Periódico Multidisciplinar da Área da Saúde
ISSN 2764-4006 Publicação online | Prefixo DOI 10.55703
www.revistacientificaipedss.com

ANALYSIS OF THE EFFECTS OF HIGH-INTENSITY ELECTROMAGNETIC CURRENT COMBINED WITH RADIOFREQUENCY ON MUSCLE STRENGTH GAIN THROUGH SURFACE ELECTROMYOGRAPHY

Authors: Natchely Estefane Vieira Perdigão[1], Bruna Caroline de Jesus Marinho[2], Graziele Maia Alves Serafim[3]
Corresponding Address: natchelyvp@gmail.com
Publication Date: August 8, 2025
DOI: 10.55703/27644006050119

ABSTRACT

Introduction: The search for non-invasive techniques to improve muscle strength and reduce localized fat has intensified. The combination of High-Intensity Electromagnetic Current and Radiofrequency technologies stands out by inducing supramaximal contractions and controlled heating, simultaneously promoting benefits in muscle functionality and the reduction of localized adiposity. **Objective:** This study aims to evaluate the effectiveness of high-intensity electromagnetic current combined with radiofrequency for muscle strength gain. **Methods:** The research was based on an experimental, qualitative, and quantitative study with 12 volunteers between 20 and 40 years of age, who presented localized abdominal adiposity and were healthy individuals, i.e., without active pathologies. Abdominal muscle strength assessment was carried out using a surface electromyography device, and reductions in abdominal measurements and subcutaneous fat thickness were also analyzed using anthropometric precision, photographs, and dermal ultrasound. These assessments were performed before and after treatment. The volunteers underwent two weekly sessions of 30 minutes, over a period of 4 weeks. The collected data were statistically analyzed to determine whether there were significant differences in electromyographic reports, measurements, and fat thickness before and after treatment. **Results:** The analysis revealed a significant increase in abdominal muscle strength, with an average rise of 58.7% in peak electromyographic values, in addition to an average reduction of 1.32% in abdominal circumferences. All participants showed overall improvement in muscle performance after applying the protocol. **Conclusion:** The combination of High-Intensity Electromagnetic Field and Radiofrequency proved to be effective as a non-invasive method for muscle strengthening and body contour improvement, demonstrating potential for clinical application.

KEYWORDS: Muscle strength; Muscular endurance; Electromagnetic field; Localized fat; Radiofrequency.

INTRODUCTION

The increase in muscle strength and body composition are essential for health and well-being, directly influencing quality of life, mobility, and physical performance of individuals. While the increase in muscle strength and endurance is fundamental for maintaining overall body functionality, the reduction of body fat has been widely desired for its aesthetic implications and for reducing risks associated with various metabolic conditions [1].

Muscle tissue is electrically excitable, which means it responds to electrical stimuli by generating action potentials that lead to muscle contraction, to an even greater extent than voluntary contractions. Thus, when stimulated by technologies such as High-Intensity Electromagnetic Current, muscles undergo supramaximal contractions induced by electromagnetic fields that act directly on neuromuscular tissue [2].

During supramaximal contractions, muscles trigger structural and metabolic adaptations. These adaptations include strengthening of muscle fibers, increasing energy reserves, and contributing to endurance and functionality, making them more resistant to exertion. Furthermore, muscles require large amounts of energy to sustain activity, initially obtained from muscle glycogen stores. When these stores become insufficient, the body begins mobilizing fat stored in adipocytes (fat cells). Triglycerides are then broken down into free fatty acids and glycerol, which are released into the bloodstream and used as fuel to meet the high energy demand. With the continuous use of fatty acids as an energy source, the volume of adipocytes is ultimately reduced [3].

In addition, associated Radiofrequency (RF) induces controlled selective heating that alters adipocyte metabolism and causes thermal damage leading to apoptosis. This natural process allows adipocytes to be gradually eliminated through the lymphatic system, resulting in reduced fat volume and body contour remodeling [4,5].

Therefore, with the advancement of non-invasive technologies, the combination of High-Intensity Electromagnetic Current and Radiofrequency technologies has shown promise in the simultaneous treatment of muscle strength gain and localized fat reduction. Hence, this study is justified by the need to investigate the effectiveness of this association, providing new evidence that can be applied in clinical and aesthetic practice.

