esqueléticos responder a estímulos eléctricos con contracciones precisas y coordinadas. La contracción muscular se produce a través de respuestas a estímulos eléctricos enviados por el cerebro a las motoneuronas de la fibra muscular, estos estímulos también pueden ser inducidos por tecnologías, una de las cuales es el campo electromagnético de alta intensidad, también conocido como corriente HIFEM, dando lugar a contracciones consideradas supramaximales que no se pueden conseguir con la contracción normal, dando lugar a hipertrofia muscular. Objetivo: Este estudio pretende analizar los resultados de la combinación de estas tecnologías para reducir el tejido adiposo. Métodos: Se trata de un estudio clínico, observacional y transversal que investiga la eficacia de la combinación de las tecnologías de campo electromagnético de alta intensidad y radiofrecuencia. La muestra consistió en 6 voluntarios. Conclusiones: Se concluye que la combinación de tecnologías de contracción muscular y radiofrecuencia representa un enfoque innovador para la quema de grasa, combinando la eficacia de la lipólisis promovida por la demanda de energía muscular con el efecto térmico de la radiofrecuencia, reduciendo el espesor de la capa de grasa en un 19,53%.

Palabras clave: terapia de radiofrecuencia, terapia de campo magnético, lipólisis, contracción muscular.

1 INTRODUCTION

The search for body definition and contour has been growing over the years, and is directly associated with muscles and their toning (Katz, 2020). The organization of skeletal muscle is complex, structured in distinct layers and functional components that facilitate its ability to contract and move. The outermost layer, the epimysium, is made up of dense connective tissue, which surrounds the entire muscle, providing protection and support, as well as facilitating the transmission of forces to the skeleton. Below the epimysium is the perimysium, a layer of connective tissue that surrounds and separates the muscle fascicles, which are groups of muscle fibers. Within each fascicle, each individual muscle fiber is surrounded by the endomysium, a thin layer of tissue that facilitates the exchange of nutrients and metabolic waste. The muscle fibers, in turn, contain the essential contractile components: the myofibrils. These are made up of sarcomeres, the basic functional unit of muscle, which are organized into actin and myosin filaments. This organization allows skeletal muscles to respond to electrical stimuli with precise and coordinated contractions, essential for all movement and support of the human body (Huxley, 1974; Lieber, 1992).

Muscle contraction occurs in response to electrical stimuli sent by the brain to the motor neurons in the muscle fiber (Lamsfuss *et al*., 2021). These stimuli can also be induced by technologies, one of which is the high-intensity electromagnetic field, also known as the HIFEM current, where stimulation of motor neurons occurs, leading to contractions considered to be supramaximal that cannot be achieved with normal contraction, resulting in muscle hypertrophy (Ducan *et al*., 2020).

Muscle can be classified based on the histochemical or biochemical characteristics of its fibers, dividing them into two main groups. Type I fibers are slow twitch, using predominantly oxidative metabolism, which makes them aerobic and more resistant to fatigue. On the other hand, Type II fibers can be subdivided into Type II A and Type II B. Type II A fibers are intermediate, with both aerobic and anaerobic characteristics, and use glycolytic-oxidative metabolism. Type II B fibers, on the other hand, are fast twitch, operating through glycolytic metabolism, which makes them anaerobic and less resistant to fatigue, being associated with strength and speed. This allows for a better understanding of the functionality of muscles in different types of activity (Powers *et al*., 2005). With this in mind, the muscle contraction of each of the fibers can vary depending on the frequency used, with a lower, continuous frequency of 20 to 30Hz to simulate low-intensity, long-duration exercise, activating the Type I endurance fiber, or higher frequencies of 40 to 150Hz to simulate explosive activities, thus activating the Type II fibers (Scott *et al*., 1998) (Evangelista *et al*., 2009).

The combination of this muscle contraction technology with the technology that leads to fat lipolysis has also been studied. Radiofrequency technology operates between 30 KHz and 300 MHz, producing heat through the oscillation of molecules as they propagate within the tissue (Ducan *et al*., 2020). It is possible that the two technologies could be combined in a single gauntlet, with the following technologies being activated simultaneously.

This association results in the contraction of the selected fiber, depending on the programmed frequency, and consequent lipolysis of fat by means of heat. In the end, this leads to a faster reduction in the layer of adipose tissue and faster muscle definition. With this in mind, the aim of this study was to analyze the results of combining these technologies to reduce adipose tissue.

2 METHODOLOGY

The sample consisted of 6 individuals. To take part in the study, the individuals had to be between 20 and 35 years old; agree to take part in the study and sign the informed consent form; have abdominal adipometry between 15 and 25mm, self-report (according to a health declaration): no contraindications to the electromagnetic field and radiofrequency. Individuals who had undergone surgical or non-surgical aesthetic procedures in the region within 6 months, pregnant or breastfeeding women and people with sensitivity disorders were excluded.