METHODOLOGY

Type of Study

This is a case study of an experimental, qualitative, and quantitative type, conducted between February and June 2025, after approval by the Research Ethics Committee of Hospital Mater Dei – MG under opinion number 7.313.220 and after the signing of the Free and Informed Consent Form by the study volunteers. It was carried out at the Research and Development Department of the company Contourline Equipamentos Médicos e Diagnósticos Ltda, headquartered in the city of Sete Lagoas, Minas Gerais.

Sample

The sample consisted of 12 volunteers of both sexes, who underwent an evaluation for selection according to the inclusion categories. For inclusion criteria, participants had to be between over 20 and 40 years old, sedentary or not, with a BMI less than or equal to 29.9/30, and be healthy individuals (without joint, cardiac, pulmonary, hepatic, and/or renal pathologies).

Procedures

The volunteers were informed about the procedure to be performed and then underwent anamnesis, during which general information for evaluation was collected, in addition to anthropometric measurements, electromyographic analysis, and photographic records.

Anthropometric measurements were taken by measuring abdominal circumference using a measuring tape, with the volunteers standing upright, upper limbs crossed in front of the body. Measurements were taken at the umbilical scar and two other areas: lower abdomen and upper abdomen, 5 cm above and 5 cm below the umbilical scar.

For the electromyographic analysis of the abdominal muscle, the volunteers were positioned in the supine position. Disposable surface electrodes were placed over the rectus, transverse, and oblique abdominal muscles, according to the recommendations of the NewMiotol equipment manual and standardized electromyographic protocols. A reference electrode was fixed to the iliac crest to minimize noise in the recorded signal. The equipment was configured to record muscle electrical activity at rest and during the execution of specific isometric contraction movements, in 3 sets of 15 seconds.

Finally, photographic records were taken in a predetermined location, with the camera parallel to the floor and the volunteer positioned on the rotating platform for image capture.

In the supine position, the volunteers received the application of High-Intensity Electromagnetic Current associated with Radiofrequency in the anterior abdominal region, twice a week. The application time was 30 minutes per session, over 4 weeks, totaling 8 sessions. The equipment was used in Expert mode, with parameters of F¹ at

20Hz, F² at 40Hz, and F³ at 20Hz, and radiofrequency between 70% and 85%, respecting the volunteer's sensitivity.

Data Analysis

Quantitative analysis was performed based on the values obtained for each participant in the pre- and post-intervention moments. To evaluate muscle strength gain, a composite index was adopted based on the average percentages of improvement observed in the electromyographic parameters of peak, mean, and integral contractions. The choice of these three indicators aimed to contemplate different dimensions of muscle function, encompassing the ability to generate maximum force (peak), maintain force during contraction (mean), and the summation of electrical activity over time (integral). Furthermore, the contraction peak was defined as the highest amplitude value recorded during each test, and the average of the three values was used for individual analysis.

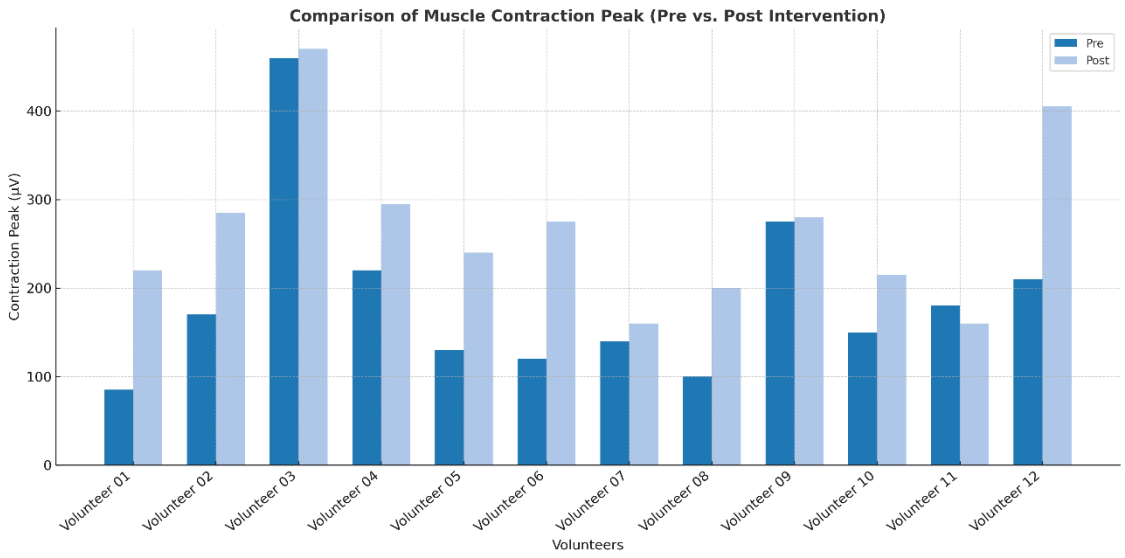
The photographic records were analyzed using the Life Viz® application, a photographic system composed of the QuantifiCare camera, chosen due to the possibility of standardizing specific angles, enabling faithful three-dimensional evaluation of body structures and comparison of photographs, without any possibility of image editing.