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2.1 PROCEDURES

For individuals who met the inclusion criteria, a body assessment was carried out and photographs were taken of these volunteers before and after the treatment using the QuantifiCare LifeViz® 3D camera. Muscle thickness and fat layer were also assessed using the InLayer US10 portable ultrasound in the abdominal region and measurements were taken with a tape measure in the abdominal region.

After the protocol was started with the groups, the Body health® Supreme Pro equipment was used, the volunteers used the equipment in Expert mode, and the parameters of F^1 at 05Hz, F^2 40 to 50Hz and F^3 from 20 to 30Hz and radiofrequency between 60 to 75% respecting the sensitivity of the volunteer. The intensity was adjusted in each session according to the sensitivity of each volunteer, and could vary from 1 to 100%. Eight sessions were carried out, twice a week, after 60 days the volunteers were invited to return to reevaluate the long-term results.

3 RESULTS

The initial sample consisted of 6 volunteers. However, two individuals were excluded for not attending all sessions. As a result, the final sample consisted of 4 volunteers.

Table 1 presents the sample characterization data. It is noted that all individuals are female, with an average age of 26.75.

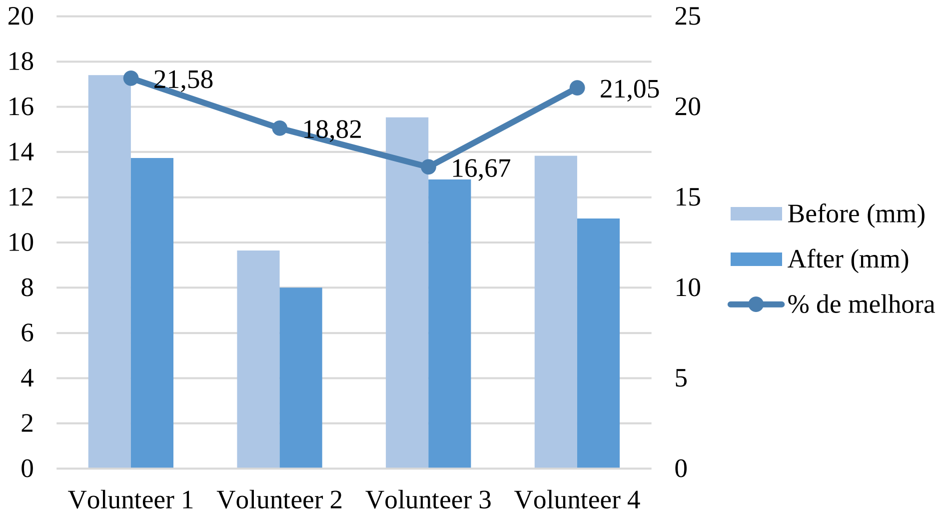
Table 1. Sample characterization data

Variable	
Gender (F)	4
Age (years)	26.75 2.95

Data presented by number or mean standard deviation.
Source: Prepared by the authors

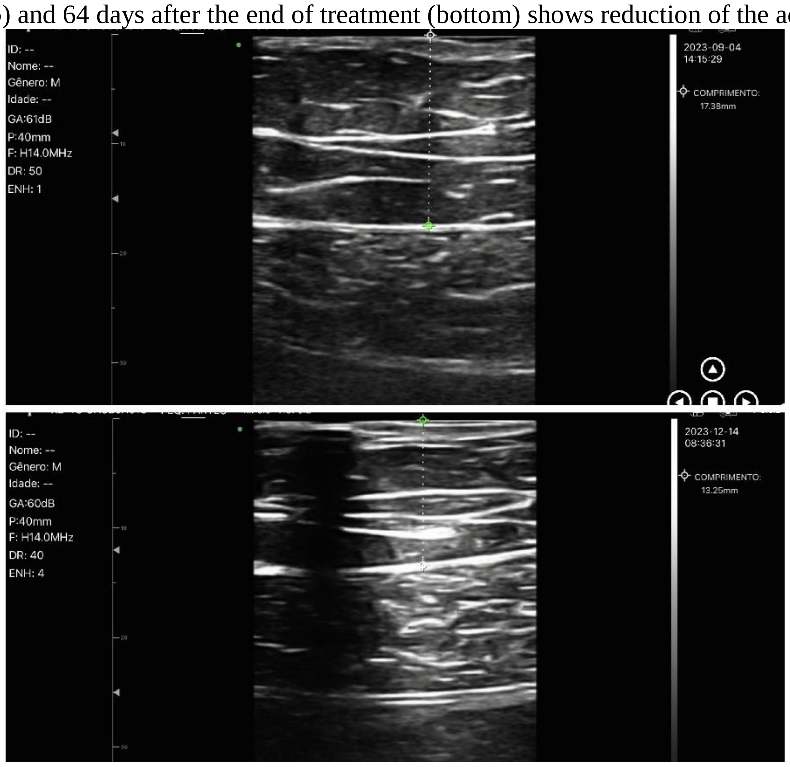
Dermal ultrasound data were collected before and 60 days after the procedure. When analyzing the results, the thickness of the fat layer was assessed, showing an average reduction of 19.53% in the fat layer in the volunteers.

Graph 1– Reduction of the fat layer



Source: Prepared by the authors

Figure 1. Ultrasound of representative assessment of the thickness of the lower right layer. Fat thickness at baseline (top) and 64 days after the end of treatment (bottom) shows reduction of the adipose layer.



Source: Prepared by the authors

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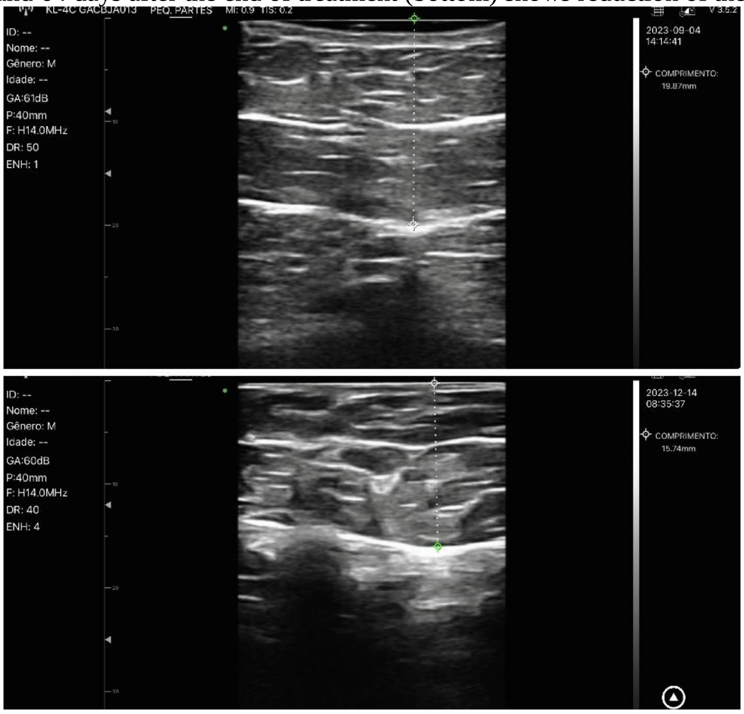
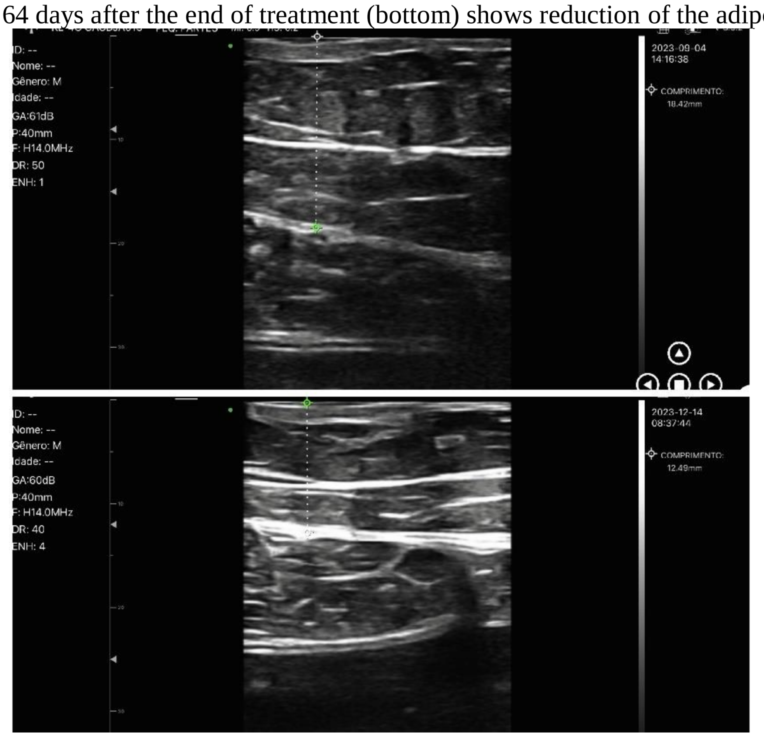
Figure 2. Ultrasound of representative assessment of the thickness of the central lower layer. Fat thickness at baseline (top) and 64 days after the end of treatment (bottom) shows reduction of the adipose layer.



Source: Prepared by the authors

Figure 3. Ultrasound of representative assessment of the thickness of the lower left layer. Fat thickness at baseline (top) and 64 days after the end of treatment (bottom) shows reduction of the adipose layer.