RESULTS

A total of 12 individuals were included in this study, which aimed to evaluate the effects of *Supreme Pro*® (High-Intensity Electromagnetic Current associated with Radiofrequency) on abdominal muscle strength gain. The treatment protocol was carried out between February and June 2025, comprising eight sessions applied twice a week.

The contraction peak variable, obtained through surface electromyography, representing the maximum force generated during muscle contraction, showed a relevant increase in almost all participants. The overall mean of individual gains was 58.7% compared to baseline values, with some volunteers reaching elevations greater than 160%. Visually, it can be observed (Graph 1) that the vast majority of participants presented an increase in post-intervention values, evidencing the effectiveness of the protocol in increasing maximum muscle strength. Only one volunteer showed a slight reduction in post-intervention peak, confirming the predominant trend of positive response in the analyzed sample.

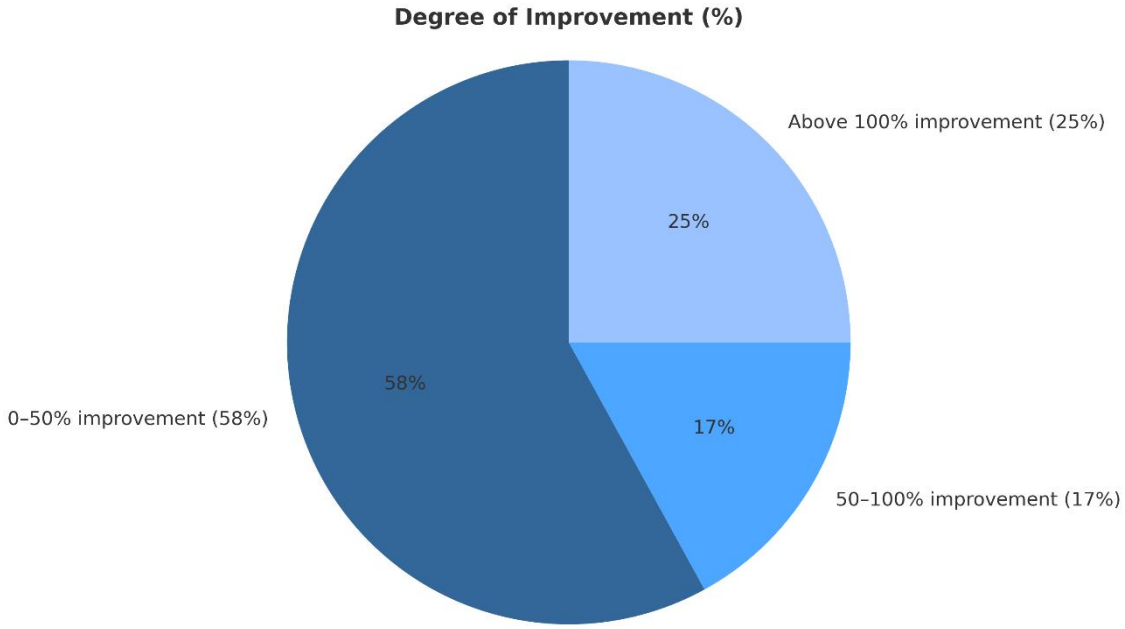
Graph 1 – Comparison of the Contraction Peak Variable (Maximum Strength) before and after intervention.