Source: Prepared by the authors

Graph 1 shows the before and after data on muscle thickness, assessed by dermal ultrasound. It can be seen that before treatment the thickness of the fat layer was significantly greater. After the application of 8 sessions of electromagnetic current associated with radiofrequency, an average reduction of 19.53% of the fat layer was observed when reassessed 60 days after the end of treatment.

Figures 1, 2 and 3 illustrate the measurement of the thickness of the fat layer in the lower abdomen region before and after treatment. It can be seen that the volunteer presented a significant reduction in fat thickness after 64 days of completing the treatment. The volunteers also reported a suggestive increase in muscular resistance when performing physical activities, suggesting an increase in physical fitness. These results suggest a favorable trend towards the use of electromagnetic current associated with radiofrequency to obtain a greater reduction in fat in a short period of time, with effects that remain for some time after the end of the treatment.

4 DISCUSSION

Fat lipolysis is a fundamental metabolic process for reducing body fat, especially in the context of physical exercise and aesthetic treatments. In aesthetic treatments with technologies, HIFEM current and radiofrequency stand out, since lipolysis is promoted in a non-invasive manner. The electromagnetic current induces supramaximal muscle contractions that are not achieved through conventional exercises, stimulating a high energy demand. This high energy demand facilitates the use of circulating free fatty acids (FFA) and intramuscular triglycerides as primary sources of energy, leading to the reduction of the body's fat reserves. Radiofrequency, in turn, generates heat in the subcutaneous tissues, increasing the local temperature and promoting the mobilization of triglycerides stored in the fat cells, facilitating their breakdown into fatty acids and glycerol, which are then used as energy. (Ducan *et al.*, 2020). Estudos mostram que, em situações onde há redução de glicogênio muscular, os lipídios tornam-se o substrato energético preferencial (Lima-Silva *et al.*, 2007).

The combination of electromagnetic field and radiofrequency used in this study suggests an effective approach to optimize fat burning. While supramaximal muscle contraction induced by electromagnetic current increases energy demand and consequently the use of lipids as an energy source, radiofrequency facilitates the breakdown of fat deposits, making them more accessible for oxidation. This combination not only promotes local lipolysis, but may also have systemic effects on fat metabolism, leading to a more efficient and generalized reduction of body fat. The thermal effect of radiofrequency may also induce adipocyte apoptosis, providing a more prolonged and sustained reduction of adipose tissue.

The results of this study indicate that the combined use of electromagnetic current and radiofrequency is effective in reducing the subcutaneous fat layer and in muscle definition. The combination of the two technologies promotes both muscle contraction and lipolysis, demonstrating a synergistic effect that can lead to a faster reduction in the adipose tissue layer and an increase in muscle tone.

The study used intermediate frequencies of electromagnetic current, aiming to target type II A muscle fibers, which predominantly use glycolytic-oxidative metabolism. Type II A fibers have mixed characteristics, being able to support both endurance and explosive activities, which makes them ideal for medium-intensity exercises of prolonged duration. During the contraction of these fibers, there is an initial mobilization of muscle glycogen, followed by the use of lipids as an energy substrate as glycogen reserves are depleted (Powers *et al.*, 2005; Evagelista *et al.*, 2009).

Data analysis reveals that after 8 treatment sessions, there was an average reduction of 19.53% in the thickness of the fat layer among the volunteers, as assessed by dermal ultrasound. This decrease is attributed to the activation of muscle fibers and lipolysis promoted by radiofrequency. Radiofrequency technology, operating between 30 kHz and 300 MHz, generates heat through the oscillation of molecules in the tissue, facilitating the breakdown of triglycerides and the use of lipids as an energy source during glycogen depletion (Ducan *et al.*, 2020).

Finally, this study contributes to the understanding of the strategic use of different stimulus frequencies for the activation of specific muscle fibers, as well as the use of combined technologies in aesthetic treatments aimed at muscle definition and fat reduction. Future studies can explore variations in frequency and intensity parameters, as well as the inclusion of different populations, to validate and expand these findings.

5 CONCLUSION

It is concluded that the combination of muscle contraction and radiofrequency technologies existing in the Supreme Pro equipment represents an innovative approach to fat burning, combining the efficiency of lipolysis promoted by muscle energy demand with the thermal effect of radiofrequency, reducing the thickness of the fat layer by 19.53%. This non-invasive method can be a viable and effective alternative for individuals looking to reduce localized fat and improve muscle definition, especially when traditional methods such as diet and exercise are not enough to achieve the desired results. In addition, the volunteers' report of a suggestive increase in muscular endurance during physical activity indicates a possible improvement in physical conditioning. Future studies are recommended to confirm these effects and further explore the benefits of this approach.

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