Source: Prepared by the authors.

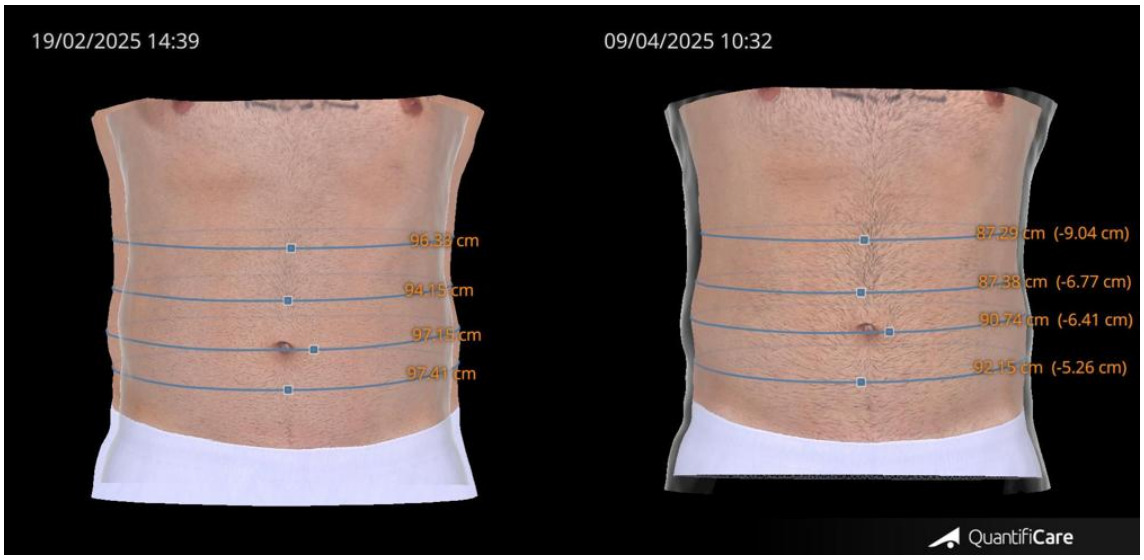
Considering the composite index of the three muscle strength metrics (peak, mean, and integral), all volunteers showed a positive response to the protocol, evidencing an overall improvement in muscle performance, even though specific variations were observed in isolated parameters. As illustrated (Graph 2), 58% of the participants showed overall improvement between 0 and 50%, while 17% achieved gains between 50% and 100%. It is noteworthy that 25% of the participants demonstrated an increase greater than 100% in the composite muscle strength index. No cases of performance reduction were recorded after the intervention.

Graph 2 – Distribution by degree of global improvement (%).



In addition to the increase in muscle strength, a reduction in abdominal anthropometric measurements was observed in most participants. The mean percentage reduction in abdominal circumference (lower abdomen, umbilical scar, and upper abdomen) was -1.32%, while individual cases presented decreases greater than -4.50% in specific regions (Figure 1). This finding reinforces the potential of the protocol not only for muscle strengthening but also for body contouring and subcutaneous fat reduction.

Figure 1 – Analysis of abdominal anthropometric measurements before and after treatment.



DISCUSSION

The association of high-intensity electromagnetic field with radiofrequency (RF) represents a relevant innovation in muscle strengthening, integrating physiological mechanisms that optimize structural and functional adaptations of skeletal muscle tissue. The stimulation promoted by the electromagnetic field is capable of inducing supramaximal muscle contractions, with the fiber recruitment pattern being strongly influenced by the frequency (Hz) of the stimulus applied. In the present study, the protocol used corroborates the preferential activation of type II (fast) fibers, which are associated with the generation of maximum strength and muscle power.

Regarding the median frequency variable, used as an indicator of muscle endurance, a reduction was observed in 10 of the 12 participants (Table 1). This finding is physiologically compatible with protocols focused on strength gain, which prioritize the recruitment of type II muscle fibers that are more efficient in generating maximum force, but naturally less resistant to fatigue. Thus, the decrease in median frequency does not represent an adverse effect but rather an expected electromyographic response due to the type of stimulus applied.

This was also described by De Luca (1984), who identified the progressive reduction in the median frequency of the EMG signal during sustained contractions, attributed both to the predominant recruitment of fast fibers and to the reduction in muscle conduction velocity resulting from the development of local fatigue.

Table 1 – Median frequency data before and after intervention with Supreme Pro and percentage change.

Volunteer	Before intervention (Hz)	After intervention (Hz)	Difference	Percentage change (%)
Volunteer 01	150.76	93.67	-57.09	-37.9%
Volunteer 02	117.29	97.41	-19.88	-16.9%
Volunteer 03	138.92	128.56	-10.36	-7.5%
Volunteer 04	100.42	99.41	-1.02	-1.0%
Volunteer 05	101.07	101.65	+0.57	+0.6%
Volunteer 06	95.01	74.50	-20.52	-21.6%
Volunteer 07	132.97	114.28	-18.69	-14.1%
Volunteer 08	99.77	90.33	-9.44	-9.5%
Volunteer 09	133.67	125.75	-7.91	-5.9%
Volunteer 10	116.56	72.61	-43.94	-37.7%
Volunteer 11	126.41	146.59	+20.18	+16.0%
Volunteer 12	114.17	91.92	-22.25	-19.5%

Source: Prepared by the authors.

In addition to the effects observed on muscle strength, a reduction in abdominal circumference was also verified. This finding can be attributed to the synergy between the high-intensity electromagnetic field, responsible for inducing supramaximal muscle contractions and increasing local metabolism, and radiofrequency, which raises the temperature of subcutaneous tissues and enhances lipolysis. These effects were also suggested by Mulholland and Paul (2011) and Weiss et al. (2013), who reported that combined protocols can simultaneously promote muscle hypertrophy and subcutaneous fat reduction.

CONCLUSION

Based on the results obtained, this study demonstrated that the combination of High-Intensity Electromagnetic Field and Radiofrequency technologies represents a promising and non-invasive treatment for muscle strengthening and body contouring of the abdominal region. The results showed statistically significant increases in muscle strength parameters assessed by surface electromyography, as well as relevant percentage reductions in the abdominal circumferences of the participants, corroborating the potential of the protocol both for functional muscle enhancement and for improvement of body contour.

REFERENCES

1. Pereira MIR, Gomes PSC. Testes de força e resistência muscular: confiabilidade e predição de uma repetição máxima – Revisão e novas evidências. *Rev Bras Med Esporte*. 2003;9(5):325–35. https://doi.org/10.1590/s1517-86922003000500007

2. Jones DA, Bigland-Ritchie B, Edwards RH. Excitation frequency and muscle fatigue: mechanical responses during voluntary and stimulated contractions. *Exp Neurol*. 1979;64(2):401–13. https://doi.org/10.1016/0014-4886(79)90279-6

3. Kennedy J, Verne S, Griffith R, Falto-Aizpurua L, Nouri K. Non-invasive subcutaneous fat reduction: a review. *J Eur Acad Dermatol Venereol*. 2015;29(9):1679–88. https://doi.org/10.1111/jdv.12994

4. Zarkovic D, Kazalakova K. Repetitive peripheral magnetic stimulation as pain management solution in musculoskeletal and neurological disorders – A pilot study. *Int J Physiother*. 2016;3(6). https://doi.org/10.15621/ijphy/2016/v3i6/124739

5. Mulholland RS, Paul MD, Chalfoun C. Noninvasive body contouring with radiofrequency, ultrasound, cryolipolysis, and low-level laser therapy. *Clin Plast Surg*. 2011;38(3):503–20. https://doi.org/10.1016/j.cps.2011.05.002

6. De Luca CJ. Myoelectrical manifestations of localized muscular fatigue in humans. *Crit Rev Biomed Eng*. 1984;11(4):251–79. PMID: 63918147.

7. Weiss RA, Bernardy J. Induction of fat apoptosis by a non-thermal device: Mechanism of action of non-invasive high-intensity electromagnetic technology in a porcine model. *Lasers Surg Med*. 2019 Jan;51(1):47–53. doi: 10.1002/lsm.23039. Epub 2018 Dec 14. PMID: 30549290; PMCID: PMC6590311.